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National Safety Congress
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**CONSTRUCTION
INDUSTRY and
PUBLIC
EMPLOYEE**



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Papers Delivered in the

CONSTRUCTION AND PUBLIC EMPLOYEES SESSIONS

Five Years of Future Dates for the National Safety Congress.....	4

CONSTRUCTION SESSIONS

Report of Year's Activities.....	Earl W. Wheeler	5
Protection Against Trench Failures.....	William C. Land	6
Safe Use of Explosives in Construction.....	M. M. Champlin	10
What's Wrong With Construction Safety in the United States.....	Harry M. Philo	13
Vibration Measurement in Construction.....	Paul C. Hosking	15
How Owner and General Contractor Coordinate Safety on Multi-Contractor Jobs.....	Thomas J. Reynolds	19
Occupational Health in the Construction Industry.....	Fred Ottoboni	21
How To Foresee Tragic Accidents by Use of the High Potential Accident-Prone Situation Hazard Control Method.....	William W. Allison	26

PUBLIC EMPLOYEE SESSIONS

Safety in the Fire Service.....	John R. Travell	31
Ideas Regarding Safety in a Police Department.....	Maj. Adam Klimkowski	34
Pinpointing the Problem Through Electronic Data Processing	Calvin V. Pelto	35
The Protection of Work Crews on High-Speed Expressways.....	Melvin G. Lyell	37
Rotary Mower Guarding.....	Warren I. Hanson	38
Hazards Encountered by the Highway Engineer, Technician, and Inspector At Construction Sites and at Material Plants.....	E. D. Sulno	39
Upgrading a Highway Safety Program at a Minimum Expense.....	Mark Markson	42
Responsibilities of the Highway District Engineer to Employees' Safety	J. H. Phillips	44
Prevention and Control of Asphalt Heating Kettle Fires.....	John M. Fries	49
Can the Cardiac Be Safely Employed for Highway Work?.....	Harvey M. Kuester	50
The Phenomenon of Automobile Tire Hydroplaning.....	Adolph Fram	52
Power Mower Safety and Vegetation Control.....	Luther A. Tippery	54
Officers of the Construction Section 1967-68.....		59
Officers of the Public Employee Section 1967-68.....		62
Other Volumes in the 1967 National Safety Congress Transactions..	Back Cover	

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OCTOBER 28-31, 1968 / CONRAD HILTON HOTEL, CHICAGO

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1970

At the '68 Congress you can meet other safety people, with the same problems and responsibilities as yourself. You can exchange views and ideas on accident prevention, health, hygiene, and fire prevention... on safety in industry, traffic, school, at home and on the farm.

1971

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1972

This four-day educational program, planned and presented by the National Safety Council, can be your most thought-provoking, most worthwhile safety experience in 1968.

Make plans early to attend the 1968 Congress and bring the other people in your organization who have safety responsibilities.

FUTURE CONGRESS DATES

1968 October 28-31
1969 October 27-30
1970 October 26-29
1971 October 25-28
1972 October 23-26

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CONSTRUCTION SESSIONS

Report of Year's Activities

By EARL W. WHEELER

General Chairman

Safety Engineer, Naval Facilities Engineering Command, Washington, D. C.

The annual Construction Section Congress programs are planned and arranged by the Construction Section Executive Committee, consisting of 95 construction industry, government, insurance carrier, and union safety engineers, and others interested in construction safety.

In addition to planning and arranging these annual Congress programs, the members of the Executive Committee collaborate in the production of Construction Safety Data Sheets, safety releases, magazine articles, a monthly newsletter, five-minute safety talks, and various other safety materials which are published by the National Safety Council to support the accident prevention effort of the construction industry. This is the type of work done by the Executive Committee throughout the year.

Besides the Congress meeting, we hold two meetings, generally in February and in May each year, to consult and take stock of our progress and to reach agreements concerning what we can do for the future in improving the construction industry's accident prevention performance.

During the Council year 1966-1967 we completed two new Data Sheets; one on "Fixed Ladders and Climbing Devices" and one on "Vertical Shoring For Concrete Forms." These are presently being readied for printing. In addition, a first draft on a Data Sheet on "Bituminous Paving" has been prepared. This is a joint effort in collaboration with the Public Employees Section.

Fifteen "Construction Safety Releases" were published during the year. This is a continuing project, and I am sure as many, or more, will be published next year. We also issued a special publication on "Training Operators of Heavy Equipment" and a

special bulletin on "Construction Safety and Legal Liability."

The several working divisions and standing committees of the Construction Section are currently at work on various other publication projects which will be reported at Congress time next year.

I must make special mention of our accomplishment in acquiring new memberships in the Council. During the past year we gained 126 new members, for a net gain of 88 members. This is the largest net gain in membership in our history.

When I first joined the Executive Committee years ago, I was immediately impressed by the tremendous wealth of construction safety know-how in this group, and by the eagerness of these people to put their know-how to work—to make it count. This talent needed only to be organized, inspired, and directed.

We were blessed with exceptionally strong leaders in our division and standing committee chairmen this year, and this accounts in no small measure for the progress we have made. Furthermore, we have a wealth of such leaders among our working members to carry on for the future. I wish to congratulate and thank all of them for your outstanding performance during my tenure as your General Chairman.

During the past year, I have noted with pleasure a considerable intake of new members on our Executive Committee. This is healthy. It means we have been noticed and people want to be identified with us. To stay alive, to grow, to increase and improve its product, any organization needs a steady influx of new blood; new talent, new leadership. I see a bright future for the Construction Section.

PROTECTION AGAINST TRENCH FAILURES

By WILLIAM C. LAND

District Mgr., L. B. Foster Company, Pittsburgh, Pa.

In ancient times, laws were enacted to protect workmen against construction failures. A Persian king once ruled that "if a builder builds a wall and does not make its construction fair and the walls fall down and kill the owner, then the builder shall be put to death." While no one today would seriously advocate that kind of "eye for an eye and tooth for a tooth" legislation, we can't help but wonder what would be the judgment of the maimed and the crippled and the dead if they could speak.

This is a critically serious problem. A great deal has been written in legislation and in the press on trench shoring. It seems a lot of people are talking about it but evidently those most involved are not listening. Because of this, death and injury in the construction industry goes on.

Excavation failure is an important engineering problem that deserves the careful attention of the engineers, contractors, and public officials who are concerned with safety and public property. Accidents involving trench wall cave-ins are among the most common to be found in the construction industry.

If newspaper accounts are any guide, excavation cave-ins account for more than half of all construction deaths. Here are a few examples, chosen at random from the pages of the nation's press:

Pittsburgh, Pa.: "A contractor will face grand jury proceedings on an involuntary manslaughter charge in the death of one of his workers when a ditch caved in and crushed him to death. The trench had not been shored and workmen in the area had not been supplied with safety hats."

St. Louis, Mo.: "A worker was killed Friday when the side of a ditch in which he was working caved in and buried him. The coroner said the ditch did not require bracing because it was six feet deep and eight feet long."

San Diego, Calif.: "A 27 year old worker was killed yesterday when a sewer line ditch caved in on him. The employee was working in a 12 ft. ditch for relocation of a sewer pipe and was in that part of the ditch which had not been shored up..."

Ft. Wayne, Indiana: "Two young college students were killed in two sewer excavation cave-ins here yesterday. The two deaths prompted officials to order an immediate halt to all excavation projects in the county."

Springfield, Ohio: "A workman died in a township ditch cave-in Monday afternoon and charges of negligence were filed against the man's employer. There was no shoring in the trench and part of the bank next to a house gave way. The sheriff said he would launch an inspection of all such construction jobs in the county."

These are not isolated cases. Cave-in deaths and injuries are common occurrences in practically every part of the U.S.

To determine the nature, frequency and location of trench cave-ins, a pilot study was conducted by the L.B. Foster Company's research agency. Press clippings from 600 of the largest dailies in the U.S. were reviewed. Naturally, not every published item could be picked up in such a survey and, no doubt, countless accidents were never reported. Let us look at some of the results of the survey.

Trench cave-in accidents in the U.S. construction industry over a 24-month period ending June, 1967, have caused more than 125 reported deaths—tragedies referred to in a national business publication as "the least excusable of all construction accidents." It takes no expertise to know that the sides of a deep trench are likely to cave in and should be sloped or shored to protect workmen.

Although the study is based on only a portion of published trench accidents, it does serve to illustrate the seriousness of the situation. The study also indicates that shoring failure is not the main problem but that many accidents are caused by lack of any shoring at all.

In the survey, 21 states reported instances of death or injury by cave-ins. Injuries occurred with alarming frequency in Ohio, Indiana, Pennsylvania, and New Jersey. Ohio and Pennsylvania were highest in the number of reported deaths.

High injury and death rates were found to be most common in late summer and early fall, probably because of undue haste in

completing projects before cold weather set in.

What are the prime causes of all trench accidents? In the 24-month period, 35 per cent of the trenches were improperly shored; half had no shoring at all. Backfill placed too close to the edge of the trench accounted for 10 per cent of the trench accidents. Broken utility lines not considered in the planning stage of the operation were blamed for three per cent of the accidents. The remaining two per cent were caused by lack of proper safety warnings such as barricades or signs.

No one has more liability problems than a contractor. The tremendous costs involving injury and loss of life, spiralling insurance premiums and workmen's compensation benefits, law suits, downtime, clean-up and job delay penalties are a high price to pay for lack of protective shoring.

In most cases, potential cave-ins could have been spotted by a simple visual survey: unshored excavations; spoil pile too close to trench; shoring and bracing too far behind diggers; no ladders for getting in and out of trench; no steel sheet piling to supplement shoring and bracing in unstable soil; and lengthy delays in bracing installations to avoid interference with other construction work—all are obvious even to the casual observer. Supervisory personnel should check the earth for cracks, settling, unusual soil conditions, and determine the location of underground utility lines. Additional checks should be made as digging progresses.

Accident prevention is as much a part of job planning as the size and depth of a trench. In the pre-bid stage of a job, the contractor spends most of his time developing a competitive bid providing for all costs plus an adequate profit. Yet accidents still happen which are caused by lack of forethought or planning. There is usually a technical reason for a cave-in, but in the final analysis, lack of job planning is behind it.

The failure of some contractors to take reasonable precautions to prevent cave-ins can work hardship on the whole industry. Crash legislation enacted to correct an intolerable situation tends to freeze methods of operation with new standards that may be unduly burdensome to the contractor. Unless the industry wants more government control, contractors must develop methods of controlling hazards in trenching operations.

Common methods of shoring open cut

trenches fall under three different systems. Where the soil is stable and the trench is shallow, the use of struts which bear against vertical planks placed at intervals along the trench can be effective.

In soft clay or loose bearing sands, the use of lightweight or regular steel sheet piling may be required for continuous support. While steel piling is not foolproof—it also requires the proper use of waling and bracing—it has certain advantages over wood that compensate for its higher costs.

For example, wood has a sudden rupture point, whereas steel yields into failure. It takes about one-third of the time to drive steel sheet piling as it does an equal length of wood piling. Because steel sheeting ranges in thickness from one-eighth of an inch for the lightweight sections to three-eighths of an inch for the regular weight sections, a negligible void results when it is extracted. Wood, because of its large displacement factor, has to be left in place on many occasions, especially adjacent to existing utilities. Unlike wood sheeting, steel sheet piling requires little trimming, eliminating a related safety hazard.

Excavating between driven walls of steel sheet piling should be followed closely by the installation of cross braces. Wales and braces should be pre-cut and ready to install as soon as possible. Probably the most important thing to remember about trench braces, besides making sure they are structurally designed to do the job, is to leave them in place regardless of how much they might interfere with pipe-laying or other operations. If they must be removed, the sheet piling must be braced by some other means.

Braces should be installed in a level position and can be provided with cleats to keep them in place and simplify removal. Enough space should be left between braces to allow for the entry of pipe sections.

Where lightweight steel sheet piling requires upper and lower wales for lateral support, vertical posts are used to maintain wale positions. This is more economical than welding brackets on sheets to support wales, thus maintaining the condition of the sheets for other applications.

Where it is impossible to drive continuous steel sheeting, a third bracing system involving vertical H-beams and lagging may be used, commonly referred to as soldier beams and lagging. The H-beams, where required, are supported by a system of wales and

struts similar to that used in the sheeting system.

In designing such a bracing system, it is important that the bracing members have adequate strength, particularly the wales and struts. In some cases, a deep excavation may require as much steel, with as intricate a design, as a small bridge.

Other special equipment such as movable steel shields may be used effectively for bracing where they permit the excavation and backfilling to proceed close-in to actual pipe laying.

In summary, shoring should be considered before the earth is turned. Where soil is unstable, use the system that will do the best job to insure maximum safety at all times.

Because of its complexity, the building code system in the U.S. cannot be described simply. A building code is a collection or a system of minimum requirements for the construction, alteration, demolition, maintenance, and other activities related to buildings and structures. These requirements are designed to protect life, health, and property. The codes are not intended as descriptions of best designs and practices.

Adoption, administration, and enforcement of building codes traditionally has been the primary responsibility of local government. In the U.S., the state rather than the federal government is the source of legal authority to enact and enforce building codes. Many states delegate most of these powers to municipal governments. None of the states retain them fully. Various estimates indicate that at least 12,000 jurisdictions issue building permits or in other ways influence building practices.

However, there have been a number of programs and activities at both the state and federal levels of government that have a direct bearing on building codes and the regulation of building construction. These activities range from state minimum requirements for construction to the standards development programs for federal procurement and the Minimum Property Standards of the Federal Housing Administration.

Efforts to overcome the diversity of local code requirements have been undertaken by virtually every segment, public and private, of the building industry. The Federal government tried in the late 1920's to develop a single national building code. In recent years, four recognized model codes have

been widely used as the basis for the requirements of the local codes.

One of the model codes is sponsored by The American Insurance Association, the other three by organizations of local building officials, namely the Building Officials Conference of America, the International Conference of Building Officials, and Southern Building Code Congress.

Here are a few excerpts from the American Standard Safety Code for Building Construction under section 8, *trenches*:

The sides of all trenches which are four feet or more in depth and where the earth is not sloped to the angle of repose shall be securely held by timber bracing. The bracing shall be carried along with the excavation and must in no case be omitted unless the trench is cut in solid rock or hard shale.

All trenches four feet or more in depth shall at all times be supplied with at least one ladder for each 100 feet in length or fraction thereof. The ladder shall extend three feet from the surface of the ground.

Where a mechanical digger is used, the bracing shall be placed as close as possible (a maximum of six feet is recommended) to the end of the boom.

The bracing shall be held in place by screw jacks or by cross braces cleated and wedged in place. Where the width of the trench prevents this, the lower end of the cross brace shall bear against a footing in the earth at the bottom of the trench, providing adequate means are taken to keep it from kicking out.

When the sloping of trenches to the angle of repose does not extend to the bottom of the trench, the timbering shall be as required to support the vertical part of the trench. The sheeting shall extend not less than 12 inches above the bottom of the slope and, if necessary, toe boards shall be placed behind the timbering to prevent material from sliding into the trench. The surface of the slope shall be cleared of boulders, stumps or other hard masses of earth to eliminate the danger of their sliding into the trench.

Excavated material and superimposed loads shall not be placed nearer than 18 inches from the sides of the trench unless bracing has been installed and designed to withstand the load.

The safety code also lists recommended

timber dimensions for trenches of various widths and depths as well as for trenches with hydrostatic pressure. It also suggests that, where desired, steel sheet piling and bracing may be substituted for wood.

In addition to these codes, many construction firms use other standards such as the U.S. Army Corps of Engineers Safety Manual, Associated General Contractors Accident Prevention Standards for the construction industry, and the American Standards Association—now the U.S. American Standards Institute (USASI)—for the construction industry.

The importance of building codes as a tool for community development is better recognized today than in the past. The detrimental effects of having a large number of requirements are being greatly reduced by the tendency of the local codes to follow closely the requirements in one of the four model codes.

It is obvious, then, that there is available a variety of standards which, if followed on every excavation project, would drastically reduce death and injury. As our study indicated, however, many cave-ins result from total lack of shoring or from inadequate shoring rather than from "acts of God." On further investigation, it appears that many smaller municipal contracts involving open cut work do not even specify trench protection. Consequently to get the job, this may be the one cost the contractor omits to become the low bidder. He then omits shoring altogether or, in some cases, uses inferior methods and materials to keep costs down.

While the contractor or the specification writer may not realize it, materials are readily available which can do the job without undue expense. Steel sheet piling which can be rented eliminates tying up capital or the necessity for investing in inventory stocks. It is a fixed expense directly chargeable to the work in progress. The interlocking design joins piling sections tightly when driven.

This provides an almost watertight construction yet permits easy separation when the piling is pulled.

Elaborate rigs or special tools are not always necessary to drive sheet piling. Light jack hammers or small impact hammers can do many jobs, while larger hammers are available for the tougher jobs. You can also rent or purchase the vibratory driver extractors that have been setting high performance standards over the last four years. They have the added advantages of relative quiet operation, a significant benefit when working in residential areas and around hospitals.

So that all bids are maintained on an equitable basis, all excavation contracts should specify a basic shoring method. Contractors could then consider alternate methods of shoring as a means of becoming low bidder rather than eliminating or decreasing protective trench shoring.

As a result of my company's efforts in this direction, the building codes of Jacksonville, Florida, now require that any major excavation project in the downtown area include either steel sheet piling or an approved shoring system. It also requires that the contractor submit his proposed excavation and shoring plans for approval by the City Engineering Department before work begins.

Since the basic responsibility rests at the local community level, it is hoped these comments will serve to direct attention to this problem. I strongly urge that it be made standard operating procedure in all local governments to have someone trained in such matters carefully review all plans and contract details to insure that such shoring systems are specified and carried out on all excavation projects. To ignore such a precaution is to risk penalties that cannot be measured against the cost of even the most expensive protective shoring system. We have the tools and the know-how. Let us then get on with the job of saving lives.

SAFE USE OF EXPLOSIVES IN CONSTRUCTION

By M. M. CHAMPION

Technical Services Manager, Explosives Department,
E. I. du Pont de Nemours & Company, Wilmington, Delaware

The industries of construction utilize explosives in many widely differing ways. The permanent or almost permanent quarry locations use blasting products and techniques peculiar to the quarrying industry. The rock excavation work for roads and dams is another kind of blasting operation, and tunnel and shaft work and other underground excavations mean yet another set of products and techniques. Within these categories there are further variations. A particular road job may present special blasting safety problems in connection with electrical hazards or difficult logistics in guarding accesses to the blasting area. Another job may be fairly free of unusual hazards. No two jobs are just alike.

The safety of construction blasting is affected by many factors which are constantly changing. And yet this safety is still primarily governed by basic and fundamental considerations of sound practice and clear thinking. As we see the situation today, perhaps we can accomplish the most good for safety by discussing the changes and the fundamentals which surround blasting safety in your industries.

The amount of blasting done in our country increases steadily and greatly with the passing years. Therefore, the amount of commercial blasting products being used increases. Blasts are bigger and there are more of them than ever before. And most important, it becomes increasingly hard to carry on safe blasting in the growing congestion of the cities, highways and countryside.

Since there are more people, it is harder to blast without endangering life.

Since there are more blasting jobs, the need for blasting crews with the necessary skills, experience, and judgment sometimes gets ahead of the supply. Blasting without properly qualified people in charge is one of the most dangerous situations that can be imagined.

Among the changing factors contributing to safer blasting are the growth of the less sensitive explosives and blasting agents. The ammonium nitrate-oil blasting mixes have meant that the major quantity of explosive products on many jobs is much safer to store

and use than it used to be with cap-sensitive dynamites.

Now that the next development—the water gels and slurries—is proving so useful and effective, even the wet work and the very hard rock can be treated with these less sensitive products as well.

The ever-improving product quality in electric caps is far ahead of a few years ago. Reliability, safety from normal handling hazards, accuracy of the delay timing, etc., are importantly better, and adequate firing methods and equipment are making today's larger blasts with fewer misfires.

Computers have made it possible to design parallel electric blasting circuits popular in tunnel and shaft work in such a way that misfires due to insufficient current can be positively eliminated. This circuitry requires solution of simultaneous equations, one for each cap in parallel. Thus, a 100-cap round means 100 simultaneous equations to be solved, to design a distribution system with adequate energy for each cap. This was not done before computers, and rules of thumb and experience were relied upon, with less than complete success.

Today, the hazards resulting from high voltage arcing in parallel firing of delay electric caps can be eliminated with current-limiting devices. The erratic timing sometimes caused, the misfired hole, and the treacherous burning powder from arced caps need not occur. These are some of the product and technical trends toward safety.

Another change is in attitude. Safety has gained in stature and acceptance. Safety is recognized as a prime function of line organization. Each level of organization requires safe performance from the level below in proportion to the momentum supplied from above. In other words, if you don't actively and positively push for a safe operation, you will be lucky indeed to achieve it.

What are the factors detracting from safe blasting? Time is a major item. Even in these safety-conscious days, when we would all admit that time must be taken to permit a blasting job to be carefully done, it is still common to find the powderman rushed by

the clock. Adequate time can be planned into a job, and adequate crew to overcome unforeseen delays can allow the job to be done with care and thought. We repeat, *care and thought!*

Reviews of accident and incident records show a very interesting fact: the causes of explosives accidents these days are the same old violations of basic safe practices as years ago caused accidents. If there was a way to be sure, it would probably show that care and thought were absent in most cases when the incident occurred. Explosives on fire, lightning, flying rock from blasting, drilling into missed holes, beating on dynamite cartridges in blocked holes, failure to evacuate blast zone, failure to properly guard, bad information on fuse burning times, careless exposure to underground blast fumes, blasting wires across rails, pipelines and other conductors, electric caps open in the front seat of a car or truck where many sources of electricity are readily available—these are still the kinds of things that hurt people using explosives.

These are the things that we assume our powdermen know thoroughly. But they don't, in many cases. We have seen powdermen send out the traffic blockers in preparation for two separate blasts, without informing the blockers that two instead of the usual one blast would take place before traffic should be allowed to resume. That sort of thing happens to a hurried man.

We have seen complete misunderstanding in signals by powdermen to these traffic guards, due to inadequate prior planning. When arm waving is relied upon, danger enters the scene. Imagine a powderman who signals that he is going to blast with thumbs-up gesture, and that it won't fire and he doesn't know why with a palms-up helpless gesture. Traffic guards working with him are going to go tragically wrong some day. Use a clear, adequate signal system—sirens, signal flags, whistles, or something that your careful thought tells you is adequate.

Let's look at another problem. How many reasons can you think of for unusual and serious flying rock from a blast? Well, you and the powdermen should try to think of them all. The list is long, the causes simple, results expensive.

Some holes get loaded clear to the very top by mistake and this fact covered up with drill cuttings. This should be a firing offense.

For safety, the hole has to be unloaded to the proper distance by some safe means, or a whole new look taken at the evacuation of the new, revised hazard zone. Or a loose zone of rock or cross fracture can cause rock to fly unexpectedly.

A hole can be unburdened by an earlier hole to fire so that its explosive load may have little rock to work on. Or a pocket of explosives may exist due to a cave or chamber in a soft seam. And the list goes on! These are all reasons for considering the danger zone as much larger than normal shot results seem to require.

A dynamite cartridge with a cap in it is called a primer. It is used to detonate each hole in tunnel work and shaft jobs. This primer should never be tamped. And yet, nearly every year, some men are killed doing it. This year, there was a fatality in another industry when a sash weight was used to bang on a primer stick which was stuck part way down a vertical hole. In a tunnel construction job, a man was very slightly injured when his primer detonated while loading was in progress. Extremely lucky to be alive, he explained later that the primer lacked two feet of going to the back of the hole, so he began to pound it with the tamping stick. Tamping that primer had disrupted it so completely that a part of the dynamite was found in the back of the hole after the blast. Put out the word on your projects: "*No Tamping of Primers!*" After all, some delay caps are five inches long. A single, sharp blow of the tamping stick can expose that cap to the next strokes of the stick. Know that this is not happening on your work.

How much danger is lightning to a blasting job? The answer is, *plenty!* Lightning is perfectly capable of firing electric detonators whether they are wired up or not, shunted or not, hit by the lightning or missed by a nearby hit, out in the open or underground. In a training session last year, about 90 men who use and sell explosives for a living were taking a course from one of us. This group was asked, "How many of you have actually experienced lightning detonations or know personally and certainly of such detonations?" Approximately 80 of the 90 raised their hands.

There are perfectly satisfactory means of blasting without electricity today for conditions when electrical hazards exist. When

electrical storms approach blasting work, someone must notice, recognize the danger, and evacuate the blasting zone until it passes. Who does this on your jobs?

In the transportation of explosives, several people have died in recent years because loads of explosives have burned. Tire fires often are treacherous contributors to these situations. Typically, a driver detects a flat, stops, and goes to summon help for the tire change. The hot tire ignites, starts the truck burning, and is reported to firemen by someone else. Firemen have been killed by these fires by not knowing the contents of the truck, or, knowing it, going on the assumption that burning dynamite will not shoot.

Don't fight dynamite fires! Don't let others fight them.

One of the saddest chapters on explosives accidents is the list of children who are hurt with caps each year. Occasionally, one of them dies of the injuries. The list which we see from the I.M.E. each three months tells how children plug the wires into wall outlets, hook them to train transformers, flashlight batteries, etc. They have no idea of the power and pain they are dealing with. Fuse caps are hammered, dug into with nails, heated with matches, thrown into fires, etc. The rest of the story is about small fingers, hands, faces, and eyes.

Children don't buy caps; they find them. In unlocked magazines, in tool boxes, in fields near their homes, on construction jobs where the kids don't belong but come anyway, along the road, and countless other places. They find them neat and pretty, with colorful wires and shiny shells.

An educational program with posters, movies, radio and TV spots has been underway for years. The number of injured children is coming down. More than 100 per year 15 or 20 years ago; now down to 36 for 1966.

We ask your help in continuing this job. Let us all be sure that our operations are not the source of lost or misplaced caps that can get into the hands of children.

What can be done to eliminate inexperience and ignorance of safety information? Get safety training for your explosives personnel. The basic safety facts must be

taught. The safety chain of organization must be maintained. If you employ personnel who are capable of this safety training, then we suggest the time and opportunity be made available. One of the very best means of getting safety instruction for your men is to ask your explosives supplier for this assistance. A lot of time is spent in safety training sessions by our men in mining and seismic prospecting work. Maybe the construction industries don't get their share of our safety instruction efforts. We recognize the difficulty of getting the powder crew into a room for training and discussion. We recognize that old powdermen may not listen to young powder salesmen. But we face this all the time. The experienced blasters, the really good ones, are grateful for new information, receptive to new ideas, hungry for safety tips. These men are among our best friends, and we enjoy working with them and learning from them. We will be glad to meet with them and their crews in training sessions and work with them on the job.

One thing can be done by all of us: our personal support will help. Whether you own your company or supervise just one helper, your personal view of safety is known by others and matters to them. As an example:

If I smoke around dynamite, I teach others to do it. If I stay around others while they smoke, they feel that I don't really think there is any hazard there. They have to know I'm serious. So, give support to explosives safety. Let your associates know you are serious about it. Demand it from them.

Explosive suppliers will help. Get together with them for the training needed in basic safety with explosives for you and your men. The discussions are interesting, informative, and lively. We have never seen a dull one yet. A regular program would be a good idea, with supplementary training when special job conditions call for it.

With these tactics, then, attention to the fundamentals, adequate time and planning for safety, and clear-cut, regular training and qualified assistance, the safety programs which you support can be ever more effective.

safety specifications of the contract. I know of no architectural and engineering firm in the country which employs a construction safety engineer. It requires great arrogance for these specification writers and architectural superintendents to write or supervise safety specifications with their level of safety sophistication. No contractor can or should be held to job tolerances in the area of safety performance that are not part of the specifications upon which he figured the bid price.

5. We have not begun to adopt the safety standards, codes, and safe practices which are required in the exercise of due care.

6. There is totally inadequate equipment—unguarded, not interlocked or fail-secured, with poor lateral acceleration capability.

7. Pay for construction safety men is totally inadequate. I know of one \$40 million construction contract where the safety man was the lowest paid man on the job; incredible, but typical. Underpaid safety personnel are perfectly capable of telling workers to "be careful" and to wear their unsafe helmets and are also capable of performing their role in a ridiculous safety awards program but are incapable of recognizing major job hazards and the safety program necessary to prevent the unsafe condition from resulting in major injury or death.

While lawyers have allowed the development of negligent industries, including the construction industry, we are in many respects much more capable of determining due care when we represent construction accidental injury victims. This is so because most construction accident investigators have acquiesced all of their lives with the negligent standards of a negligent industry.

An example to illustrate the different approach to be expected from lawyers who investigate in the course of adequate representation of their clients:

A few years ago, four construction workers were killed during the building of the Yellowstone Dam in Montana. A few seconds prior to their deaths, they were passengers in a manskip on the lead line of a cableway. The lead line crossed the main haulage cable, shearing the haulage cable. The manskip was smashed against the side of the dam, and the men were dashed against the side of the dam and thrown several hundred feet to their death.

Several representatives of the owner, the Bureau of Reclamation, the cableway manu-

facturer, the cable manufacturer, and component part manufacturers investigated the tragedy for weeks with the contractors and concluded there was one cause of the deaths—a negligent failure to inspect the cableway installation in all positions of travel prior to use.

The lawyer's conclusion was far more complete. The legal bills of complaints charged:

1. There should have been a broken cable safety device to prevent the runaway of the haulage cable in the event that it broke.

2. The men should never have been allowed to ride a manskip when they could be killed if either the lead line or the haulage cable broke. (There were six instances of cable failure during this job, but fortunately only one occurred when men were in the manskip.)

3. There should have been a safety checklist for the purchasing department for use at the time of purchase of the cableway.

4. The cableway manufacturer should have had a safe design checklist, which would have flagged the necessity of providing a broken cable safety device similar to those used on elevators for nearly one hundred years.

5. There should have been an installation checklist for the rigging superintendent.

6. There should have been an inspection checklist, including the drawing board plotting by descriptive geometry of the head-tower installation.

7. There was a lack of understanding of the applicability of the A.S.A. Conveyor Code.

8. There was a commingling of safety functions without proper coordination between government and contractor personnel.

The birth of the American Trial Lawyers Association was the birth of a revolution in legal liability. As I said earlier, it is only the beginning. Decency will not allow us to tolerate a social policy which results in 110,000 accidental deaths and ten million disabling injuries each year.

The value of the safety man to his company will increase as legal liability expands. His income comes from his value.

As one who represents the widows of construction workers, the quadriplegics, the paraplegics, the brain damaged, those with broken backs, etc., I want to assure you that the trial lawyers are not only your allies in preventing accidents, we are your allies in your

Construction Section

fight for full professional status—in your fight for adequate incomes—in your fight for dignity and respect.

It is not only the safety engineers for the good companies such as duPont, Chicago Bridge & Iron, Bethlehem, American Bridge & Iron, H. K. Ferguson, Ingram, etc., but every safety man everywhere who has nightmares after the construction catastrophe.

In the short run you may believe that it is in the interest of your company to fight liability. In the long run the development of liability will increase your company's profits. This is so because liability will separate the men from the boys. The safe companies will maximize profits—the unsafe companies will go out of business.

Safety is sophisticated business—liability will bring sophistication. Sophistication will prevent injuries and give you dignity and respect.

Can you prevent the construction death resulting from being buried alive in a trench? Of course you can.

Can you prevent the fall resulting in serious injury or death? Of course you can.

Can you prevent the construction hoist failure injury? Of course you can.

Can you prevent the injury from failure to guard machinery? Of course you can.

Can you prevent the injury from failure to cover or barricade holes? Of course you can.

Can you prevent asbestosis and lung cancer in insulation installation? Of course you can.

Can you begin to get adequate protective equipment? Of course you can.

I challenge you to debate the merits for the next year and to come up with the program which will eliminate major safety costs

from the bid price and have them added at cost plus 25 per cent to the bid price with a national arbitration system to settle disputes.

There should be a Federal Construction Safety Code with owners' liability similar to the Federal Employers Liability Act and the Jones Act.

I challenge you to help achieve this and adopt construction safety standards equivalent to those detailed in duPont's Engineering Department's *Construction Safety Manual*—their Brown Book—and forget the low level standards reflected in the helpful but inadequate *Accident Prevention Manual in Construction* of the Associated General Contractors and the A.S.A. *Safety Code For Building Construction*.

I challenge the top 400 construction firms to give vice presidential status to their top safety man, and all your companies to pay the salaries and give the authority and respect necessary to their safety personnel.

I challenge you to insist upon competent sub-contractors—those with adequate safety programs, safe equipment, and competent personnel.

I would urge that you recognize the development of our ordered society as desirable. Develop your professional status—yours is a discipline as important as law, medicine or any of the professions.

Treat safety as a sophisticated field.

Adopt strict standards and codes.

When your employees are injured, look for third parties—this will advance safety and recover sums for your own company.

When your company is a defendant, look for potential co-defendants.

Together we will save thousands of lives and hundreds of thousands of injuries. I know of no better goal.

VIBRATION MEASUREMENT IN CONSTRUCTION

By PAUL C. HOSKING, P.E.

Vice President, Vibration Measurement Engineers, Inc., Evanston, Illinois

Every construction contractor is safety conscious. He knows he must enforce safety measures to protect his workmen. He also must take precautions to protect persons and structures in the neighborhood from injury

or damage during the course of his construction project. Finally, he must protect himself against unwarranted damage claims.

Such claims can occur whenever vibration is transmitted by the soil and through the

1987 National Safety Congress

air. They occur in projects of every size—from blasting for a subdivision sewer to pile driving for a new John Hancock Center or Federal Office Building.

For instance, let us assume that the Village of Hometown, which has been working with individual wells, is now putting in a complete water supply and sewerage system. Your firm has been awarded the contract for excavation and placement of the necessary pipe lines. You know that the overburden is only two to three feet deep and that, over a considerable portion of the excavation, your firm necessarily will remove a lot of rock within fifty feet of homes along the right-of-way.

We know that there are many ways of removing rock and one of the less expensive methods is to use explosives to break up the rock in such sizes as can be handled conveniently without wearing out your equipment. As an experienced contractor, you also know that properly used explosives are an excellent tool. They are readily controllable and, if the shooting gets tricky, experts in rock mechanics are available to assist you.

But the public—residents of the community in which your operation will take place—does not share this knowledge and easily may panic unless prepared in advance. A properly handled public relations program will pay dividends in good will and prevent unnecessary and expensive damage claims.

The first step might be a public meeting. Talk to the mayor of the town, and to the local newspaper. Local officials will help you set up a meeting and usually will provide space for it, such as the council rooms or a school auditorium.

Make sure this meeting receives adequate advance publicity. If the newspaper will not handle the meeting as a news story, buy an ad in the paper to inform everyone of the time and place and purpose of the meeting. The news story or ad should stress that the project will be explained in its entirety—what the project means to the area, the conveniences to the individual homeowner, and/or new business it will bring. Stress the precautions that will be taken to insure the operation will be safe from a safety engineer's standpoint, and the precautions that will be taken to protect the property of neighbors.

At the meeting, the mayor or other local official should begin by describing the advantages of these local improvements to the

town. (Incidentally, the publicity the mayor receives through the meeting may help him to be reelected, and you will be provided with a local tie-in on the project. You are no longer just a stranger in town, but a friend of the mayor or other local official.)

The next speaker should be the president of your firm and/or your safety engineer, with a few well-chosen words about safety—hard hats, etc.—this is your field.

The third and most important speaker, I modestly claim, will be your vibration consultant. He will explain measurement and vibration control on the project, and tell his audience these simple but important facts:

1. You are going to hear the shots.
2. Your house will shake.
3. Your dishes will rattle.

Always tell the people these things will occur; otherwise, they will become alarmed when the dishes do rattle. If the story is properly presented, the homeowner will remember that the dishes also rattle when he stomps through the house.

Before your project starts, the homes along the right-of-way should be inspected, not only to record the defects (cracks) in each room of each house, but to point out these conditions to the homeowners. This is especially important if the homes are in a poorer section of town and if they are old and in poor repair.

No formal reports are necessary—just the inspection notes of the vibration consultant, so that, in the event of future litigation involving one of these houses, he may then refer to his notes and write a report which could become part of court testimony.

During the course of the project, record the vibrations with a portable seismograph. Move it around so that you acquire vibration recordings in various parts of the project. If you get complaints, investigate them or, better still, have the vibration consultant investigate.

To recap a moment—remember, the neighbors already have been told to expect to hear noises and feel vibration. If you had started blasting without preparing them, their reaction would be something like this: "My God! What was that? It really shook the heck out of this house. Look, Mabel, there's a crack over the doorway and another over the window! I'm going to call my lawyer. You run over to the neighbors and see if their houses were damaged."

These people are acting in good faith. If

their ten-year old son slams the door and shakes the house, they expect it. On the other hand, the first blast on a construction project is a new experience. This is a new disturbance.

Blasting is not the only culprit. Other typical disturbances are the headache ball or frost ball and pile driving.

In line with your program of good community relations, be careful about dust. Wet down the roads whether needed or not. Let the people see that you are trying to be a good neighbor.

Now, let's put the spotlight on a large, urban project.

Chicago is a great city; I'm proud of it. But what a heck of a spot to build a city! The history books tell us Chicago was built on a swamp, and many cities like ours are built on river mouths because our earliest transportation depended on our waterways.

Some of our city structures are built on spread footings. When we build near one of these, we can, if we are not careful, damage the existing structures. In such cases, we recommend that additional precautions be taken.

The project actually should start 30 days before ground is broken with a program that will ensure proper safety measures and record keeping. During this 30-day period, the buildings adjacent the project should be located by a survey crew under the direction of a licensed land surveyor. The buildings should be located both vertically and laterally and settlement points established so that, at a later date, the crew can return to determine if the building has shifted.

These points should be established at the same time the nearby buildings are being inspected by an inspection crew who note each defect: that is, plaster cracks or cracks in the exterior stone work. A formal report is issued on each building, with copies going to the client and to the owners of each building.

During the course of construction, especially during pile driving and excavation, recordings are made, under the direction of the vibration consultant, of the vibration and sound pressures emanating from the project. Also, during construction the settlement points should be checked by the survey crew; how often they are checked depends on the progress of construction and on whether any change is noted by the crew. If

changes occur, step up the program. Inspect or check more often.

The reason for all the preliminary work is to have proper references as the structure progresses. We have found that nearby buildings tip, sometimes away from and sometimes toward the project. As we have pointed out, the building owners usually have no real knowledge of the condition of their buildings. Our experience tells us that a report of the condition previous to construction is worth much more than its weight in gold. If, during construction, a neighboring building is damaged, you want to know about it. But, on the other hand, you certainly do not want to pay for any alleged damage that actually existed prior to your construction work.

Thanks to the research carried out by the Bureau of Mines and various insurance companies, together with the research and experience gleaned by the thousands of recordings taken by vibration consultants, excellent criteria have been established as to how much vibration various structures can withstand before any damage might occur to them. Here, I am referring to vibration in the broad sense that includes vibration transmitted by the soil and through the air.

Even though the vibration consultant can calculate the vibration caused by various construction processes, a recording of the vibration, at a specific building or at a specific location from a specific disturbance like a blast or pile driving, is proof of what actually happened.

We are all familiar with personnel problems connected with a project. When it terminates, the superintendent and crews move on to new jobs, and one loses touch. Five years later, you have a problem, and you must find out where, why, and how. To your insurance company and your lawyers, this information is most valuable. If you do not have the information available, many thousands of dollars may be spent trying to find it.

The vibration consultant keeps such records. Insurance companies have come to us regarding jobs done ten to fifteen years ago and, needless to say, they were very happy to learn we had the information needed.

Just as "one picture is worth one thousand words", an actual recording of the vibration is worth infinitely more than a lot of theory, even though that same theory is based on actual measurement. If, in a lawsuit, the vi-

bration consultant brings this recording to the stand, the attorney shows it to the jury, and it is entered in evidence, in all probability no jury member could analyze the recording. However, the jury will recognize that this document is evidence and will believe the interpretation of the evidence by a vibration consultant.

Although this recording is very important, it is not a panacea that will stop all complaints. In addition to the recording, we need to know the "where" and "when" of the shot. Don't say, "It was on 55th Street in Hometown." Do say, "The shot was located at Station Number 570-300" or whatever the drawing description is. Add to this information that the shot was "in front of 3620 West 55th Street", and add also the location of the seismograph. When describing the location of the seismograph, we need more than "at Mrs. Murphy's house". There may be more than one Mrs. Murphy living on the street. The location of the seismograph should be described as "on the concrete basement floor N.W. corner 3617 West 55th Street". In effect, our description of the shot point location or the seismograph location must be accurate enough so that one can go back to the same spot.

The vibration consultant will record all this information for you or provide you with the proper forms to do it yourself. The importance of keeping good records cannot be over-emphasized.

If you put off a blast, locate it. On a moving job, such as a new water or sewer system, pinpoint the blast from the stations shown on your drawings, locate the seismograph and the distance between the shotpoint and the instrument.

If your blasting is confined to one area, such as a quarry or building excavation site, set up coordinates or a grid system to locate each shot. A typical and good system uses letters from north to south and numbers from east to west. With this sheet, the blaster quickly can fill in a letter and a number and locate the shot. Example: F-27. A description such as "West Face" or "North End West Face" is not good enough because, once we shoot this west face, it isn't there any more—it's gone.

Most blasters keep excellent records to show how much explosive is used in each shot. To help the vibration consultant in the event of claims against your project, aug-

ment basic explosives records with the following information:

1. Number of holes.
2. Spacing.
3. Burden.
4. Depth of holes.
5. Maximum explosive per delay.
6. Location of shotpoint.

What should you do when you get a complaint?

Despite all the precautions you have taken, on any large project you are going to have complaints. We recommend that you set up a procedure for handling them. Assign one person to the duty of answering the phone and writing down complaints. The vibration consultant can supply you with a form for recording the data. Make sure that the person answering the phone knows how to use the form and fills it out completely. Insist that he be polite to the person complaining. Your man should not say "We didn't do that, mister. That was a sonic boom." He first should make sure he is right, and then call the complaining party back. Many times, due to a misunderstanding, when we thought there had not been a blast at 10 o'clock a blast had taken place.

The phone rings—someone is on the line. Here are some don'ts. When the caller starts complaining:

1. Don't hang up.
2. Don't agree with him.
3. Don't disagree with him.

As an example, someone calls and says, "That was a terrific blast this morning".

Don't say, "It was not".

or, "It sure was".

or, "We didn't do it".

You realize the language quoted above is not nearly as colorful as examples each of us have heard.

Do say,

"Just a moment please. I want to write this down"

Then, take notes. Fill out the form provided. Get the name, address, and telephone number. Get the date and time of day the caller says the disturbance occurred. The date and hour are important for comparison with your blasting operations on that day. You may find the caller is complaining about a disturbance that had nothing to do with your operation. It is wise to make a note of any unusual noise that was heard in the vicinity of your project—an automobile accident; a sonic boom, or what have you.

WHAT'S WRONG WITH CONSTRUCTION SAFETY IN THE UNITED STATES?

By HARRY M. PHILLO

Partner, Marcus, McCroskey, Libner, Reamon, William and Dilley, Muskegon, Mich.

Lawyers and safety men are natural allies, but too many persons believe that safety is simply common sense and they, therefore, have a long way to go to recognize this potential alliance.

We each must ask ourselves the question: "How can due care prevent injury?"

A moral society will not tolerate 2,700 construction deaths and 250,000 disabling injuries annually. The fault lies not in our technology but rather in our social policy. The technical responsibility for a substantial reduction lies with the manufacturers of construction machines, equipment, and materials, and with construction safety personnel. The social responsibility, however, lies with lawyers, judges, and legislatures, and the law is beginning to meet this challenge. Your invitation to me is recognition of the revolution that is beginning in the law of liability for construction injury or death.

You have all observed the revolution in the law of liability for injuries caused by defective products. The law must and will respond similarly as regards construction injuries. Accident prevention comes from liability, and only from liability. Corporate executives are charged with responsibility for maximizing profits. If there is no legal liability for negligently caused construction injuries, then little or no attention need be given to construction safety. But legal liability, where it exists, can be very expensive. It must be considered in the cost of doing business. The point on the cost graph when accident prevention programs win is that point when it becomes more expensive to perform in the unsafe way.

Some ten years ago, the top safety engineer for the U. S. Coast Guard wrote to the Coast Guard Commandant and heads of civil and naval engineering that due care required specific safety rules in bid specifications. He was told by letter that it would be too expensive and would limit their ability to get contractors, since contractors would not want to be so regulated or would insist upon more money if they were compelled to perform safely.

On February 24, 1967, the man in charge of all major construction for the Ford Motor Company testified in a Federal court matter that in his opinion it was not necessary to cover a floor hole adjacent to a pallet of bricks and under which employees of contractors were expected to work.

On July 27, 1967, the assistant director of safety for General Motors testified that upon being subpoenaed to bring the A.S.A. *Safety Code For Building Construction* and A.S.A. *Code For Cranes, Derricks and Hoists* and *Accident Prevention Manual in Construction* that he was unable to find them and as far as he knew General Motors never had them.

General Motors engineers testified that their legal department had more than fifteen years ago written the safety specifications of the construction contract general conditions, and that General Motors employed architectural firms to custom fit the safety specifications to the contract but knew the architects were incapable of writing the safety specifications because of lack of expertise.

These vignettes are symptomatic of what is wrong with construction safety in the United States.

There are seven basic reasons, all resulting from a totally inadequate social policy.

1. The owners who are undertaking construction enjoy both the advantage of a cheap bid and immunity from liability in too many jurisdictions. The contractors who recognize the need to use nets, trench shoring, safe personnel hoists, etc., are faced with a choice of computing their costs as part of the bid price and losing the bid, or not computing them in the bid and therefore being handcuffed in their use and winning the bid. Death's handyman is the victor.

2. In every construction bid, all aspects of safety are presumably part of the bid price on a cost-plus basis above the bid price.

3. Hold-harmless agreements are legal licenses to kill. They are against public policy and encourage negligent performance. They should be outlawed everywhere.

4. Most construction contract specification writers are totally incompetent to write the

Pass all the data along to whoever investigates the complaint, preferably your vibration consultant. Provided with the facts, the investigator and complainer usually are able to discuss the problem reasonably and realistically. In most cases, if the complaint is unfounded, the claim is dropped and a lawsuit prevented.

If the complaint is justified, as indicated

by vibration records, you will be so advised by the vibration consultant, and steps can be taken to change the blasting practices to eliminate a repetition of trouble.

In either case, vibration measurement—together with good public relations and thorough record keeping—is the key to protection for the construction contractor.

HOW OWNER AND GENERAL CONTRACTOR COORDINATE SAFETY ON MULTI-CONTRACTOR JOBS

By THOMAS J. REYNOLDS

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Bethlehem Steel Corp., Chesterton, Ind.

An examination of the records indicates that prior to the 1900's lack of safety programs and indifference to human suffering were prevalent. The steel industry became the leader in safety movements to correct the lack of concern in industry for human life and limb.

Through the intervening years, since the early 1900's, the quality of safety programs has steadily improved, and previously unthought-of accomplishments have been gained through the initiative of management and cooperation of labor, to the point that we now think of zero frequencies as our ultimate and attainable goal.

In the early 1950's, with progress necessitating greater expansion and improvement of operations, Bethlehem Steel Corporation developed a program to assist contractors in accomplishing a safe operation while working within producing operations; by coordinating our safety efforts with theirs. With mutual cooperation costly delays, damaged equipment, and, most important, personal injuries could be minimized or avoided entirely. It soon became apparent that guide lines would have to be set down to standardize the safety activities of the various contractors throughout the numerous operations. In order to accomplish standardization, a code was developed after many meetings, revisions, and final approval. A standard acceptable code was published and issued in 1957 entitled "General Safety Rules for Contractors" for the guidance of contractors and

their subcontractors, to assist them in planning for and conducting a safe operation under their contracts with the company. The guidance provided by the code and the placement of responsibility for safety immediately began to reflect itself in a reduction of all types of accidents.

In the early 1960's when Bethlehem began making plans for what, at that time, was the largest private construction project in the world, an accident prevention program for the project was included. With the gratifying results of planned programs in the steel industry in mind, similar planning went into the program for safety construction of the Burns Harbor Project. The plan was entitled "Accident Prevention Plan—Burns Harbor Project".

Prior to the beginning of work on the project, meetings between all parties concerned were held. The chief engineer of construction at Burns Harbor and his staff together with other Bethlehem personnel such as plant protection and safety met with contractors and subcontractors and their principal supervision at which time the Accident Prevention Plan and "General Safety Rules for Contractors" were reviewed. At the same time, copies of each were issued to each contractor and subcontractor. Once these guide lines had been established, they were continually reviewed at subsequent meetings.

The Accident Prevention Plan was clearly and concisely worded and outlined, beginning with the objective: "To reduce to a

minimum injury to employees; to promote maximum efficiency; and to effect savings by preventing injury and by reducing interruptions caused by occupational accidents."

The objective was followed by an outline of methods of obtaining the objective: "The effectiveness of the Accident Prevention Plan will depend upon the participation and cooperation of supervisors and employees of all contractors and sub-contractors engaged on this project; and the coordination of their efforts in carrying out the following basic procedures:

1. Planning all work to protect against personal injury, property damage, and loss of productive time.
2. Maintaining a system of prompt detection and correction of unsafe practices and conditions.
3. Making available and enforcing the use of personal protective equipment and mechanical guards.
4. Establishing an effective system of tool and equipment inspection and maintenance.
5. Establishing an educational program to insure the interest and cooperation of all employees through:
 - A. Personal example and safety contacts.
 - B. Instruction in safety requirements and insistence on compliance with such requirements.
 - C. Safety meetings.
 - D. Effective use of bulletins, posters, or other safety literature.
 - E. Investigation of all accidents to determine their cause and promptly taking the corrective action to prevent their recurrence.
6. Each contractor's and sub-contractor's principal supervisors shall obtain a copy of and shall comply with the Indiana Safety Code for the Construction Industry, and rules and regulations applicable to the work performed by each employer on this project."

Following the outline of six methods to gain the objectives, the responsibilities of the chief project engineer, the safety coordinator, the contractors and sub-contractors, and the job foremen are outlined.

The chief project engineer is responsible for the entire plan as I have outlined it to this point and, in addition, must appoint a safety coordinator, authorizing him to enforce safety measures and to recommend corrective action when sub-standard practices and conditions are observed.

The responsibility of the safety coordinator is to follow all phases of the plan as they have been outlined and in addition maintain adequate records.

The responsibilities of the contractor and sub-contractor are:

1. Comply with all provisions of the Accident Prevention Plan, including attendance at and participation in safety meetings.
 2. Appoint a qualified representative with full authority to act on all matters relating to the Accident Prevention Plan.
 3. Plan work to protect against personal injury, property damage, and loss of productive time.
 4. Cooperate with the project safety coordinator.
 5. Comply with the requirements of the Indiana State Code and all other codes relating to his operations.
 6. Provide to employees and visitors all personal protective equipment required by the exposure and enforce the use of such equipment.
 7. Insure that prompt first aid is administered to an injured employee and transport him to the project clinic or as otherwise directed by the clinic.
 8. Comply with all required accident reporting procedures.
- This outline of the job foreman's responsibilities include:
1. Setting a good example for the men.
 2. Instructing in safe work practices and work methods.
 3. Use of proper protective equipment and proper tools.
 4. Checking for unsafe conditions and practices.
 5. Completely investigating accidents to determine causes and taking all necessary corrective action.
 6. Promptly completing required Accident Reports.
 7. Holding meetings with men.

The Burns Harbor construction supervision and safety personnel are continually in the construction areas and insist on strict compliance with the Accident Prevention Plan and the "General Safety Rules for Contractors". The fact that the Bethlehem Steel Corporation provides workmen's compensation and general liability insurance to cover approved contractors on the project greatly enhances enforcement of the safety program by Bethlehem and compliance with the program by the contractors.

Weekly safety meetings are also held by the craft union stewards, and designated committees from these meetings in turn meet with plant protection and safety department personnel of the Burns Harbor plant to further assist in the compliance by all contractors toward the desired goal of maximum safe working conditions.

Periodically, the business agents for the crafts make safety tours of the construction areas with members of the construction and safety departments pointing out various constructive improvements to further improve the program.

Considerable time is spent working with the A.F.L. craft union safety representative to insure a mutual understanding that, for a safety program to be effective, requires the cooperation of both management and labor. Without the complete sincere support of the

unions toward a sound safety program, frequently only "lip service" for safety exists with no meaningful action resulting.

Compliance and cooperation on this project has been excellent. Only infrequently have actions, other than firm reminders, been required to bring the safety program back into line. The aid of the purchasing department is enlisted when the most severe corrective actions have been necessary and this procedure has been most effective.

Our program is not unlike other programs in the construction industry, having the common denominator of: planning, motivation, communication, and follow through accompanied with dedicated hard work on the part of each individual on the site. We attempt to implement our program with enthusiasm and a directness of purpose eliminating "lip service" and the attitude "we will look at the problem later".

OCCUPATIONAL HEALTH IN THE CONSTRUCTION INDUSTRY

By FRED OTTOBONI

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Occupational health in the construction industry is a subject that has not yet received any real interest or attention in the United States. Articles appear from time to time in the American literature on a specific health hazard, such as lung cancer in asbestos insulators, or lead poisoning in painters. Other than a few papers originating in California, where a start has been made on the heat, noise, and dust problems of heavy equipment operators, almost nothing seems to have been written on the present health status of the individual crafts or on the overall health problems or needs of the industry.

This lack of interest and work is significant. Either there are no problems in the industry worthy of mention, or there is an appalling lack of some vital ingredient which is necessary for stimulating the growth of a systematic interest in the health of more than four million American workers.

First, let's define "occupational health". The term has been so loosely used over the

last few years that intelligent discussion of the subject has been difficult. Some people interpret it to mean everything from a cut finger to the social well-being of the craftsman's family. For our purposes here, however, occupational health means the prevention of work-caused disease and disability by control of the work environment, an area where both labor and management have a clear responsibility for observation, discussion, and hazard control. This definition acquires particular meaning when one realizes that the majority of occupational diseases are not curable; they are only preventable.

Five conclusions have emerged from our studies of occupational health problems in the construction industry. We feel they are fundamental, if progress is to be made. They are the result of nearly five years of observations in California. They dramatically reveal the lack of interest, the lack of programs and the lack of action that beset the industry. It is recognized that the immediate demand of

pressing safety problems in the industry may, in part, be responsible for submerging any concerted interest in health problems. While no attempt is made here to detract from the important responsibility for accident prevention in the industry, it is time that programs in work-induced disease prevention begin to receive the attention they deserve. High accident frequencies cannot, by any stretch of the imagination, justify a lack of interest in healthy working conditions.

Our first conclusion—there is a basic need to recognize that construction workers are now suffering job-induced diseases and that new diseases will emerge with advancing technology.

To the casual observer or even a member of the industry itself, it is reasonable to believe that occupationally-induced diseases in construction work are not a problem. The crafts have long histories of working outdoors in the fresh air with hammers, shovels, and other tools which have in the past traditionally presented safety problems, but not health problems.

A look at the Federal or State health statistics appear to support this concept; not because there is a lack of problems, but because neither the Federal government nor the states—with the possible exception of California—keep any statistics on the subject. When no disease is reported, it is natural to conclude that none exists. However, what appears as no problem is, in reality, no information on the problem.

Experience in California supports this conclusion. In recent years, physician's reports of occupational diseases among construction workers have been coming into the State Health Department at approximately twice the average rate for all California workers. Since 1949, when recording began in California, this rate has been continuously among the three highest of all the major industries. The diseases involve the skin, the lungs, systemic poisonings, hearing loss—essentially the whole range of illnesses normally believed to lie in the exclusive province of factory workers.

Field investigations suggest that more is to come. For example, an estimate based on hearing tests conducted at construction sites by fully-qualified audiologists indicates that some 20,000 heavy equipment operators now working in the state have permanent noise-induced hearing loss. The trend toward

larger, faster, and more powerful equipment, designed without consideration for the long-term health of the operator, is expected to intensify this hearing loss problem. It also is expected to introduce silicosis for the first time as a disease of the operators of dozers, power shovels, and front-end loaders.

The equipment operator is not alone in facing these health hazards. The recent replacement of the plasterer's conventional trowel with a spray nozzle has introduced serious hearing loss problems insofar as the plaster guns that we have measured are concerned. Further, the gun application of asbestos-containing fireproof coatings continues without control and without concern. Yet, data coming in regularly from studies of men working around asbestos dust leave very little doubt that the gun operator and other craftsmen in the area are being subjected to the risk of asbestosis and lung cancer.

There are many more examples. Plastic adhesive and surfacing materials have made life an itchy nightmare for the tile setter and the cement mason. It is important to realize that much of this skin disease is accompanied by a permanent allergy to the epoxy resin hardener used in the process. The slightest further exposure to the hardener brings on a repeat case of the itch and the man is permanently disabled for any further work with the plastic.

Another example involves today's welder. There was a time when very little except ordinary steel was found on a construction job. An unprotected welder could work with very little hazard from fumes. Alloys are changing this. For instance, inhalation of the fumes from manganese steel will produce an illness which closely resembles Parkinson's disease. Consider also that nickel, cadmium, vanadium, and some other metals are toxic by inhalation.

It is clear that the pick and shovel are gone, and along with them went the fresh air and the iron man. The construction industry has entered the era of machines and chemicals, and it should recognize this.

A second conclusion—it must be recognized that the methods which have been developed for the protection of the factory worker may not be feasible on a construction job.

Most of the occupational health literature and practically all of the preventive methods in use were developed with the factory

worker in mind. The factories presented the critical industrial health problems of the 19th and early 20th centuries and this is where the interest, the research, and the money has been invested. The emphasis today, although comparatively small, is still on the factory. As a result, the standard control methods available in all the textbooks, ventilation, isolation, enclosure, substitution, and personal protection, are organized to make practical and economical sense in a factory setting.

The factory hand works for the most part in a fixed location. Exposure is repetitive and predictable over a long period of time. Utilities are available and control methods can be designed, tested, and finally built-in as part of the company's long-term capital investment. It is not unusual to see a \$20,000 ventilation system built into a plant to protect 10 or 15 welders.

But look at the welders on the construction job. In a lifetime, each will have done about as much work and generated as many fumes as a factory welder. However, the control system here is non-existent, because the control methods in the textbooks do not make practical or economic sense on a construction job.

Factory spray painting is done in a ventilated booth, according to the books. Since a booth would cost too much on a construction job, we scratch our heads and spray paint anyway.

Dust, noise, heat, and almost any health problem is controlled by cookbook methods in the factory. The cook book doesn't work for construction, so we live with the problems and hope they will go away.

It is now critically necessary that we accept the fact that a construction job is not the same as a factory job, and that the factory hazard-control cookbook—although free—is not applicable.

A third conclusion—we must begin to develop our own occupational health standards.

The golden era of occupational health in the United States ended in the mid-1950's. The movement which began in the 1930's and provided wide knowledge of industrial diseases and excellent textbooks is slowly dying. The Federal program is small and without legal authority. State programs not only have been declining in manpower, but show little interest in the construction industry. The traditional standard-setting agency

for occupational health in the country, the American Conference of Governmental Industrial Hygienists, is dependent upon its dues-paying members for support. Its \$13,000 yearly total budget will not cover more than a fraction of the country's problems, and that fraction will be factory-oriented.

On this basis, it is unlikely that the widely subsidized work that went into helping the industrialist to understand his problems and to custom-tailor his environmental control will be available to the construction industry. The facts are that the responsibility for providing a reasonably healthy place to work lies directly with construction labor, and construction management.

The need for environmental standards is growing with each day. Noise offers a fine example: Heavy equipment, trucks, compressors, chain saws, jackhammers, and a wide variety of power hand tools are producing hearing loss that is reaching scandalous proportions. There are choices. The individual contractor can hire an acoustics expert and modify these tools at his own expense. As another choice, he can attempt to stuff ear-plugs in his men, a method that will be of no practical value on a construction job, and one that will probably reduce productivity. A popular alternative is to do nothing and let the insurance companies worry about it.

The sensible solution is to collectively write a set of performance standards for power equipment. These can be written right now, from knowledge at hand, and would specify maximum allowable noise intensities at an appropriate given distance from the equipment. The tool manufacturers may have difficulties at first. But their engineering and research departments are available and in the best position to control hearing loss at the lowest possible cost.

Adequate labelling also must be considered. Very few of the materials capable of causing eye, skin, or lung problems such as plastics, paints, welding rods, fluxes, solvents, lubricants, etc., have useful warning labels when they reach the construction site. This has two negative effects, in addition to the potential for injury. First, even the interested men cannot find out how to protect themselves. And second, if the material does cause a problem, the men have no clear information that might be useful in selecting a less harmful product for the next job.

This is particularly dramatized by the experience of the cement masons, where labels are often so vague as to make it impossible for them to determine whether the surfacing material they are expected to apply on a particular job is a dermatitis-causing epoxy, a bronchospasm-causing urethane, or a relatively safe polyester.

The noise and label problems are straightforward. They follow the textbook closely. Others may not be so simple because of the mobile nature of construction work. Solutions to these will require imagination and money. Ideas from the space program are sure to be useful and we expect to see exploitation of the controlled individual environment in the form of air-supplied suits for plasterers, cement masons, and welders; and air-conditioned, noise and dust-tight capsules for heavy equipment operators. Standards, once set, can make these easily accessible at mass-produced costs.

The logical approach is to accept the responsibility and begin to develop some standards that can be put into contracts and equipment purchase orders; otherwise the industry faces attrition of skilled manpower, higher compensation costs, hazard pay, and if the problem gets bad enough, the inevitable application of the ill-fitting industrial cookbook to these construction jobs.

A fourth conclusion—records and statistics must be kept.

I repeat, health information on working men is scarce. This is particularly so in the construction industry because even the information that is obvious in a factory is clouded by the nature of construction work.

A factory is a relatively permanent environment. Jobs acquire reputations; they smell; old timers get lung disease; this or that chemical will make you sick if you inhale it. This is epidemiology in its most primitive form, done without the help of the professionals or the government. Nevertheless, it is very effective in discovering diseases and developing control methods.

Contrast this with a construction job. The office is often a house trailer and a single craft is not likely to be on a given job for more than a year. Who now is going to do the epidemiology? Work-induced health damage suffered by a craft during the course of a single project very easily passes without notice. It is not until a series of such projects—and years—have passed that disability is

marked enough to prevent further employment. At this point, cause-effect relationships are obscure. No single event can be held responsible, and the work force has a few less craftsmen. If, by some chance the illness is recognized as work-induced, the last employer may be held responsible for the entire cost of compensation. This is no solution.

For example, earth mover operators have long suspected that somehow spinal problems are connected with their jobs. This may or may not be so; there are no statistics. It is hardly possible that all equipment operators are born with bad backs. It is most likely, however, that the vibration and bouncing on some types of seats on some types of equipment are causing spinal damage. Unless it is known, first, whether or not operators are truly suffering spinal problems and second, exactly which machines and what conditions are responsible for the problems, prevention of "back trouble" will be impossible.

With computers now available, it is feasible to record the pertinent details of every job, every illness, and every death for every man working in the construction industry. This should be done by every craft union, with the cost shared by the employer. Routine computer output will then tell us whether painters die young; or equipment operators get silicosis, or plasterers get emphysema, and whether the lung cancer that has been found in asbestos insulators is being controlled or not controlled.

A fifth conclusion—uniform, reasonable regulation must be insisted on.

Competition is very real in construction. In fact, it appears to be so fierce that it often is cited as the justification for poor health and bad safety practices. For instance, the question as to why water is not being used to control dust on a given haul road very often will bring the reply that this is highly commendable; however, "it was not included in the job estimate because the competition never includes such things; and in order to bid the job successfully it was necessary to dispense with the water wagons."

This is a standard answer for many problems. Its effect is to penalize the legitimate contractors and to make the natural growth of healthy working conditions next to impossible. This fanatic interest in cost-reduction seems to be eroding the few existing health standards accepted by the industry.

For example, everyone knows that a sandblaster should wear an air-supplied helmet.

Construction Section

This has been accepted without question for decades. Yet during the last year the writer has seen five construction jobs where sandblasters were working. They all religiously wore the proper helmets—but not one had an air-supply hose connected to the helmet. Apparently the air supply isn't being figured into the bids anymore, even though it is still in the law.

Diesel engines in underground construction are an example of long-term, legal erosion. Diesels were allowed underground only after long study and, finally, the setting of rigorous standards by the Bureau of Mines. These included specially designed engines, matching exhaust scrubbers, and ventilation rates based on numbers which accompanied the vehicle from the manufacturer. Competitive progress over the last 20 years has led to the erosion of standards and the acceptance of any diesel vehicle with a home-made scrubber, and ventilation rates based on air sampling methods that have not been proved reliable. The engineered and tested standards and safety factors prepared by the Bureau of Mines are being forgotten. Although a few contractors still use Bureau of Mines equipment, continuous pressure from the industry has eroded the minimum standard. One thing is certain: eroded standards, no

matter how legal, neither increase profits nor make diesel exhaust better to smell nor safer to inhale.

The competitive inducement to save money by shaving health and safety costs need not continue. Good applicable standards, as they are developed under our third conclusion noted above, can be made a part of all construction contracts and all labor management contracts. In this way, healthy working conditions will be officially recognized as a legitimate cost of doing business, and the toll will be paid in dollars by the buyer of services rather than in the health and longevity of the craftsmen who provide them.

The construction industry has a host of hidden and pressing occupational health problems, with more to come. For the short term future, government rescue does not seem possible and a serious and planned effort by management and labor is badly needed.

The construction industry has enjoyed and become addicted to the privileges of hard work and fresh air. Change is always difficult. But one way or another, like it or not, the technology that we are using to change the face of the earth will, in the long run, change us also.

HOW TO FORESEE TRAGIC ACCIDENTS BY USE OF THE HIGH POTENTIAL ACCIDENT-PRONE SITUATION HAZARD CONTROL METHOD

By WILLIAM W. ALLISON,
Safety Director, Sandia Corp., Albuquerque, N. M.

HIPO or High Potential is practical, down-to-earth accident prevention. It *does* require judgement analysis. But it is not a theoretical plan. Instead, it is a method that has been used successfully in chemical, construction, and atomic energy work to prevent needless waste of lives and money. Only after years of successfully using the method, have I formalized and verified it by statistics and theory.

HIPO is the qualitative expression and predecessor of the best aspects of the various forms of systems safety. It remains the most reliable, practical and highest quality hazards control method.

There is *nothing* mysterious about High Potentials. The HIPO method starts and ends with emphasis on the *real* hazard-control point: the situation *before* any major damage or injury occurs. It emphasizes the control of *causes* as contrasted with *after-the-fact* injury-oriented safety programs.

The High Potential Situation Hazards Control method provides a *realistic* picture of the true hazard problem areas. It provides guidance and direction to effective hazards control.

There is nothing mysterious about High Potentials. HIPO's are very simply determined by asking, "Can this situation, practice, procedure or process, under possibly different circumstances:

- a. of timing, distance or sequence of events,
- b. of environment such as temperature, pressure, static, moisture, wind, sand, sun, storm, or soil conditions,
- c. of materials such as compatibility, corrosion, wear, evolution or residue of peroxides, conductivity, or strength,
- d. of personnel such as height, weight, sex, experience, age, strength, specific training, or habits established on different types of equipment,
- e. of equipment with different operating characteristics, controls, etc.?"

lead to a fatality or to serious damage of

health, sight, limb, equipment or facilities?"

We can thus be forewarned of the *future's* tragic accidents and we can prevent them by concentrating on HIPO. Situation Hazard Control and corrective action *before* crippling injuries and major damage occurs.

The High Potential accident rate of HIPO accidents per million hours worked, combined with a judgement analysis of facilities, provides the safety department and management a realistic picture of the true hazard problem areas. It provides guidance and direction to effective hazards control.

Accident costs in all industries, from compensation claims alone, were \$1,800,000,000 in 1965, and two billion dollars in 1966. The compensation costs alone are increasing 200 million dollars per year.

One small 700-employee company is paying \$55,000 more this year than last year for compensation alone. Large industrial corporations are each paying out over \$1 million a year. Construction firms are losing out on bids due to excessive compensation costs.

There is a pressing need for change and improvement from a purely economic viewpoint.

Let's look at the humanitarian picture. In all industries in 1961, there were 13,500 fatalities. In 1965, 14,000; in '66, 14,900.

In construction alone there were, in 1963, 2500 deaths; in '64-2600; in '65-2700; in '66-2800.

In construction there were 210,000 disabling injuries in 1963; 225,000 in 1965, and 240,000 in 1966.

There is a pressing need for change and improvement from the humanitarian viewpoint.

Why change the standard method? Why not just improve our efforts?

A typical monthly summary safety report utilizes both the minor injury and the serious injury experiences. Manufacturing had a 16 per cent *increase* in minor injuries. Next maintenance had a 20 per cent *reduction* in minor injuries and a 33 per cent *reduction* in

serious injuries. General services had a 6 per cent increase in minor injuries and metallurgy had a 21 per cent reduction in minor injuries and a 100 per cent reduction in serious injuries.

We see an encouraging so-called trend of a total overall reduction of 50 per cent in serious injuries.

The greatest improvements are:

1. Metallurgy—a 21 per cent reduction of minor injuries and a 100 per cent reduction of serious injuries.

Poorest performances were the 6 per cent increase in injuries in general services and the alarming 16 per cent increase of minor injuries in manufacturing, which dictates concentration of safety department efforts in the manufacturing division.

Now let us look at the same company's experience in the same month—as it was reflected in the High Potential Analysis Method.

A totally different picture is now clearly shown. Manufacturing is not a problem, despite its 16 per cent increase in minor injuries.

General services is not a problem despite its 6 per cent increase in minor injuries.

But maintenance, despite its 33 per cent reduction in the so-called serious injuries, has 7 high-potential accidents, so it is the real accident problem area; and chemical division and metallurgy each with one H.P. are our only other current problem areas.

We have only nine high-potential accidents to really concentrate our efforts on. Only 9 for a 7000-employee corporation—instead of the 290 minor injury total, or the 148 minor injuries in the three divisions with the most minor injuries.

We see that this H.P. accident rate, the number per million man hours of work, provides a monthly accident rate. A simple, ready-to-use, logical standard. No matter how we apply it, it is at least 1000 times more realistic than the present method.

And these nine important high-potential accidents are very concisely reported on the back side of the monthly summary form. The tabulation clearly identifies the areas and the problems where safety engineering effort must be applied to prevent disabling injuries.

The high potentials are a small sample—but a sample selected by the use of good judgment as those few which are truly sig-

nificant cases because they forewarn of impending tragic injuries and losses.

In actual experience with the high potential method with another 6000-employee group over a ten-year period, the high potential method did foresee and prevent tragic injuries before they occurred. The H.P. method also resulted in reducing compensation costs to a low of one cent per hundred dollars of payroll compared with a corporate average cost of 29 cents per hundred dollars.

Now we have seen that there is both an economic and humanitarian need for improvement. We have seen how misleading the injury data reports are. We have seen how the high potential accident data give a totally different picture.

Perhaps we need to be reminded that prior to the fatal and tragic accidents in space chamber tests, there were three previous fires involving pure oxygen in space chamber tests. None of those three previous high potential accidents involved loss of life. Repeated ammonium nitrate explosions occurred prior to the horrible Texas City disaster.

Hundreds of men wearing canister masks went down into tanks never to return alive and thousands died in the fire service wearing canister masks before safety authorities finally provided them self-contained compressed air masks and a chance to live.

Hundreds are crippled or killed when scaffolds fail. Hundreds die from inadequately shored excavations, and from the almost total lack of understanding and appreciation of the high-potential-accident-prone-situation-concept on the part of the designers.

To foresee and prevent tragic injuries and losses, we need only to recognize, investigate and take corrective action on the 14 high-potential accidents out of each 100 minor and 580 near-injuries that occur.

The employees, the first-line supervisors, the in-plant safety engineers are already aware of the high-potential near misses. But, unfortunately, our national safety contests, our company contests, the standard reporting methods, and our own programs have effectively discouraged reporting high potentials. We have inadvertently taught too many supervisors and employees the wonderful saving grace of keeping a few band-aids on hand; of burying the mistakes, the close calls, the high potentials. Too many safety

programs owe their past fame to the standard bookkeeping method, not to accident prevention.

We in safety can honestly share the blame for our natural but unfortunate compulsion to concentrate on injury data; and thus bar the door to the danger signals and the lessons which the high potential accidents offer us. Instead of learning from no-injury accidents and no-damage accidents we follow the USASI standards which ignore forewarning accidents and are based solely on injuries and fatalities.

Top level management study groups have reported that they found our nationally standardized methods of compiling injury data (which we call FREQUENCY OR ACCIDENT RATES) are wanting, meaningless, and useless.

It appears that alert top managements have classified as members of the old school? all who continue to go along without speaking out against the antiquated Standards methods.

The President of the National Safety Council has warned us that accidents are definitely increasing rather than decreasing. The 6 billion-dollar annual losses to industry alone and the tragic space accidents have clearly illustrated the huge loss control needs that demand a new, more effective approach now. If we fail to take this giant step forward, other disciplines will be forced to take over the job that must be done.

About 75 per cent of all Safety Directors have indicated "off the record" that, "about the only time top executives really participate in actual accident prevention activities, is when a fatal or very serious injury, or a catastrophic accident occurs."

But why is this so? Why? Because that is the first clear notice they have given top management that they are in trouble.

But, did you ever hear of a budget director or treasurer waiting until the company was in such deep financial trouble that even the public press knew about it before he alerted the top executives?

Most safety reports to management do not predict or forewarn of tragedy. They cannot forewarn because they do not include the danger flags of the high-potential accident cases that can forewarn us of tragedy and serious losses. Even worse, your own safety department reports have typically indicated that 85 per cent of all your safety problems are the unsafe acts of persons. So,

your top management reacts logically by appealing to Personnel and Training to step up their services or they assign some propaganda specialists to wage a propaganda war to combat this human element that you, yourselves, report to be 85 to 95 per cent of the problem.

Do you realize that one result of our over-all national safety programs, based on the Standard Frequency Rates and Serious Injury Indexes, has been to reduce, not the number of injuries, but the number of injuries reported?

Surprisingly few people seem to be able to face the fact that what is done under the name of "accident prevention" is 99 per cent injury prevention. It is natural that incidents resulting in human injury should assume special prominence in human minds. Yet, paradoxical though it may sound, this almost compulsive concentration on injuries is also the major obstacle to further real advancement toward preventing serious injuries.

In the light of all this, it is scarcely an exaggeration to designate the High Potential Near-Miss Loss Control Method as a "modern key to safety," in tune with modern technological advances.

Since we even loosely speak of accidents, when we really mean injuries, let us recall that an accident is any unintentional occurrence that may or may not result in injury, damage or loss.

An injury is the result of any occurrence that produces harm to the body.

Now, the major reason given for retaining the injury-based "measurement of safety performance" is that an injury is that (necessary) readily identified unit of measurement. But, let us see if this is really so.

Here we have newly developed expressions of the accident-injury ratio. For the first time we see in bold print a factor we have long hidden under the rug—numbers that show the varying ratios of the reported injuries to the actual injuries.

There are only:

100 to 200 minor injuries reported when 360 minor injuries actually occur.

There are:

0 to 1 injuries reported as USASI lost-time cases when 1.5 injuries are actually chargeable.

There are:

6 to 9 serious injuries reported or charged to every 12 serious injuries that occur.

These figures were obtained from in-depth

Construction Section

interviews with employees at Koppers Company and at the Westinghouse Atomic Power Division. They were further verified by a joint study and analysis of the records of about 100 Westinghouse plants by the late Harry Duffus, the Westinghouse Corporate Safety Director and myself; and subsequently by the records of Sandia Corporation.

In every case in every company, a drive on reducing minor injuries resulted in dramatic decreases in the number of minor injuries reported. In several instances a strong warning edict from top levels resulted in immediate reductions of up to 40 per cent in cases reported.

At Westinghouse, Mr. Edgar Barnes, Dr. Raymond Masters, and I established and promoted a radical procedure that encouraged all employees to fully utilize the medical and first aid facilities without any requirement to obtain supervisory permission. Medical provided safety and the employee's supervisor with an individual report on each treatment. No safety department reports of minor injuries were issued to supervision or management, except the monthly totals as an aside to the high potential summary.

This program resulted in a substantial increase in the number of minor injuries reported and a proportional decrease in the actual number of serious, major, disabling, and lost-time injuries.

The figures which Mr. Duffus and I developed have been combined with those developed by Mr. Heinrich and Mr. Bird. They show that, of approximately 13,000 on-the-job accidents, there are:

10,000	No-injury, no-damage accidents
2,035	Near-injury accidents
500	Damage accidents
360	Minor injuries
100 to 200	Minor injuries reported
50	High potential accidents
15 to 35	High potential accidents reported
12	Serious injuries
6 to 9	Serious injuries reported
3.5	Major injuries
0 to 1	Injuries reported as USASI lost-time cases
1.5	Injuries chargeable as USASI lost-time cases

77% of all accidents are no-injury, no-damage accidents.

15% of all accidents are near-injury accidents

4% of all accidents are damage accidents
1 1/2% of all accidents are minor injuries reported

7/100 of 1% of all accidents are serious injuries reported

7/1000 of 1% of all accidents are lost time USASI reported

3/100 of 1% of all accidents are major injuries

4/10 of 1% of all accidents are high potential accidents known of by employees.

For the first time, we see some cold statistical data showing why no two plants or facilities can compare their injury ratios. Many supervisors and employees react to the meaningless, though well-intentioned "Be Careful-Reduce Injuries" campaigns by giving just what is asked for—a "better" record by not reporting all injuries.

Now we all know that the ratios will vary to some degree from one department to another and from one company to another, and one industry to another. They will also vary from year to year. Nevertheless, in every back-breaking study that has covered tens of thousands of incidents, the same general ratios emerge.

Remember that your individual plant tallies have not included the unreported injuries and incidents. I do not intend to argue or defend the specific numbers nor the terms. It would frankly take quite a book to cover the many examples and data that verify the H. P. method.

Suffice it to say the labels are those used for several decades. And it is amazing that any ratios can be established. Statisticians tell me that only when huge numbers of cases are considered can we cancel out the vagaries of definitions and chance.

Until we devote our major efforts to these high-potential accidents, we will continue to be surprised by tragic accidents. We will be trapped by the overwhelming emotional and other pressures to write and publish "defensive" reports of those tragic accidents.

QUESTION: Mr. Allison, would you say that what you have developed and are proposing as the standard method of hazard control is essentially what some of us have been attempting to do in our actual safety engineering work as opposed to the injury analysis, the injury case and injury reporting and contest work that keeps consuming the major efforts of even those of us who try to resist it?

1987 National Safety Congress

ANSWER: Yes, we are in a sense now using a standard method that might well be compared to the time-test life jacket that was only recently discovered to invariably float the body face down. I honestly believe that, if safety engineering as a body, does not face up to this need, other disciplines will do the job that must be done now.

QUESTION: Do you ignore all injuries in your HIPO Hazard Control Method?

ANSWER: No, all injuries are scanned and it is amazing in practice how readily the few HIPOs among them are identified. The overall new Accident-Injury Ratios I have shown you indicate that, statistically, only two per cent of all injuries are HIPOs. Of course, you cannot literally apply exactly 2% to the small number of injuries your facility may have in one month or one year. It may be many more or less in a given small sample.

QUESTION: I certainly agree wholeheartedly with your concepts and am sure everyone who has a well established accident-prevention program agrees that your HIPO HAZARD CONTROL METHOD is the next step we should take to advance accident prevention. Why do you believe we find so much resistance to it from the Z16 Committee?

ANSWER: I hesitate to answer that question. I can only tell you that most of its members are now proudly winning Injury Rate Award Placques. They are winners under the Standard Method. Why change the rules when you are winning? Many people insist that we must have safety contests; that it is the heart of their association and council programs. I believe the very fact that the contests have been the heart of past programs is the major reason that, in this year, 1987, we still have not scratched the surface of the gold mine of the accident-prone situation and design concepts that now cost industry 85,000 permanent cripples and \$6 billion dollars a year. If safety leaders insist on contests, the only realistic measurement is the yardstick of dollar costs per \$100 of payroll. The HIPO Rate of HIPOs per million hours worked is not intended for contests. It is intended for use with judgment by your own Safety or Hazard Control Staff.

QUESTION: I am not sure I understood why you do not use Damage Control. Would you explain why?

ANSWER: The HIPO HAZARD CONTROL Method foresees tragic or major injuries and damage so they can be prevented before they occur. After many years of preparatory work, followed by seven years of a complete program of Damage Control in its founder's own plant, he says in his book, "There was no significant reduction in Disabling Injuries."

On the other hand, after only a few years of full use of the HIPO Method in its founder's own plant, Disabling Injuries were practically eliminated for years at a time and compensation, medical and fire losses were reduced to a mere one cent per hundred dollars of payroll compared to the corporate average of 29 to 39 cents.

QUESTION: Are you saying that your recommended unit of measurement of safety performance as a new standard is the cost of accidents per hundred dollars of payroll, and if so, why that unit?

ANSWER: For many, many years some corporations have recorded their direct costs of compensation, medical treatment and fire losses on the basis of cents per hundred dollars of payroll. It provided me a measure of the true hazard control of approximately one hundred plants with which to compare our costs. This unit rather accurately reflected a realistic measure of safety performance. Indeed, in auditing our performance, it so impressed the Corporate Safety Director that he heartily endorsed the HIPO Hazard Control Method. He also said that, from his own very knowledgeable audits of other plants, those with obviously poor performance, invariably had a very high cost ratio. Since these costs are common to all operations and are direct costs, they provide a base for realistic comparisons of hazard control or safety performance. It is a cost figure that is readily understood and accepted by management as an essential part of their responsibility. In other words, it makes hazard control (safety) an essential part of the management function and lifts safety out of its nickel and dime and its mythical and far-out frequency category.

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GLASS & CERAMICS SESSIONS

COMPUTERS CAN HELP PLAN A SAFETY PROGRAM

By MANUEL SPINNER

Manager, Plant Engineering Dept., Glass Division, Ford Motor Co.

You may consider the computer as the exclusive property of the "whiz kid" fresh out of college, who plans to revamp your entire firm with this magic wand. However, if your firm is going to have this "new look," it will not be done singlehandedly by the recent college graduate, but by men who have practical training and experience, who can make the computer a most valuable weapon. But you must provide the computer with data that makes sense.

How can this be accomplished? Of course, if you have a new plant to construct, you have a better start, especially when it is generally understood that safety is an integral part of a plant and safety requirements must be satisfied before the plant can go "on stream."

Too often new plant construction safety programs are given the "stepchild" treatment as emphasis is placed on those items essential to begin production. Consequently, a plant start-up is usually void of many essential safety requirements, resulting in temporary implementation and many times requiring "crash" projects to complete.

A possible deterrent to this condition is the Critical Path method of planning and scheduling which has come into its own in the last five years and has seen wide acceptance in the construction field. The first step in using computers to plan a safety program is the knowledge of the Critical Path Program. This technique utilizes computer calculations which permit the "management by exception" principle, where you can concentrate on reviewing the status of the critical items only. This technique provides safety engineers with the means to participate more actively in plant construction, expansion, or renovations.

CPM Fundamentals.

Before proceeding with how this technique works, let us discuss briefly the fundamentals. A minimum training effort in this method, which would be the "A-B-C's," is

needed before using it; it is not difficult. To understand the fundamentals, several basic terms have specific meanings which, in this technique and the literature, differ from general usage. This basic terminology allows for understanding the philosophy of Critical Path and permits presenting a relatively simple training course.

PERT and CPM can be considered as having the same results through activity and event orientation.

Let us begin the "mini" course.

The Critical Path method is a new management technique for *planning, scheduling, and controlling* projects which consist of a group of interrelated activities or jobs that are directed toward a common goal.

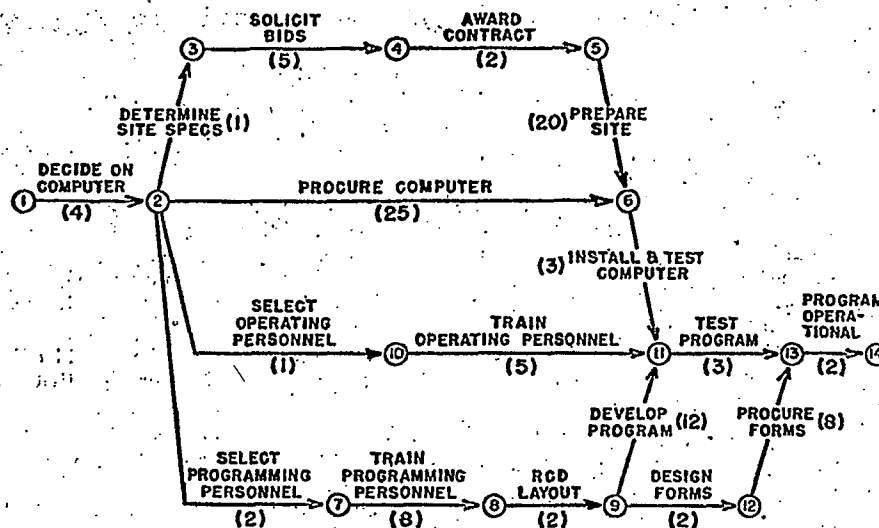
The *planning* phase of a project consists of determining a proposed method of action or procedure. In this technique, planning must be separated from scheduling; therefore, it is independent of timing. Planning involves making an analysis to determine what specific jobs are to be done, the sequence of work required in accomplishing the project, and the interrelations between jobs.

Job 1, 2 "Decide on Computer" (Fig. 1.) must be completed before any other jobs are started. The job "Procure Computer" 2, 6 must be completed before Job 6, 11 can be started. Also Job 2, 6 "Procure Computer" can be performed concurrently with the jobs on three other paths: the path above Job 2, 6; the path below it; and the path at the bottom of the diagram.

Drawing the network plan on "arrow diagrams," which is done in conjunction with the planning analysis, allows for answering questions such as these:

1. What other activity(s) must be completed before this activity can start?
2. What other activity(s) can be done while this activity is being done?
3. What activity(s) cannot start until after this activity is done?

SAMPLE PROBLEM — ARROW DIAGRAM



— ESTIMATED JOB TIMES (WEEKS) Fig. 1

After planning, the next major phase is *scheduling*. Scheduling is the development of a timetable from which time estimates are placed on the plan. The schedule indicates when each activity is to be accomplished.

The numbers within the parentheses (Fig. 1) are estimated time requirements for each job. They may be days, weeks, or months. Job 1, 2 has a time estimate of four weeks; Job 2, 6 requires 25 weeks; etc. The time estimates must be realistic in order to produce a good schedule for meeting deadlines and avoid unnecessary project costs.

The next step in scheduling is to determine the Critical Path. It is the longest path on the network for the project in terms of time. The project duration is the total time required for the jobs on the Critical Path.

The Critical Path is determined by adding the time requirements for the jobs in each path:

The top path via Jobs 1, 2, 3, 4, 5, 6, 11, 13, 14 requires 40 weeks.

The next path requires 37 weeks.

The third path requires 15 weeks.

The next path requires 33 weeks.

The last path requires 28 weeks.

The 40 weeks required for the top path is the longest in duration of any of the paths, and is the Critical Path. This 40 weeks is, therefore, the estimated time required to complete the project.

Jobs on the Critical Path have no "float." Float is defined as the time the performance of a job may be delayed without delaying overall project completion. On all other paths in the diagram, some flexibility is permissible without delaying the project completion. The actual scheduling—establishing the start and finish times for each job—can then be made by management. This includes making decisions on how to use the available float for the best allocation of money, manpower, and other resources. For small projects, the calculations can be made manually; for large projects, a computer is required.

The third major phase of the Critical Path method is *controlling* the project. Exercising control of the work in a project consists of coordinating action in such a way that objectives are accomplished in accord with management planning. With the Critical Path method, management personnel are provided

with periodic reports based on output printed by a computer. These reports keep management abreast of the progress of the project. The reports show (1) jobs completed, (2) actual completion time of the completed jobs, (3) jobs that are on schedule, and (4) jobs that are behind schedule.

To summarize, using a different project from the computer installation, we will compare this management information system with the conventional bar chart familiar to almost everyone in industry and which has been the traditional approach to planning and scheduling. This chart provides some valuable information, such as the duration of major items and starting and ending times. However, from the standpoint of effectively planning, scheduling and controlling a project, additional and more accurate information is required. For example, this method will have an exceptionally difficult task to answer these questions:

1. Which portions of the design can be done concurrently with fabricating and procuring parts?
2. Which parts of the design must be completed before other parts of the design can begin?
3. Which activities are to be given priority in order not to hold up completing the project on schedule?

Yet, when we note the network, we can answer these questions rather readily. For example:

1. While we are procuring parts and shop fabrication, we can be preparing the installation designs.
2. The sequence of designs, design equipment, detailed equipment design, and installation designs are distinctly shown.
3. The path—design equipment, detailed equipment design, procure parts, install equipment and tryout—must be given priority as this is the critical path.

As the Critical Path permits improved methods for controlling projects by the use of a computer, substantial time can be saved in decision making. Alternate methods can be evaluated with some degree of thoroughness.

CPM Application.

Our plant engineering activity has used the Critical Path method on a number of multi-million dollar programs. Since the Mt. Clemens paint plant allowed for rather ac-

tive participation by the safety personnel through the use of Critical Path method, we can use it as a typical example:

The Mt. Clemens paint plant doubles our previous paint production, as well as producing resins heretofore purchased for use in the paint formulation. Approval to go ahead was given by the Board of Directors in October, 1964. Construction costs were in the millions, and the entire program required over two years to complete. As this was a new venture for automotive manufacturing personnel the complexities that were expected to be encountered made the use of the Critical Path method a mandate.

The CPM diagram for the paint plant shows only major activities. For this size job some firms would prepare diagrams of 3,000 to 5,000 activities—this diagram contains about 500. Our activity uses CPM to stress planning by monitoring periodically construction progress against the diagram and with specific reference to the status of the milestones.

Milestones represent the key objectives during the course of a program or project. So that the end completion date is defined properly, milestone dates must be met: *Milestone—Start Paint Production, Node 246, 3/1/66*. All of the activities needed to support the production of paint which lead into this activity will determine the planning date. A computer run predicts the ability of confirming this date.

The milestone concept leads into the safety engineer's participation. Our division safety engineer became one of the astute students in CPM and was quick to learn the impact of milestones. He used Node 246 to investigate all of his safety items and activities essential to the production of paint. Such items as gate security, hose carts, extinguishers, protective safety equipment, and other industrial relations items for which he also assumes responsibility are diagrammed—"keyed" to milestones which have been oriented to production. Most important is the means by which he can apply logic, as simple as it may seem, to develop the scope of his responsibility.

The timing of these safety items was evaluated from computer-based programs designed by Ford Motor Company with the output reports being peculiar to Ford Motor Company procedure. The information contained is the type of information that our or-

ganization believes is desirable and it may not necessarily be appropriate for other activities. Information available through the computer outputs include milestones reports, schedule data, and bar charts.

In the milestone report the safety engineer can review a summarized schedule relating to his particular milestones, of which he has incorporated the master diagram milestone report. Node 248, for example, shows from this report that he is 22 days behind schedule.

The safety engineer will then look at the scheduled data report and will note the activities that contribute to the behind-schedule condition. In this instance, there are a number of activities that contribute to the delays and the safety engineer is able to take each of these items and act accordingly. Where the responsibility rests with him, he must contact suppliers and expedite deliveries. Where the responsibility lies with management heading the project, he must notify them of the impact of not having the various safety innovations on time.

Based upon his review, the safety engineer communicates with management personnel citing substantial facts at an early date of the pending problems. Critical Path planning will provide the ability to predict in advance and avoid crises.

Another computer printout is the bar chart. At a glance, the Division Safety Engineer is able to note the pertinent activities with respect to a calendar if a job is behind schedule, being performed on time, or ahead of schedule. This chart is primarily used for reviewing alternatives during the course of a program. For example, when there is a delay anticipated, some planning activities can be juggled, based upon their proposed starting times.

Conclusion.

In conclusion, we can substantiate the usefulness of CPM with these facts: Paint production, which was admittedly complex, was able to start within 15 days of the March 1 planned starting time. When you consider that this date was determined about two years prior to start-up and the labor

climate and equipment delivery conditions causing abrupt changes during this period, the Critical Path technique did help us meet our commitments.

CPM has its share of pitfalls but a great deal of them are due to inexperience, and the problems lessen with the completion of another job. However, there are still problems inherent with the present method and the scope of these problems is dependent on the individual. Time and effort is necessary to keep this technique a dynamic part of the project; therefore, for effectiveness this type of work must become a portion of your working routine.

Secondly, as the computer essentially answers only "yes and no" questions, the programming is extensive and input data takes time to prepare. We at Ford would like to reduce this detail and are pressuring Operations Research to simplify as much as possible the input requirements. We are getting encouraging response.

Finally, an essential requirement of CPM is personal discipline for thorough analysis and thought. The program is as effective as your ability to think and plan, which you diagram.

My answer to those who show resistance to this type of program is this: I know I am "one up" on anyone else in the planning of my project by using this technique. If there is a better way, I do not know of it.

CPM cannot provide 100 per cent assurance of a successful program but it most certainly will give you a great deal of management information data to deal with potential problems and, therefore, the ability to maintain an orderly direction of your project. If I can make any recommendations, it is that computers are here to stay as the potential is boundless and we must learn to use them properly. If I were asked to offer a suggestion for a basic training course essential to computer oriented operations for safety engineers, as well as any other activity, it would be to learn the Critical Path method. Logic is "the name of the game," and here is a way to "play" it.

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**INDUSTRIAL
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NATIONAL SAFETY COUNCIL

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55th NATIONAL SAFETY CONGRESS

Papers Delivered in the

INDUSTRIAL SAFETY SESSIONS

DRIVER IMPROVEMENT

- How to Recruit and Train a Team of Good
Instructors and Keep Them Happy.....*R. Paul Lawrence* 5
- Defensive Driving Course for Traffic Law
Violators in Tampa.....*Merrill Pollard* 6
- How to Organize State Employees for DDC Training.*Dr. Thomas S. Claros* 8
- Defensive Driving Course Graduates Get Point
Credits in West Virginia Program.....*Lieutenant R. E. Stanley* 11

MEDICAL AND HEALTH

- Applying Medical Concepts to Injury Control.....
Julian A. Waller, M.D., M.P.H. 13
- The Role of the American Medical Association
in Accident Prevention.....*E. B. Howard, M.D.* 19
- The Nature and Prevention of on the Job
Accidents to Office Workers.....*Norman C. Kiefer, M.D., M.P.H.* 22

EYE SAFETY — PROGRESS AND PROBLEMS

- Eye Protection in Industry and Education.....*Francis Wischmeyer* 29
- Eye Safety—One Firm's Formula.....*B. S. Edmondson* 32

HUMAN FACTORS ENGINEERING

- An Overview of Human Factors Engineering.*Julien M. Christensen, Ph.D.* 37
- Application of Human Factors Engineering
To Safety Engineering Problems.....*Ross A. McFarland, Ph.D.* 49
- Justification for Introducing Human
Factors into an Industrial Setting.....*Dr. Jack A. Kraft* 62

THE SAFETY SPECIALIST'S FUNCTION

- What I Expect of the Safety Specialist.....*Arthur H. Christian* 69
- The Safety Engineer—What I Expect From Him.....*Paul A. Stewart* 77
- What Labor Management Expects of the Safety Specialist.....
J. George Eichhorn 80
- Middle Management.....*Harvey E. Jonas* 82

(Continued on next page)

CONTENTS—continued

OFF-THE-JOB SAFETY

Opening Remarks.....	Robert F. Beeson	85
Developing an Off-the-Job Activity.....	Robert B. Regan	85
Safety Glass Demonstration.....	Thomas C. Klapperich	87
The Psychological Point of View.....	Howard Klopp	90
The Community Viewpoint.....	Janice R. Westaby	92
Industry Response.....	William J. Kerns	94
Hazards of Using Urethane Foam in Enclosed Spaces....	Edwin M. Murphy	99
Hazards and Controls in the Industrial Use of Lasers.....	R. M. Lumley	102
Maximum Acceptable Weight of Lift.....	S. H. Snook and C. H. Irvine	107

TRAINING—COMMUNICATIONS IN SAFETY

Are You Hard of Listening?.....	Kenneth J. Lille	113

SAFETY PAYS AT MOBIL OIL

Mobil's Safety Philosophy.....	H. J. Peckhelser	116
Profile of Mobil Oil Corporation.....	F. J. Doolan	117
Mobil's Safety Program Worldwide.....	J. J. McKenna	119
Safety in Mobil Chemical.....	C. S. Dedon	121
Fire Prevention at Mobil.....	Leonard O. Franklin	125
Mobil Fleet Safety Programs.....	Donald E. Johnson	127
We Want You to Live.....	Nicholas L. Bristow	128
Protection of Employees on the Job.....	T. E. Allen, M.D.	131
Safety Research and Engineering.....	H. S. Mahley	134

SAFETY IN SCHOOL CURRICULUM

How Can Industry Help Educators Build a Better Curriculum for Total School Safety Education.....	Cecil G. Zaun	137
Do Students Receive Satisfactory Safety Training.....	George W. Greenwood	140

MEDICAL VIEWS OF 3 A'S IN INDUSTRY

Attitudes.....	Vladmir G. Urso, M.D.	145
Alcoholism.....	Robert R. J. Hilker, M.D.	148
Absenteeism.....	Gerald W. Grawey, M.D.	152

Officers of the Industrial Conference 1967-68.....	155

Members of the Associations Committee 1967-68.....	157

Five Years of Future Dates for the National Safety Congress.....	158

Other Volumes in 1967 National Safety Congress Transactions.....	Back Cover

Driver Improvement Session

HOW TO RECRUIT AND TRAIN A TEAM OF GOOD INSTRUCTORS AND KEEP THEM HAPPY

By R. PAUL LAWRENCE

General Manager, Alberta Safety Council, Edmonton, Alberta, Canada

Canada covers a vast area, but traffic is no problem over a great deal of the Northern Territory. Where it is a problem, however, it is just about as intense as in the U.S.A.

The concentration of population in Canada is confined to the southern portion of the country, a strip about 500 miles northward from the border stretching east and west across the country.

In Alberta, there are two principal cities and eight small ones. Calgary, the home of the famous Calgary Stampede, is about 175 miles north of the boundary with a population of 360,000. Edmonton, the capital, is 200 miles further north and has a population of 400,000. The population of the province is about one and a half million.

Recruiting Instructors.

In the beginning, the Board decided as a policy of the council that we would not charge any fee whatever for training instructors. We would not differentiate between instructors who were being trained for company work and those who wanted to teach public courses for us. Naturally, we extracted a promise from everyone that they would teach at least two courses for us, but the main idea was to get them teaching courses to someone. Furthermore, we decided to pay the expenses of out of town applicants accepted by us for instructors' courses in Edmonton or Calgary.

The Board also decided that this policy would be rescinded when it had accomplished its purpose of getting D.I.P. away to a running start.

You can appreciate that with this training policy, we could be choosy about the people we would accept as instructors. We took full advantage of conditions and made our early instructor courses strictly invitation affairs.

I can assure you that this very selective policy of choosing and training instructors has paid off in quality of instruction. Most of the men who trained with us in the fall of

1965 are still our star performers and are trainers of instructors in current courses.

There have been some recent changes in policy. As of September 1, 1967, we no longer pay travelling expenses to out of town candidates. Local organizations sponsor instructors to our courses and it is becoming a mark of prestige to be accepted for training as an instructor of D.D.C. We still make no charge for training or for the *Instructor's Manual*.

Our recruiting policy will now be moving 35 miles or more away from centres which already have instructors.

Training.

The strength and effectiveness of D.D.C. stems partly from the fact that amateurs instruct it. Professional teachers might do a more skilled job, but they might not identify with the class as readily as a person who is making a hobby of helping his fellowman.

However, we put quite a lot of effort into making our volunteers as skillful as possible. For example, we limit the size of instructors' classes to 15 people.

The first day we give them the Defensive Driving Course itself.

One of our qualified trainers of instructors is in charge. He may teach two or three of the eight sessions, but he will have arranged for several other qualified instructors to come in and give one or two sessions each. In this way, the class is exposed to a number of different personalities.

At the end of the first day, the students receive their *Instructor's Manual* and are given practice teaching assignments for the next day.

The first hour of the second day is taken up with "Session 9". In this session we emphasize correct use of visual aids. We stress over and over the necessity to speak clearly and to answer questions clearly and concisely. We unpack an instructor's kit and re-pack it, and we caution students to be careful with

films. Last, but not least, we advise them to always dress properly when instructing. Jackets and ties are a must.

At this point, the practice teaching begins, and a panel of about two instructors and one student act as critics. If we have no more than 15 students, each student will have almost 20 minutes on his feet. The more students there are, the less individual attention can be given to them.

This procedure seems to give most of the candidate instructors a keen desire to excel and many of them come back in groups of four or five to do more practice teaching.

How To Keep Them Happy.

I wish there was a guaranteed way to keep people happy, but I'm afraid there

isn't. We do the obvious things of course. Praise and recognition and gratitude reach the ears of their bosses, their families, etc. Occasionally we have one of them interviewed on radio or T.V. and perhaps wangle a quote in a newspaper. In other words, we do all we can to boost their image in the community.

Now and then we try to arrange an evening out for the instructor and his wife. Sometimes this is a nice dinner for three or four couples. At other times, I can manage tickets to some banquet and dance which they will enjoy.

In short, we try to make D.D.C. instructors feel that they are members of a small, exclusive fraternity doing skilled and important work for the benefit of the community.

DEFENSIVE DRIVING COURSE FOR TRAFFIC LAW VIOLATORS IN TAMPA

By **MERRILL POLLARD**

Executive Director, Greater Tampa Citizens Safety Council, Tampa, Fla.

The first Instructor Development Course was conducted for the Greater Tampa Citizens Safety Council by members of National Safety Council staff, in April, 1965. Among the students were four members of the Tampa Police Department who were serving as instructors in traffic courts of Tampa Driver Improvement School. These men were tremendously impressed, began to compare it with the course they were giving to traffic law violators, and came to the conclusion that National Safety Council Driver Improvement Program was more effective than what they were doing.

The Florida Federation of Safety Councils had been formed early in 1964, its nucleus being the Dade County Citizens Safety Council, the Jacksonville Duval County Citizens Safety Council, and the Greater Tampa Citizens Safety Council. From its very inception, the Federation worked closely with the Florida Highway Patrol.

At the first annual meeting of the Federation in May, 1965, there was agreement that the Federation, in cooperation with Florida Highway Patrol, should prepare a Procedure

Guide for the Administration of the National Safety Council Driver Improvement Program in Florida. As incoming chairman, I was given the responsibility for drafting the Guide. This was approved by the Executive Committee and the Florida Highway Patrol and formally accepted at the Federation's next meeting in September of 1965.

Without this Procedure Guide, Florida never would have been No. 1 in the nation for number of people trained in 1966 and for most of 1967. And it never would have been accomplished without the Florida Highway Patrol. Captain Roger C. Collar, Chief Safety Education Officer, has been spokesman for the Patrol and its representative at each Federation meeting. His recommendations helped to make our Procedure Guide the sound document it has proved to be.

From the time of its introduction in Tampa, the value of the Driver Improvement Program was recognized, and the citizen leaders of our Safety Council gave it their complete support. This is best evidenced by our standing second only to Balti-

Industrial Safety Subject Sessions

more for number of people trained in both 1966 and to date in 1967 among safety councils across the country.

In January, 1960, the Tampa Police Department Traffic Division's Captain L. J. Buchanan was asked to suggest a project for the Greater Tampa Freight Carriers Association, an organization of trucking companies. His twenty years of experience had led to the belief that nothing was more important than driver education. He suggested such a program for traffic law violators and the freight carriers donated \$500 to get it underway.

A non-profit organization was formed and chartered by the state to run the school. The director and officers were the Municipal Court judges. Supervisors of Tampa Police Department Traffic Division agreed to serve as instructors for the school. Knowing of the fine work being done in driver education by the Traffic Education and Safety Division of the Municipal Court of Chicago, a letter requesting details of their course brought prompt response.

With this information, an outline was developed to meet the problems of Tampa's drivers. The course consisted of five two-hour sessions conducted at night in one of the Municipal court rooms. A violator assigned by the court had to attend school one night a week for five weeks, the fifth session consisting of tests in the driver lab and a final examination. The first class began June 13, 1960. Supervisors of Tampa Police Department Traffic Division instructed on their off-duty hours. Students were traffic offenders sent to the school by Municipal Court of Tampa and the Juvenile Court of Hillsborough County.

From its beginning, Traffic Courts of Tampa Driver Improvement School had the support of many organizations. Helping to finance the program were the Independent Insurance Agents of Greater Tampa, while the Safety Council loaned films used in the school. After two years both the city and the county included the school in their budgets. The Independent Insurance Agents agreed to finance one-third of the cost, with city and county support adding the remaining two-thirds. This agreement made it possible to pay the police instructors for their off-work.

The school continued to grow, with new classes being started once or twice a week.

Many organizations, including MacDill Air Force Base, took advantage of the available instruction and sent their drivers through the school. It was also found that the students became better drivers. The repeaters were less than one per cent.

Having heard so much about the National Safety Council Driver Improvement Program from his instructors, Captain Buchanan took the Instructor Development Course in March, 1966, and recognized that here was a better mousetrap. He began to ask for details of administration and agreed with Greater Tampa Citizens Safety Council to buy all student materials through them and report numbers trained once each month. Independent Insurance Agents of Greater Tampa approved and supported this arrangement.

Beginning August 29, 1966, the old outline was phased out and the Defensive Driving Course became the training program used by Traffic Courts of Tampa Driver Improvement School. Violators assigned by the court on Monday, for example, attend four Monday nights, those assigned on Tuesday, four Tuesday nights, and so on through Thursday.

Instructors were more and more pleased with class participation and are now the most ardent advocates of DDC. Captain Buchanan would like to build a classroom and conduct courses morning, afternoon, and night five days a week for the public.

In the spring of this year, Tampa's mayor ordered all city employees who drive city vehicles to take the Defensive Driving Course. Tampa Police Department was the first of twelve departments in the city to complete it—and you need not be told who served as instructors. These men from the Traffic Division also helped to conduct courses for the other departments. Since this phase of training has been completed in mid-June, the City's Safety Director, Robert George, reports an 18 per cent reduction in accidents involving city vehicles.

The Police Department, as well as the Fire Department, now includes DDC as part of its recruit training program. The course is also being offered to all city employees.

We in the Safety Council have another advantage because of Traffic Courts of Tampa Driver Improvement School. Whenever a student misses a session in another course being offered in the community, he can always make it up there. Individuals

calling wishing to take the course are referred to the school and have their choice of one of four nights each week they can attend.

Tampa has one of the finest police departments in the nation. It has intelligent, dedicated officers and those who serve on the Driver Improvement School faculty are among the best instructors to be found anywhere. Their effort has helped to keep our Safety Council first in Florida and Florida first in the nation.

You may wonder why this is so important to us. Perhaps a statistic provided by the Florida Department of Public Safety will explain. Our great state was visited by nearly 18 million people last year—82 per cent

coming by automobile. Our drivers must really learn defensive driving tactics and maintain a courteous attitude towards tourists, one of the state's greatest assets.

When you come to Florida you, too, will be impressed with what we have to offer. An outstanding Highway Patrol will guide you to Tampa where you can visit Safety Village, also sponsored by the Independent Insurance Agents, and observe how youngsters learn about traffic safety during the day, and then take the time to visit Traffic Courts of Tampa Driver Improvements School at night—not as a violator, but for the purpose of observing some genuine professionals instruct the people who need it most in the Defensive Driving Course.

HOW TO ORGANIZE STATE EMPLOYEES FOR DDC TRAINING

By DR. THOMAS S. CLAROS

Chairman, Driver Improvement Program, State of Connecticut, Hartford, Conn.

The Connecticut State Police were the first state employees to find out about the Driver Improvement Program. The State Police Commissioner approached Governor Dempsey on this program. The governor put his complete support into the D.I.P. and we were on our way. Your first step, therefore, is to get the governor of your state to support the program.

On January 27, 1968, Governor Dempsey called a meeting of all major agency heads, some of whom were not members of his cabinet. Present were the Commissioners of Highway, State Police, Health, Mental Health, Education, Auditors, Banking, Insurance, Consumer Protection, Development (now called Community Affairs), Finance and Control, Labor, Military, Motor Vehicles, Personnel, Public Works, Secretary of State, Tax, Welfare, and a few others. At the meeting, he announced that he was starting a Driver Improvement Program, gave a general orientation of D.I.P. to the agency heads, and requested their cooperation in making the program a success by authorizing all training to be done on state time.

He also announced that he had appointed

a Coordinating Committee of five to coordinate the D.I.P., with his Executive Assistant as a liaison. The committee consisted of the State Training Coordinator, the Highway Chief Safety Engineer, the Executive Director of the Connecticut Safety Commission, the Fleet Administrator, and the Commanding Officer of the State Police Traffic Division. We suggest that a Motor Vehicles Department representative also be placed on this committee. Your second major step, then, is to have a committee representing traffic, safety, training, licensing and state fleet administration.

This meeting received television coverage by all Connecticut channels, the major radio stations and newspapers. The people of Connecticut thus became aware of the fact that the state was trying to make state employees better, safer, defensive drivers.

The Coordinating Committee met after the governor's meeting, chose a chairman—the training coordinator, because it was a natural for the training man. This was explained to me quite profusely by the other four members of the committee.

Our first official act was to draft a letter to

Industrial Safety Subject Sessions

be sent under the Governor's signature to all agency heads. We next met February 10, 1966, at the office of the secretary of the Hartford Accident and Indemnity Insurance Company, our State Fleet Insurer. The committee, the Hartford A & I secretary, and Carl Basl, National Safety Council District Director, were present at the meeting. Mr. Basl explained the procedure to be followed in training instructors for our 30,000 state employees; how the Connecticut Safety Commission would apply to become a cooperating agency; how to order materials and the approximate costs. The secretary of the Hartford Accident and Indemnity Company informed us that they would underwrite the costs. The actual costs by the way, to train 119 instructors and 6,156 employees during 1966 was \$8,762.26. It was decided that we would need about 100 instructors to cover 30,000 employees; ten training kits; 10,000 student materials to receive the maximum discount from the National Safety Council, and that we could train our first 50 instructors on March 23-24, 1966. The third step to bear in mind is a sponsor. We believe that your state fleet insurer would be the ideal sponsor for your D. I. P., or D. D. C.

The third and last meeting of the Coordinating Committee took place on February 14, 1966. At this meeting, 25 agencies and institutions were selected, and allotted from one to five instructors. This was based on the size of the agency as well as the jurisdiction and physical area covered. Departments with district offices throughout the state were given more instructors than those agencies located physically in one building, even though the latter may have had the same number of employees. During this meeting, a list of the Coordinating Committee member's names, addresses, and telephone numbers were distributed to all, along with minutes of the previous meetings.

A letter was drafted to be sent to designated agencies. In this letter we advised the agency heads to select the number of instructors we suggested from employees who could teach and to include, if possible, the agency motor vehicle safety officer. This worked out very well until we discovered that one prospective instructor who was an excellent teacher did not have a driver's license, nor could she drive. So make it a point to emphasize the fact that designated instructors should have a driver's license.

The committee felt that all stencilling, xeroxing, letter-writing, ordering, communications in general should be done at one source, go to one source, and leave from one source. In addition, the storage and maintenance of the kits, the storage of the student materials (almost two tons) should also be in one central area, preferably close to the training coordinator's two training rooms. The fourth step to be remembered is the proper selection of instructors.

The latter part of February we received our code designation of 7-AA1 and in March we trained 54 instructors from 29 different agencies and institutions. The State Police Department, in the meantime, had trained 22 instructors, two from each barracks, plus six from the Highway Department and the Fleet Administrator. Our March report to Governor Dempsey showed 84 instructors and 187 employees trained.

The first class of instructors was again highly publicized through television, radio, newspapers, and personal interviews. This was something new, and news media gave us unsolicited coverage, for which we were very grateful. A statement from the governor was also read to the graduates, and each one received his green card and a *Certificate of Achievement* designed by us. The latter was signed by the governor, the chairman, and the agency head. Each instructor was also given a form letter to be used in requesting an instructor's training kit and training materials. This is still being used with great success today, as well as two monthly reporting forms to the governor. One of the forms is designed to keep a running total of the number of employees trained since its inception and the other one is a general report. The fifth step in organizing DDC training for state employees is to devise a number of forms to facilitate reporting and make the requests for materials uniform.

The chairman made it a point to visit every instructor while he was actually teaching a class. He made return visits to present each instructor with his instructor's card. In each instance he took five minutes of the class time to congratulate the participants and instructors, and to bring them up to date on the D. I. P. progress. This is a necessity, because I did run into a situation where two instructors were not following the proper procedure and we did get into an awful mess. It was necessary to have the em-

ployees take the course over again. The sixth step is close instructor supervision.

By September of 1966, we were running into difficulties because of the shortage of instructors, but our ten kits were sufficient. In November we trained another 35 instructors, from 13 agencies, bringing our total of instructors to 119. At the same time, the National Safety Council informed us that they were changing the films, and the Fleet Administrator informed us that the Hartford Insurance Group was no longer our insurer. The Travelers Insurance Companies, the new insurer, knew all about our D.I.P. They agreed to continue sponsoring the program and went a step further. They permitted us to use their training facilities to train our instructors; we trained 14 of their employees as instructors and they also became a Cooperating Agency.

In December, another governor's directive was sent to all department and agency heads informing them that those agencies which had no instructors could contact us, and that their employees could attend D. I. P. in the state office building in Hartford. Our main objective was and still is to have the instructor travel, not the students.

By March of 1967 we had 15 kits and 15 new sets of films. All instructors were asked to preview the films and this was done. During this month we received the February issue of the National Safety Council *Newsletter* which reported that the State of Connecticut was fourth in the nation by number of employees trained. By this time, we were receiving a sufficient quantity of Newsletters and these were and are being sent to all instructors.

In July we ordered another 10,000 sets of student materials and these, of course, were the new *Student Workbook and Outline*. The instructors were all asked to come into Hartford in small groups, and our instructor went over the material in detail with them. There were no problems involved in the passout material changeover, as there were no difficulties in the film changeover. In July we renewed our Cooperating Agency status and also reexamined our instructor position, based on a communication from the National Safety Council. We transferred some candidate instructors and eliminated others, ending up at present with two qualified candidate instructors, 92 quali-

fied instructors and four qualified instructor trainers.

At the present time we find that we must train additional instructors for our institutions, such as our Health and Mental Health Department Regional Centers. This will be done some time in November. As of today, we have trained 13,498 employees of our total 30,000 at a cost to our insurers of \$13,424.41. This, over a period of nineteen months including October, 1967. We feel that this will be a continuing program, even though we train 10,000 a year and will cover all state employees by 1969. We have labor turnover, new employees being hired, thus making it necessary to carry this important course as an integral part of our In-Service Training Program.

Don't let the enormity of the program scare you. You can do it and you do have some guidelines that many of us didn't have when we started. All you need is self-confidence and determination.

If you want your program to be successful:

1. Make sure DDC has the full support of the governor of your state. With his support the agencies, departments and institutions will participate fully. The occasional governor's directives have an excellent prodding effect.

2. Suggest a coordinating committee, consisting of experts in their fields: safety, your Safety Commission; traffic, your State Police; safety engineering, from your Highway or Labor Department; licensing, from your Motor Vehicle Department, and your State Fleet Administrator, the fellow in charge of all your state vehicles.

3. You must have a sponsor and the most logical one is the insurance company which insures all state vehicles. Your insurer wants to see the accident rate lowered. There is no doubt that he will cooperate in this effort to make your drivers safer ones and accident free.

4. The future and the success of your program depends upon the proper selection of candidate instructors. Make sure they are teachers, if possible; if not, make sure they can stand up before a group and speak. They can be taught to teach, but you do not have the time to assist them in overcoming stage fright. They must be licensed drivers. Having a legless man teach running is not too receptive by the students.

5. Develop forms to be used by you and the instructors. It is time-saving and makes your operation uniform.

6. It is of utmost importance to supervise your instructors. You have their schedules. Drop in on them. You will thus make sure

that they are teaching the eight-hour course in eight hours; they will appreciate your dropping in and giving their class the overall picture and general progress of the program. Visit your older instructors as well as the neophytes. Take no chances.

DEFENSIVE DRIVING COURSE GRADUATES GET POINT CREDITS IN WEST VIRGINIA PROGRAM

By LIEUTENANT R. E. STANLEY

Chief, Accident Prevention Bureau, West Virginia State Police, Charleston, W. Va.

West Virginia was somewhat of a "Johnny come lately" in implementing its Point System, which was adopted during the latter part of 1962. There had been a great deal of discussion on the merits of this particular type of program in West Virginia for a number of years and it had been discussed at several Coordinating Committee meetings.

Available information and that resulting from internal dialogue indicated that the negativity of the Point System *per se* needed to be offset by some type of positive action, preferably retraining for those drivers who habitually drove in a reckless or unsafe manner.

These discussions indicated that the state very definitely needed a system whereby reckless or careless drivers could be identified, not necessarily for the purpose of elimination but that they might be rehabilitated or motivated to drive in a safe, law abiding manner.

There are two paths that can be followed in establishing a driver control or Driver Improvement Program. It can be incorporated into the law by legislative mandate or by general legislative authority to operate under administrative rule.

West Virginia chose the latter for two reasons; to allow latitude in administration and to eliminate the time gap between obvious need and legislative action.

The West Virginia Motor Vehicle Code gives the Commissioner of the Department of Motor Vehicles discretionary suspension power when a driver had been convicted with such frequency of serious offenses against traffic regulations governing the movement of vehicles as to indicate a disrespect for traffic laws or a disregard for the safety of other persons on the highways or is

a known habitually reckless or negligent driver of a motor vehicle.

This particular law was interpreted to mean that the Commissioner of the Department of Motor Vehicles could establish a system of evaluating drivers by assigning certain numerical values to violations of the road law and that this could become in effect a "Point System".

The main advantage of this type of system is that the entire evaluation system and all procedure can be changed by administrative order; however, without specific legislative mandate and financing, it was impossible to establish any type of mandatory driver retraining school.

West Virginia is, for the most part, rural and is divided east and west and north and south by sizable mountain ranges which increases the number of retraining schools needed and in effect made the cost of state sponsored and financed schools prohibitive. The Point System has handled about 60,000 conviction reports per year affecting about 32,000 individual operators. Of these 32,000, only about 7,500 reach the warning letter level and only 2,500 accumulate sufficient points for hearing or suspension action. Less than one per cent of the state's total driving population is actually suspended as a result of Point System action.

Every year there are some 20,000 convicted traffic violators in West Virginia who are never contacted in any manner concerning their driving behavior. The need for some type of retraining became more apparent each year; however, cost remained prohibitive.

As a result of discussions between the Department of Motor Vehicles, the Department of Public Safety, and the West Virginia

Safety Council, the Defensive Driving Course developed by the National Safety Council became the obvious vehicle to obtain the objectives of retraining without cost to the state. The Defensive Driving Course had received enthusiastic support throughout the state and was available on a state-wide basis. It very definitely covered the needs of the state's Driver Improvement Program.

The adoption of the Defensive Driving Course as a part of the State's official program was announced in May of this year.

Several restrictions were placed on the system's point reduction program.

1. No more than three points could be removed from a licensee's record through attending an approved course. Three points normally represents one moving traffic violation, or 25 per cent of the total needed for suspension.

2. All instructors must be certified by the National Safety Council and approved by the West Virginia Department of Public Safety.

3. Course must follow the format of the Defensive Driving Course as outlined by the National Safety Council and approved by the West Virginia Department of Public Safety. Film and visual aids must be approved by the Department of Public Safety.

4. Attendance must be totally voluntary; however, attendance may be made a part of probation as determined by the Department of Motor Vehicles Interview Officer.

5. Points may be deducted one time only.

6. Points will not be deducted for a course attended prior to the accumulation of points.

7. Attendance of the licensee at the course must be certified by the instructor, the West Virginia Safety Council and the Department of Public Safety.

8. If points are removed as a result of attending an approved course and the licensee accumulates additional points and reaches the hearing level, the violation for which the points were removed will be considered along with all other violations.

Governor Smith, in announcing the Defensive Driving Course—Driver Improvement Program, expressed the personal opinion that any person's driving would be improved by attending the course and emphasized that the course was available to anyone interested in becoming a safer driver.

Evaluation of this program after such a

short period of time is difficult; however, the state is well pleased with its acceptance and effect at this particular time. Over 250 drivers have taken advantage of the program and it is interesting to note that the majority of these drivers were at the three point level.

In addition to the 250 who have taken the program, many others have expressed a desire to participate as soon as the course is available in their particular area. In fact I know of three courses sponsored by organizations because some member of that organization desired to take advantage of the point reduction privilege.

We have encountered a few problems in administering this program in that it is not available at all locations all of the time; however, we have been able to provide each applicant with an opportunity to attend the course within a reasonable time and within a reasonable distance. Some people are apparently reluctant to announce that they have accumulated points and make application after the course has been completed. This necessitates the maintaining of accurate records by name and National Safety Council card number.

A brochure discussing the Point System and outlining the procedure for point reduction will be mailed with every vehicle registration plate next year. This should better inform the driving public of the program and increase participation.

West Virginia recently enacted a Junior or Probationary license law which provides for the cancellation of license until age 18 if the licensee is convicted of two moving violations; therefore, these people are unable to take advantage of the Defensive Driving Course training opportunity. This is a good example of the rigidity of license provision legislation. Hopefully this provision will be modified at the next session of the legislature.

West Virginia is now considering the possibility of requiring the Defensive Driving Course for all state employees who drive a state owned motor vehicle. Some seven state departments have already required their employees to attend the course with excellent results.

Most of West Virginia's school bus drivers have completed the course and the Department of Education is considering the possibility of making it a yearly pre-requisite to licensing for all school bus drivers.

Medical and Health Session

APPLYING MEDICAL CONCEPTS TO INJURY CONTROL

By JULIAN A. WALLER, M.D., M.P.H.

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The prevention and alleviation of human suffering is a common concern of the practice of medicine and the field of injury control. The similarity between the two areas, however, goes much more deeply into the historical and conceptual bases underlying them. As a scientific discipline, medicine undoubtedly has been on the scene for a longer time. It has gone through all of the pains of growth and development that now beset the field of injury control. It is appropriate therefore, to examine some of the history, concepts, and methods used by the medical profession in order to suggest how the humanitarian ends sought by injury control programs may be more speedily achieved.

Similarity of Problem Area.

The problem of accidental injury and the problem of human disease can be defined in virtually the same way. In each case the problem is deeply rooted in a very broad matrix of human activity—of man's characteristics as a social animal, of his attempts to utilize his environment, and of the fact that the human organism has inherent limitations both in its capability to perform tasks and in its ability to resist a large biological insult.

Secondly, the overall problem in each case actually represents a mosaic of specific problems, each with a specific cause or group of causes. The factors involved in the occurrence of a stroke, a case of the sniffles, arthritis of the spine, or a complication of pregnancy could hardly be lumped together. In similar fashion, swallowing of poison by a child, a single vehicle crash, a boiler explosion, and a fall by an oldster are in many ways highly dissimilar.

Thirdly, in each case, the basic problem has been present for many centuries, but the specific pieces are constantly being reshaped. Plague, tuberculosis, poliomyelitis, fatal complications of pregnancy, and other conditions have largely run their stormy courses as major forms of human suffering, to be replaced by heart diseases, certain new viral

diseases, cancers, and emphysema. These, in turn, probably will be followed by other disease entities.

On the accident scene, Mrs. O'Leary's cow or one of its descendants is not likely to kick over a kerosene lamp, children are less likely than a quarter century ago to get arms caught in wringer washers, and few are likely to be killed by runaway horses. But power lawnmowers, automobiles, skateboards, motorcycles, and glass doors have come to take their place.

The *Wall Street Journal* of September 17, 1967, notes, for example, that the shiekdom of Kuwait, in moving from a poverty ridden collection of Bedouin camps to a wealthy metropolis has, in the process, purchased a traffic accident problem that is twice the U. S. rate. One in every five cars is in a smashup each year, and about a third of the country's non-oil industry is devoted to automobile repair.

Finally, despite the apparent diversity of causation, the actual mechanisms for imparting injury are relatively limited. Viruses, x-rays, and cancer-producing chemicals all appear to act by modifying cellular structure. Many other diseases produce their damage by modifying chemical or electrochemical processes in the body. With respect to the production of accidental injury, Dr. William Haddon has noted that most (but not all) injury results from transfer of energy in an amount and at a rate that is excessive for the upper limits of resistance of the human body.

Attitudes and Concepts.

Despite the similarity of problems the attitudes and methods of the medical and health professions are not always shared by those who are concerned with accidental trauma. Before describing the differences, I wish to emphasize that these are differences of degree rather than absolute states of dissimilarity. For the most part, I will discuss general

trends, or normative patterns, rather than the entire range of concepts and methods.

The historical development of concepts about causation in the medical area has been lucidly summarized in a single sentence about mental illness but applicable to a much wider range of organic and psychiatric disease conditions. Ferguson recently stated, "Behavior dysfunction historically has been viewed first as a matter of demoniac possession, then as a spiritual disorder, later as a moral disorder, and later still as mental disease." One need only read the Book of Job, or follow the history of epilepsy, plague, or various other disorders to realize that this conceptual evolution was not limited to mental illness.

Where does injury control lie on this evolutionary scale? First, it is important to note that even the word "accident" is a carryover from a much earlier period of thinking because, by definition, an accident is a random event. The fact that injury does not occur randomly in a population has been proven many times over, making the word accident an anachronism. Furthermore, although the word actually is only a description of an outcome, it has taken on other connotations, such as the connotation of an unavoidable event. Therefore, wherever possible, it is preferable to use other words to describe the outcome that we hope to avoid, such as crashes, or injury, rather than to use the word accident.

Most people today understand injury to be the result of either spiritual or moral backsliding. During the 1962 National Safety Congress, for example, a minister explained at a research session that accidents are the result of sinful thought. A short time later he fell off the speaker's platform. The attitude that injury is the end result in the natural order of events of carelessness, thoughtlessness, woolgathering, and lack of consideration, represents an understanding that, were people morally somewhat more pure, the injury problem would literally vanish. I will not quote the voluminous number of references expressing this viewpoint.

Distinction Between Cause and Effect.

Beginning in the early 1800's medicine on an organized scale began to more accurately recognize the distinctions between cause and effect. Previous to such a distinction, a so-called manifestational classification of disease

had been proposed around 1760. This system guided medical thinking for the next several decades. According to this system, all diseases were classified according to four major groups—fevers, wasting disorders, local disorders, and nervous disorders. Can you imagine how successful a physician would be in treating carcinoma, tuberculosis, and a streptococcal infection in exactly the same way simply because all three had manifested themselves with fever?

The medical profession now classifies and treats conditions according to a much different system, viz., one based on causes such as bacteria and viruses, nutritional deficit, genetic disorders, etc. In addition, there are many conditions which we classify according to organ system involved (such as heart disease) or mechanism by which disability is produced either at a gross or cellular level (such as arthritis, multiple sclerosis, or cancer); but we do not fool ourselves by believing that such a description provides any information about the real causes.

In contrast, in the injury field we still believe, or act as if we believe, that speed in excess of road conditions, failure to yield right-of-way, following too closely, smoking in bed, playing with matches, inattention, etc., are ultimate causes rather than manifestations only. These categories of injury "cause" can be found in drawer after drawer of "accident" report forms in industry, police, and fire departments, insurance companies, and many other organizations concerned with injury control. For most of us they represent some of the major structures for analyzing injuries. Consequently, they guide the planning of our control efforts. Just how far some of these categories may be from true causation will become clear in some examples provided later.

Concept of Multiple Causes and Multiple Effects.

Finally, the medical profession during the late 1800's and early 1900's became generally aware of the fact that a single cause, such as streptococcal infection, can manifest itself in many ways; for example, a sore throat, scarlet fever, kidney disease, or heart disease. Much of the current investigation into the causes of certain types of cancer and of birth defects suggests that viruses may play as important a role here as in causing poliomyelitis, the common cold,

measles, and other communicable diseases.

The medical profession has also recognized that, because the human body has a limited number of ways of reacting to an insult, a single sign or symptom may have a variety of causes. Fever, epilepsy, and high blood pressure are only a few examples. In this context it is important to note that chiropractic has not been accepted by the medical profession precisely because it has been much too simplistic both in its concepts of causation and in its methods of treatment.

Perhaps most important is the recognition by the medical profession that it takes more than a single cause for potential illness to result in disability or death. The factors that lead to disease and those that result in severe disease may be entirely different. Why does a tubercle bacillus in an Eskimo result in rampant illness and early death, whereas the same type of organism in a Middle European Jew attempting to survive in a Nazi concentration camp frequently produced, by comparison, only minor disability? Why is one person with an elevated blood sugar concentration severely disabled by diabetes, but another—in fact, an entire segment of the American Indian population—is scarcely bothered by equally elevated concentrations of sugar in the blood? The answers lie in an understanding that causation, scientifically speaking, is a relative term, and that several factors may be needed in order to initiate a specific train of events and to carry it through to a given conclusion.

Contrast this level of understanding with the general attitude that "80 per cent of accidents are caused by human failure," that injury occurs to those are "accident prone," that the causes of run-of-the mill crashes and of fatal crashes are the same, or to similar simplistic concepts about injury causation and, consequently, about appropriate methods for reducing the extent of the problem.

Need for Program Evaluation.

To what can these differences in attitude and understanding be attributed, and what are the consequences? The medical profession has had a long history of scientific attack on the problems of disease definition and control. This has included a basic understanding, becoming especially prevalent in more recent years, that whatever is offered as new information or new procedure must be carefully evaluated and re-evaluated

using rigorous scientific methods. The development of such a pattern took time and was achieved only by a constant struggle against dogma. Witness, for example, the struggle to introduce the concepts of immunization, or of antisepsis or to do away with bleeding and cupping as forms of treatment.

Such an approach only now is beginning to be accepted in the field of injury control and, frequently, only where fear of legal or economic sanctions literally forces us to do so. In many communities, attempts at honest evaluation are likely to be met with indifference or even hostility. Despite the fact that many investigations indicate alcohol is a factor in about half of all fatal highway crashes, most communities still have no real information about the extent to which it is a local problem, and only one study in the world has been done directly evaluating the effect of a specific control effort on the incidence of crashes attributable to alcohol. In 1933 a paper was presented at the annual meeting of the Highway Research Board indicating that alcohol may be an important factor in the causation of nonhighway injury also. The first scientifically designed study of this problem is now in progress, almost 35 years later.

Need for Qualified Personnel.

Basic to the establishment of a pattern of scientific investigation is the presence of a cadre of professionally trained personnel who have the interest, the pride, and the capability to accept the challenge that scientific evaluation entails. The medical profession has followed a fairly consistent pattern of improving the quality of training available to its members and has set high standards for other health personnel as well. Licensing and accreditation procedures are the rule rather than the exception. I hardly wish to suggest that all is perfect; it's not. But a solid floor of knowledge and skill underlies each person who becomes accredited.

In the field of injury control, the only group with a consistent level of training is the engineers, and their concern is not specifically with the avoidance of injury. Health personnel are primarily concerned with the maintenance of health. But the highway engineer is concerned primarily with transportation, not with the avoidance of injury—a point that has become painfully apparent in the recent re-evaluation of highway design.

In fact, there is no comparable rigorously trained group concerned specifically with injury control.

Despite the fact that injury shares with heart disease the dubious distinction of being the major cause of lost man-years of productivity, despite the fact that 110,000 people are killed and a quarter of the entire population is injured each year, during the past 10 years only two physicians outside of Federal service have worked on a full time basis for any prolonged period of time in the field of injury control research, either involving highway or non-highway trauma, and only a relative handful have done research even part time. The number of workers from other professions who are similarly engaged is pitifully small. Sources of funds are, at best, capricious and, at worst, nonexistent for the well trained person who wishes to make a career of investigation into the causes and control of accidental trauma. I am repeatedly faced with the difficulty of suggesting training and work opportunities to the several young physicians who call or visit me each year and state that they wish to make injury control their life's endeavor. This lament must sound old and stale to many who have heard similar feelings expressed by Dr. William Haddon, Dr. John Conger, and others. I repeat it because, despite the recent clamor, the problem continues virtually unabated.

The Need for Diverse Approaches.

The concepts and professional training in the health field have resulted in the use of a variety of approaches to illness covering the entire range of services, from prevention to early detection and avoidance of complications to rehabilitation. At each of these steps the problem is attacked both by modifying people and by changing the environment, the latter approach in recognition of the fact that people no matter how well motivated, are subject to human limitations.

The equivalent in an automobile crash would be the prevention of the crash, the prevention or limitation of injury once the crash has been initiated, and the prompt provision of emergency services afterward, with consideration at each step of the driver or pedestrian, the vehicle, the highway, and the entire surrounding environment. An indication of how far behind in its concepts is the field of injury control is brought home

by the fact that this broad approach, which is basic to the field of medicine, came as such a surprise to the injury control "professionals" during the congressional hearings that preceded the passage of the National Highway Safety and National Traffic Safety Bills. The general public still isn't much the wiser. They must be educated, not just regarding the aspect concerned with highway injury, but about the entire scope of the problem.

Two examples, drawing largely on our recent investigations, will be used to illustrate the concepts that have been previously discussed. They are chosen from the highway injury area but are equally applicable to injury occurring elsewhere. Both are examples of the confusion that can exist between manifestation and cause, of the possibility of identifying a single cause where several simultaneous causes may exist, and of the implications these errors have with respect to control efforts.

Inattention, Carelessness and lack of attention have been stated to be frequent causes of crashes on the road. I believe that, especially in the middle aged and older population, they most frequently are manifestations or intermediate causes rather than primary causes. In recent investigations we have found that drivers with certain medical conditions have about twice as many crashes per million miles driven as do healthy drivers of similar age. We have further shown that only a quarter to a third of the excess crashes involve obvious medical impairment. We also have found however, that drivers with chronic conditions have significantly more crashes involving only a single vehicle, collision with a parked vehicle, or crashes which have been attributed to "inattention" or similar poorly definable cause. Is this truly inattention or, as we now believe, medical impairment?

Laboratory information now supports the conclusions, based on studies of actual crashes, that inattention and carelessness, rather than being moral backsliding, may simply be manifestations that the driver—or the pedestrian—after all, is human and therefore has physiologic limitations. Recently, physicians in Philadelphia, West Germany, and elsewhere have been using electrocardiographs to monitor drivers, some of whom have had heart attacks. Shockingly large proportions of drivers, both healthy

P
Pages - 17 thru 32

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more severe injury, perhaps a fatality, would have occurred, there was the disturbing fact that the lens, in its entirety, had left the frame. In no other accident involving safety glasses, in our experience, had the lens been completely dislodged.

Thus came the grim realization that throughout our plants there were employees who did not have the complete eye protection that we thought they had. I was shocked when I learned that an employee had lost an eye while wearing safety glasses supplied by our company. Then I learned that there were some 1,700 other employees in our plants wearing prescription safety glasses fitted with the same type of inferior frame, and I immediately authorized a crash program to get them replaced.

A meeting was quickly convened consisting of representatives from our safety and purchasing departments, the optical company who supplied and fitted the safety glasses, the president of the company who supplied the frames to the optical company, and as a courtesy gesture, we invited a representative of the Industrial Accident Prevention Associations of Canada to sit in as an observer.

We had borrowed testing equipment and, during the meeting, proceeded to test several sets of safety glasses borrowed at random from various employees. In some cases, the glasses passed the test OK. In others, the lenses were shattered. In every test where the inferior frames were involved, *the lenses were knocked completely out of the frame.* In other words, this particular type of frame had very little lens retention power. Then with all the confidence at his command, the president of the frame manufacturing company removed the safety glasses he was wearing and asked that they be tested. When his glasses failed to pass the test, the moment of silence that prevailed in that room was something to experience.

Needless to say, it took very little time and discussion to work out an amicable arrangement, whereby the optical company and the frame supplier agreed to send into our plants several teams of qualified optometrists and technicians. These men were to replace, check, and fit all prescription safety glasses that had been purchased by us through this source. They came into our plants for both the day and night shifts and

altogether some 1,670 prescription safety frames were replaced.

This, then, is the end of our story, but it is not the end of the story regarding "The Importance Of Following Safe Eye Protection Standards".

It is not enough that we adhere to one specification in our eye protection program and forget or ignore other equally important specifications. Take, for instance, the safety frame. To meet American Standard Safety Code for Head, Eye and Respiratory Protection, paragraph 6.3.4.2.1 provides:

"The frame with lens shall be supported on a wooden block of such size and shape as to fit the frame securely but not to touch the lens. A $\frac{1}{8}$ -inch-diameter steel ball, weighing approximately 1.56 ounces, shall be freely dropped from a height of 50 inches onto the horizontal upper surface of the lens. The edge of the lens shall not chip from the shock nor shall the lens be displaced from the frame."

The frame that will pass the test and retain the lens is not an ordinary frame as you can see from the following picture. (*at this point a slide was shown.—Ed.*)

On the left is a line drawing showing a cross section of an ordinary ophthalmic or dress frame with a safety lens in place. You will note the 90° lens groove on the frame and the 113° bevel angle of the lens which has been standard in the optical industry for nearly 50 years.

When the lens is inserted in the frame, you will note there is a clearance at the bottom of the groove for the apex of the lens bevel. With a non-heat-treated lens, this clearance is necessary to protect the lens bevel from shock transmitted through the frame when a person lays or bangs his glasses down on the edge. Such a shock could cause the lens bevel to chip.

From the sketch, it can be seen that a regular heat-treated safety lens mounted in an ordinary dress frame is inadequately supported. Any frontal blow on this lens could readily displace it from the frame and thus the lens itself or fragments of the lens could become secondary missiles which could cause serious injury.

If we examine the drawing on the right, which is a cross section of a typical safety frame with a safety lens properly mounted, you will see what makes a safety frame safe. You will notice that the groove angle of the

frame is 113°, identical to the bevel angle of the lens. Further you will notice that the groove is off-center in relation to the cross section of the frame being closer to the front than it is to the back of the frame. Also the depth of the lens entry to the frame is greater at the back than at the front.

Thus it is that the higher back bevel provides a buttressed effect preventing the lens from being pushed back into the wearer's eyes when struck with frontal impact.

Is this such an important specification in our eye protection program? As far as one employee, a mechanic in our Montreal Truck Branch, is concerned, it was. He was about to remove a set of dual wheels from a large truck. In order to loosen them, he struck the outer edge of the axle with a sledge hammer. The force of the blow was such that a piece of steel broke away from the head of the hammer striking him directly on the glasses with such velocity that one lens was completely shattered. The lens remained in the frame and his eye was uninjured.

Another employee realized the importance of a safety frame. While performing a production operation, a bolt thrown up by a passing lift truck struck him on the right lens of his safety glasses. The bolt fractured the lens but the lens remained in the frame. No injury was sustained to the eye of this employee.

Unfortunately, we have found that some employees have had a dress or ordinary frame substituted for the safety frame. In some instances, this substitution was made with the full knowledge of management. Condoning such a substitution must certainly be the result of ignorance of the safety frame specification and the potential injury to which employees wearing such dress frames are exposed.

Why is there a resistance to the wearing of safety glass lenses in an approved safety frame? Appearance and perhaps weight have long been the main criticisms of safety glasses.

Initially, when safety glasses were first introduced, they were anything but attractive; in fact, they were ugly and indeed bothersome because of their weight.

To overcome this, the optical industry now provides safety glasses in a variety of attractive styles. They are comfortable to wear and certainly the objections of the past have largely been overcome. With these im-

provements in appearance, one is encouraged to wear his safety glasses off-the-job as well as on-the-job. The fact that they are safety glasses is not readily noticed. However, to appease one's vanity, there are some employees willing to sacrifice safety for fashion. Because safety frames are not available in the same multitude of styles as dress frames (simply because such a frame just couldn't pass the safety test in these styles) some employees are willing to run the risk and substitute a dress frame.

As safety men, we cannot afford to allow this practice to continue. We must get across to our people that wearing safety lenses alone is not sufficient. We have to tell them why safety frames are equally as important.

In a recent story in our plant magazine, "GM Topics," we talked not only about the importance of wearing safety glasses, but also why only the combination of safety lenses in safety frames can give maximum protection.

A word of caution, however, with respect to the many safety frame styles. At GM of Canada it has been our experience that with so many types of frames, it is virtually impossible for supervision to recognize at a glance whether or not safety frames are actually being worn. For this reason we insist that all safety frames be supplied in pink crystal, clear, or flesh color only. Any single exception for medical reasons must be reviewed with an approved by the safety department.

Another very important A.S.A. specification is that which pertains to flammability. Paragraph 6.2.5.2 provides:

"Where plastic materials are used, such materials shall be slow burning. Cellulose nitrate, or materials having flammability characteristics approximating those of cellulose nitrate, shall not be used. Flammability of the materials shall be no greater than that exhibited by cellulose acetate or acetate butyrate."

Let me show you what this means. Let us expose, to a flame, a temple made of cellulose nitrate. You will notice how readily it bursts into flame and, in no time, the temple would be completely consumed.

By comparison, we will take the temple of a pair of safety glass frames made of acetate and try to ignite it in the same fashion. This temple resists burning and when eventually it does ignite, it burns very slowly.

In our plant we had an employee who was replacing a lag bolt in the floor. Molten lead was to be poured in the hole surrounding the bolt. The employee thought that the hole was dry and reasoned that oil would not have to be poured in as is the normal safe practice, so he proceeded to pour in the molten lead.

The moisture present caused the lead to explode and spray the employee's face with hot lead. Only his safety glasses saved his eyes. Had the safety glass frames not conformed to this flammability standard, the frames themselves could have burst into flames and disintegrated, undoubtedly severely injuring his eyes.

In so far as the general requirements for the lens itself are concerned, I am going to deal only with the obvious specifications which a layman such as myself can understand. A.S.A. Standard 6.3.2.1, which deals with optical quality, reads as follows:

"All lenses shall be made of material suitable for ophthalmic use and both surfaces of the lenses shall be well polished and free from visible surface defects. The lenses shall be free from striae, bubbles, waves, and other visible defects and flaws which would impair their optical quality."

A.S.A. Standard 6.3.3.1, dealing with lens thickness, states:

"Glass or plastic lenses for use in eyecup goggles, metal- or plastic-frame spectacles, or foundrymen's goggles shall be not less than 3.0 millimeters, nor more than 3.8 millimeters in thickness."

"Plastic lenses for use in flexible-fitting goggles, plastic-eyeshield goggles, or plastic-eyeshield spectacles shall be not less than 0.050 inches in thickness."

As a result of our lost eye accident, we now carry out at random, spot checks to ensure that our safety glasses are up to specifications.

Our safety inspectors have available to them calipers which measure lens thickness.

A.S.A. Standard 6.3.4.2.2 deals with lens hardness:

"The lens shall be removed from the frame and placed horizontally on the end of a hardwood tube having an upper periphery conforming in shape and size to the lens to be tested and a wall thickness not greater than 3/16 inch. A washer of rubber packing not more than 1/8 inch thick and of the same shape and size as the end of the tube shall

be placed between the lens and the tube. The rubber washer shall be of the quality required for a grade A gasket in federal specification HH-C-156. The 3/8-inch steel ball shall be freely dropped from a height of 50 inches onto the horizontal outer surface of the lens. The lens shall not fracture from the impact of the steel ball."

To establish that a lens has, in fact, been hardened, our safety inspectors are supplied with polarizers. This very simple device, when applied to a lens, indicates whether or not the lens has been hardened by the cloud pattern which is revealed. Pictured here is one of several different cloud patterns. (Shows slide—Ed.) A lens which is not hardened will show up completely opaque when examined through a polarizer.

A.S.A. Standard 6.3.4.2.3 deals with the breakage pattern:

"As a test to determine the type of breakage pattern exhibited by a lens when subjected to a force sufficient to break it, a lens may be broken by increasing the height of drop of the 3/8-inch steel ball or by employing a heavier ball. If made of glass, the lens shall break predominately with radial cracks with a minor tendency toward concentric cracks. Any tendency to break with lines of cleavage parallel to the surface indicates an unsatisfactory heat treatment; and the lens represented by that sample shall be considered as not conforming to these requirements."

Should a properly treated safety lens shatter, it will shatter or fracture in such a way to minimize the possibility of glass fragments breaking away from the lens itself and entering the eye. When safety lenses are shattered, the fragments resemble large sugar granules. They are without sharp edges.

In addition to the calipers and polarizers used by our safety inspectors for spot checking, we have had fabricated for our own use, a testing apparatus to verify the fracture resistances outlined in the A.S.A. Standards.

Incidentally, it is my understanding that these standards are being reviewed and among other changes, according to a member of the review committee, consideration is being given to improving the ball drop test by increasing the size of the steel ball from 3/8 inch to 1 inch in diameter and increasing the weight from approximately 1.56 ounces to 2.4 ounces. These revisions, if and when they come, will be under the sponsorship of

the National Society For The Prevention of Blindness.

While these revisions to the standards have not yet been approved, we at GM of Canada feel they are so significantly important that we already insist that all of our safety glasses meet these new proposed standards.

We have included a means of making a test to these new revisions in our testing apparatus. (Shows slide.—Ed.) The tube on the right is for the present standards test using a $\frac{7}{8}$ -inch steel ball. The tube on the left is for the new proposed standard using a 1-inch steel ball.

You will be interested to know that some suppliers of safety glasses not only test to these new suggested standards but go well beyond them to ensure the quality of their product.

Here is a close-up of the lower portion of the testing apparatus showing the steel ball striking a heat-treated safety lens. (Shows slide.—Ed.)

This equipment is vital to our program of random checking that we are carrying out to ensure that our safety glasses are up to A.S.A. standards, and that we are getting the protection for which we are paying.

The lesson we have learned about knowing and following safe eye protection standards is one we will not forget.

To those of you who have eye protection programs, I have one final remark to make. If you were an employe working in the plant and your management required that you wear safety glasses for your protection, would you be satisfied with glasses that did not conform to the safety standards?

Human Factors Engineering

AN OVERVIEW OF HUMAN FACTORS ENGINEERING

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The objective of this paper is twofold: To define human factors engineering and to describe to a limited extent the nature of the contributions that this emerging discipline might make to the design of safe and efficient systems. In spite of the fact that the discussion and number of examples are quite limited, it is hoped that a point of view regarding design for safety will begin to emerge that will affect the reader's attitude toward the design problems that confront him in his profession.

Definitions.

Three terms should be defined and briefly discussed before proceeding: Accidents, human factors engineering, and systems engineer.

Accidents. Chaponis¹ definition of an accident has been adopted for the purposes of this paper:

"An accident is an unexpected and undesirable event which arises directly from a work situation; that is, from faulty equipment or the inadequate performance of a person. There may or may not be personal injury and damage to equipment or property. Accidents, however, always interrupt the normal work routine and are associated with increased time delays or errors."

Although most would accept the above definition as essentially correct, many would find it necessary to interpret "work" as including leisure activities also.

An accident is *prima facie* evidence of ineffectiveness in a system. Some temporal or permanent incompatibility among the men and the hardware of a system must exist or an accident could not occur. The term "men" as used here includes not only operators and maintenance men but also those who manage the system, those who establish the requirements, those who design the system, etc. In addition, it would seem completely in order to include environmental considerations, since a little thought suggests that a system might be virtually accident-

free in one environment yet be quite dangerous in a different environment. A general formula could be written to express these relationships:

$$SA = f(Me, Ma, E)$$

where SA = system accident rate

Me = men

Ma = machines (equipment)

E = environment

These terms are almost certainly interactive. That is, certain men will have accidents with certain machines under certain environmental conditions, while other men (or the same men with different machines) might not, and so on. Unfortunately, at the present time it is usually impossible to state how much of the total "accident variance" is attributable to each of these terms (Me, Ma, and E) and their interactions. If this could be done, it would be most helpful, since it would disclose where effort should be concentrated in order to have the maximum effect on reduction of accidents. The total accident variance is equal to the sum of the variances due to each primary cause (Me, Ma, E), plus their first and second order interactions, plus error.

$$\sigma^2_{SA} = \sigma^2_{Me} + \sigma^2_{Ma} + \sigma^2_E + \sigma^2_{MeMaE} +$$

$$\sigma^2_{MeMa} + \sigma^2_{MeE} + \sigma^2_{error}$$

Greatest reduction per unit of expenditure generally will be realized by concentrating on the term(s) that make the largest contribution to σ^2_{SA} .

Human factors engineering is the application of knowledge regarding human capabilities and limitations to the design of equipment and systems. It is an applied science that draws its basic information from such biological and behavioral sciences as biophysics, medicine, physical anthropology, physiology, psychology, and others. It will become evident later that there is also signif-

icant reliance on the engineering sciences, particularly industrial engineering. In practice, human factors engineering is (or should be) one of the many disciplines that support those who have primary responsibility for the complex undertaking that is termed "systems engineering."

Systems engineer. The systems engineer is the individual who must take the necessary information from all relevant areas of science and engineering and, within the constraints placed upon him, design a system that meets specified requirements. He must have a more global outlook than the term "design engineer" generally connotes; above all, as has been pointed out elsewhere⁶ he must have a sensitivity to, and a thorough understanding of what is meant by, integration.

Solutions to Accidents.

There are at least six approaches that have been taken with respect to the prevention of accidents. Each has met with varying degrees of success, depending upon the appropriateness of the approach in a specific instance and upon the skill of those applying it. We will do little more than mention the first five, devoting the majority of our attention to the sixth, which is directly related to the topic of this symposium.

1. **Selection and training.** Strict adherence to this approach requires that initially the job be described in detail and individuals selected and trained to do the job. Those who can't reach certain criteria of effectiveness within some specified period of time are shifted to activities more suitable to their talents.

2. **Education.** The term as used here refers to industrial and governmental sponsored programs in safety education and is not concerned with the teaching of specific skills necessary to do the job. The purpose generally is to make individuals more "safety-conscious."

3. **Admonishment and punishment.** These terms refer to the withdrawing or suspension of rewards or privileges; hopefully, so that the same mistake will not be made again. In a sense it is similar to what McFarland²⁵ has referred to as post-accident studies, which he defines as "... attempt(s) to allocate the blame for what has happened and to suggest subsequent corrective measures."

4. **Rewards for accident-free behavior.** In a sense, this is the antithesis of the previous

technique. The "zero-defects" program of the Department of Defense is a variant of this technique, including, however, all errors, whether accident-related or not. One side benefit of such programs apparently has been a heightened awareness on the part of management regarding its responsibilities to its workers in attempting to produce error-free behavior. McFarland²⁵ made this point over 20 years ago with respect to air transportation. A significant reduction in accidents undoubtedly awaits an alert and progressive management that makes this item as central to their thinking as such topics as profits, efficiency, time-schedules, etc. While no one believes that all accidents can be reduced to zero, nevertheless the accident-reduction criterion is another criterion that must be considered appositively with all the other criteria (efficiency, initial cost, maintenance costs, etc.) by those who specify, design, procure, and manage a system. It is currently popular to say that these considerations must be "traded-off" one against the other.

5. **Identification of accident-prone.** Much has been written about the accident-prone individual. Undoubtedly there are such individuals; however, one is on perilous ground when he attempts positively to identify such a person. Many unfortunate persons probably have lost their jobs because they had an undue number of accidents in a specified period of time when, in reality, they were victims of chance or other circumstances over which they had no control or to which they made little, if any, contribution. The final elucidation of the concept of accident-proneness, in our opinion, must await a more complete understanding of the personality and motivational factors that relate to "accident-behavior."

6. **Design for safety.** Numerous examples could be given of equipment that was designed poorly from the point of view of safety. One aircraft in World War II was so difficult to fly that it was disaffectionately known as the "widow maker." Certain automobiles seem to suffer a higher accident rate than others, and so on. The point is that improvements in safety can be made in the design of almost anything. The trick, of course, is to do so without unduly sacrificing other qualities such as performance and economy.

It is with respect to this last solution, design for safety, that human factors engineer-

ing has a special contribution to make to the reduction of accidents. Later in this paper we will examine several example of designs that tend to induce fewer errors than do others. It will be noted that in nearly all cases it would cost no more to design the element correctly (from the human engineering point of view) than to design it incorrectly.

Tools of Human Factors Engineering.

There are at least six tools or techniques that human factors engineers should find useful in their attempts to contribute to the design of accident-free systems and one which they should use with considerable caution. None is exclusive to human factors engineering, each being used by at least one other discipline. Most of the contributions that the human factors engineer makes are directly or indirectly dependent on the systematic collection of data in the laboratory or in the field (as in the case of anthropometric surveys), so most of the treatment that follows will be devoted to the last of the six.

1. *Accident records.* An analysis of Air Force flying accidents conducted several years ago suggested that in 60 per cent of the accidents the pilot was either a direct or

the inadequacies of such data when he states that such classifications are inadequate "... not only because it (they) presuppose(s) a perfect pilot, but because there is a tendency to place the responsibility on errors of judgment when no other obvious cause is present."

It might be instructive to examine one or two of these "pilot error" accidents. It used to be a fairly common occurrence in a certain type of Air Force airplane-for a pilot, immediately after touch-down, to actuate the lever that controlled the alighting gear of the aircraft rather than the lever that controlled the flaps, causing the aircraft to descend to its belly and slide down the runway. Inspection of the cockpits of these aircraft disclosed that the knobs on these two levers (flaps and gear) were identical in shape and size and positioned down and to the right of the pilot's seat, far out of his line of vision which was quite correctly directed out of the aircraft and down the expanse of runway on which he was trying to maintain the aircraft.

McFarland²⁵ notes in another example that the mixture controls of certain World War II aircraft were exactly opposite in function; in one, the operator pushed the mixture control forward for military (full) power, while in the other the same actuation would shut down the engine. Numerous fatal accidents have been attributed to the confusion resulting from an individual flying first in one type and later in another with opposite control actuation.

The point is obvious. Even a minimum respect for candor would seem to dictate that a significant portion (how much is not known) of the pie chart in Figure 1 should be devoted to "designer error." That is, some of the features of the aircraft were designed so as to assure that under certain circumstances the pilot would make an "error" and have an accident.

There is another reason why statistics such as those in Figure 1, if true, would be most disheartening. According to the psychological tests that have been used to select Air Force pilots for approximately the past 25 years, they, as a group, represent one of the most intelligent, highest aptitude groups in the population. They possess enormous potential for acquiring skill in extremely complex jobs. Thus, if they can't do the job, who can? Human factors people would argue that

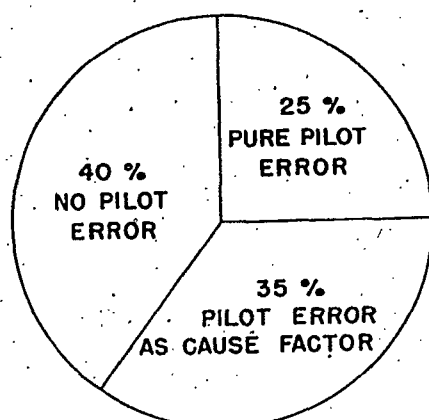


Figure 1

contributory cause. (Figure 1.) This alarming figure agrees generally with a figure of 75 to 85 per cent given by McFarland²⁵ for general air transportation. (The fact that McFarland's figure is higher may be due to the fact that it also includes human errors attributed to maintenance and supervisory personnel.) McFarland clearly recognized

they most certainly can do the job, and any foreseeable flying jobs, if aircraft designers will adequately consider their capabilities and limitations when making their design decisions.

2. *Activity analysis.* Results of analyses of the activities of operators, maintenance men, production workers, etc. have usually been used to increase efficiency (e.g., to reduce or eliminate unnecessary or inefficient motions). One such technique was used quite effectively by the writer^{4,5} to obtain information that significantly increased the efficiency of the Arctic navigator by supporting requirements for better equipment and more efficient layout of the workplaces of the navigator and radar operator. Time and motion studies (a method of activity analysis) are, of course, traditional in industry. Although there is not too much information to support this contention, it would appear that activity analyses made from the point of view of disclosing situations that might tend to induce accidents should be quite useful.

3. *Interviews.* An obvious way to gain information regarding the causes of accidents is to question the survivors. If one wants to get at the true cause, he must be careful to conduct the interview in such a way as to assure the interviewee that information he yields will not be used to implicate him in any way.

One method that has been usually fruitful has been the use of the critical incident technique which is similar in many respects to what McFarland²³ terms the "near-accident" technique. Fitts and Jones²⁴ used the critical incident technique to identify accident-inducing design features in aircraft. McFarland and Moseley²⁵ used the near-accident technique to determine the nature and conditions of similar features in long-haul trucking operations. These two groups of studies differed in one important respect; Fitts and Jones relied on accounts of events detailed by those who had experienced them, while McFarland and Moseley asked observers to accompany the truck driver and record the conditions that prevailed at the time of the incident. Those who intend to use such techniques should refer to Chapanis⁸ before doing so. Chapanis, in reviewing the work of Vasilas *et al.*,²² points out, among other things, that those who were asked to describe near accidents were much more responsive under conditions that

assured anonymity and when in the presence of their peers who were being asked to render similar reports. Unfortunately, they also discovered that the types of incidents reported varied as a function of the method used to elicit the responses.

4. *Systems analysis.* It is often instructive to try to perform a paper and pencil analysis of at least the critical stages of the "mission" that a system is intended to satisfy. The analyst can use information from similar systems or even generate synthetic task times to help him estimate where critical shortages of time may occur. A shortage of time in which to perform a task is a stressful situation and, like other stresses, causes errors and can be assumed to cause accidents. (It is not meant to imply that the above represents the only purpose of mission analysis. Such analyses are also important to those who must generate manpower requirements and training requirements, and often will also disclose manual tasks that might better be done by machines, or equipment tasks that might better be left to man. Descriptions of the various levels of analysis useful in human factors engineering may be found in Woodson and Conover²⁶.)

5. *Simulators; mock-ups.* At least the major components of any system of any complexity should be mocked-up or simulated prior to manufacture. Things that simply cannot be visualized from blue prints become apparent when presented in three dimensions.

With the advent of high-speed computers, there are additional instances where significant portions of a system can be simulated with high fidelity prior to "tin bending." The simulation of the dynamics of an aircraft flight control system is a case in point. Objective measures of performance can be obtained on the simulated control systems, making extrapolations to the operational situation significantly easier and more valid than if only a paper and pencil analysis had been performed.

6. *Laboratory experiments and field surveys.* As mentioned previously, the source of the greatest part of the human factors engineer's contribution to design lies in the results of laboratory experiments and field surveys. Most of the rest of this paper will be devoted to a description of a representative group of such studies. Before proceeding, however, it might be wise first to dispose of

a concept that we feel has caused much confusion among designers and design engineers—that of the “average man.”

A design engineer, lacking and often not seeking information regarding the physical and psychological characteristics of those who eventually will operate and maintain his products, has often resorted to information as to what he can do and what he prefers. Such engineers apparently consider themselves representative or “average” when, in truth, there is no such thing as an average or 50th percentile man, a 25th percentile man, a 75th percentile man or any other percentile man, except with respect to isolated features and attributes. Seashore (in Stevens,²¹ following the lead of Thorndike, has stated that the “. . . typical coefficient of correlation between various human abilities is of the order of 0.15 to 0.25” or slightly better than chance. Matters appear to be quite similar in the physical realm; the median intercorrelation for 144 anthropometric dimensions is $+0.22^{22}$. (Both of these average correlations, the $+0.25$ for mental characteristics and the $+0.22$ for physical characteristics, are obviously completely dependent on the representativeness of the dimensions measured. To the extent that they are not representative, these averages are false. Expert opinion in both areas, however, suggests that the average interrelationship is low and something of the order of $+0.20$ to $+0.30$. At any rate, it is inconceivable that any truly representative set of mental or physical dimensions would yield average intercorrelations so high—at least $+0.90$ —that average figures could be used in design work to represent a population.) It seems obvious that engineers must design for ranges of dimensions, both physical and psychological, and not for specific point values of any human attributes.

Expert opinion. In a somewhat similar vein, one wonders about the procedure of accepting any expert user's opinion as to whether or not a design is suitable for those who must eventually operate or maintain it. The test pilots employed by aircraft companies are a case in point. These are magnificent pilots, but one is led to wonder how appreciative they are of the skills of the thousands of those who, in the final analysis, will determine the success or failure of the specific aircraft. Might it not be preferable to have new designs tested by a representative, sample of those who eventually will use

them, with the expert observing the pilot's behavior and assuring safety of flight during test? Would not the designer of farm equipment, to take another example, be well advised to test his equipment on a representative sample of farmers, and not on the product engineers in his plant?

Laboratory Experiments and Field Surveys.

Now that we have introduced a note of caution with respect to the use of data or opinions that may not be representative of those who must eventually assume responsibility for the operation and maintenance of the equipment in question, let us look at some results that should be generally useful to designers. While the conditions of sampling have not always been ideal in these studies, at least the variability problem has always been recognized, and an attempt made to measure its degree.

Controls. The Fitts and Jones study referred to earlier²³ disclosed that many errors can be traced to the design of controls. Studies by Jenkins^{24, 25} disclosed that controls can be designed so as to be distinguished one from the other by use of the tactile sense alone.

A study by Warrick²⁶ disclosed that under most conditions most individuals have definite preferences as to which way a knob should turn in order to control a specific function. Of fifty Air Force pilots asked to center the light on a control-indicator arrangement, 44 per cent consistently turned the control knob clockwise, 6 per cent consistently turned the knob counterclockwise, and 50 per cent turned the knob sometimes clockwise, sometimes counterclockwise. Warrick also showed that direction-of-motion preferences are much stronger when both the control and the display lie in the same plane. Certain other population stereotypes are shown in Table I.

TABLE I*

General Population Stereotype Reactions

1. Handles used for controlling liquids are expected to turn clockwise for “off” and counterclockwise for “on.”
2. Knobs on electrical equipment are expected to turn clockwise for “on,” to increase current, and counterclockwise for off or decrease in current. (Note: This is opposite to the stereotype for liquid.)
3. Certain colors are associated with traffic, operation of vehicles, and safety.
4. For control of vehicles in which the operator is riding, the operator expects a control motion to the right or clockwise to result in a similar motion of his vehicle, and vice versa.

5. Sky-earth impressions carry over into colors and shadings: Light shades and bluish colors are related to the sky or "up," whereas dark shades and greenish or brownish colors are related to the ground or "down."
6. Things which are further away are expected to look smaller.
7. Coolness is associated with blue and blue-green colors; warmth, with yellows and reds.
8. Very loud sounds or sounds repeated in rapid succession, and visual displays which move or are very bright, imply urgency and excitement.
9. Very large objects or dark objects imply "heaviness." Small objects or light-colored ones appear light in weight. Large, heavy objects are expected to be "at the bottom." Small light objects are expected to be "at the top."
10. People expect normal speech sounds to be in front of them and at approximately head height.
11. Seat heights are expected to be at a certain level when a person sits down.

*(Woodson and Conover, 1964.)

Warrick²⁴ conducted another very significant study in which he disclosed that lags as small as 40 milliseconds in feedback to the operator, regarding the results of his control input, have a detrimental effect on tracking performance (single-dimension pursuit tracking, in this case). His results are shown in

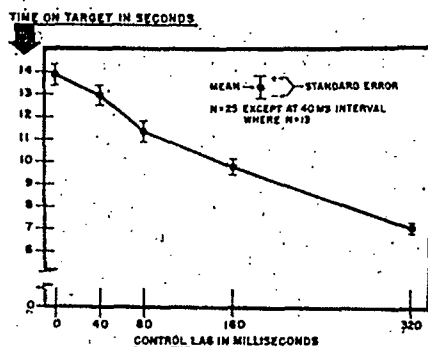


Figure 2

Figure 2. This early study made it clear that immediate feedback as to the results of one's control inputs is important and that, in general, the designer would do well to reduce all such lags to zero. This idea later gave rise to the concept of display "quickenings," by Taylor and Birmingham,²⁵ which is achieved by eliminating lags in the system.

The latest development in this chain of events is the predictor display, whose development is generally attributed to Kelley.^{26, 27} The essential idea here is to display not only the current position of one's vehicle but also the position that it will occupy some finite time in the future assuming, of course, that no change in control input is

made in the meantime. Frost and McCoy^{21, 22} are among those who have made further investigations with the predictor display.

An example of one interesting application is shown in schematic form in Figure 3

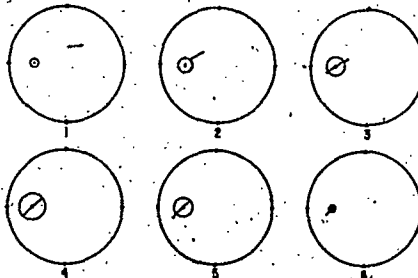


Figure 3

which represents the interception of one space vehicle (represented by the dot in the circle) by another. The current position of the controlled vehicle is indicated by the point at the right end of the arc while its predicted position (in this case, 15 seconds hence) is shown at the left end of the arc. The six diagrams show what the pilot might see at successive stages of the interception. The diameter of the circle is proportional to the square of the relative velocity of the two vehicles, expanding as it increases and contracting as it decreases. This tells the interceptor pilot how he must control his velocity in order to overtake the other vehicle and yet not crash into it. Figure 4 shows how dramat-

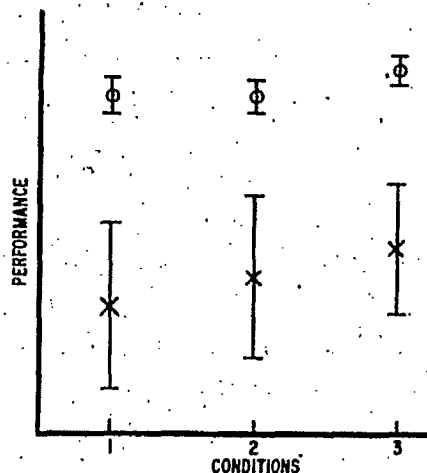


Figure 4

ically performance was improved in one case with the predictor display. Note that not only is average performance improved but also that variability of performance is greatly reduced or, put another way, performance is more consistent.

The concept of the predictor display is an exciting one and one can't help but wish, for example, that there currently was some way of predicting to an automobile driver the position, even five seconds hence, of all other automotive vehicles in the vicinity of his own. (Good drivers, incidentally, surely use a technique analogous to the predictor display by estimating where their vehicle will be a few seconds hence with respect to other vehicles and obstacles. It would seem that one should always drive "out ahead" of his automobile without neglecting, of course, events in the proximate environment.)

The predictor display which has just been described might have been included in the next section, "displays." It was included here simply because it seems to have arisen as a logical extension of some earlier work that primarily emphasized the controls aspects of such control-display systems.

Displays. The early human factors work in the displays area was characterized by insights and innovations commensurate with those described in the controls area. One of the best known of these early studies was performed by Grether²³, using as his experimental vehicle the three-pointer altimeter. As can be seen from Figure 5, Grether was

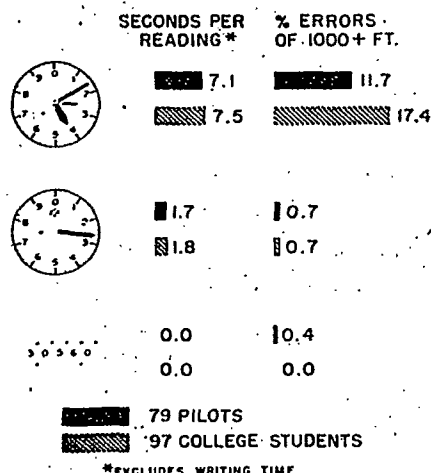


Figure 5

able to produce alternate designs that greatly reduced both reading time and errors. The significance of this study lies not only in the fact that it attacked a problem suggested as very important in the results of interviews and accident analyses (see Fitts and Jones²⁴ and McFarland²⁵), but also because from it Grether was able to adduce principles of general use in the design of dials, such as the general undesirability of having more than one pointer on an instrument. It is important also to notice that Grether's subjects did better on the new design, although they had never seen the instrument before and had an average of approximately 1,500 hours experience on the old, less perfect design. This is frequently the case; good human engineering design can often dramatically reduce the time and training required to reach an acceptable level of performance.

Similar dramatic results were obtained by Senders²⁶ in the area of check reading. Horizontal pointer alignment increases by a factor of eight the number of dials that can be check-read in a given period of time.

White's work²⁷ discloses that alignment for normal operation is better at the nine o'clock position than at the three, twelve, or six o'clock position. It is rather easy to see why nine o'clock would be better than six or twelve, since it is well known that the eye can scan much more efficiently in the horizontal dimension than in the vertical dimension. That nine o'clock is better than three o'clock may appear puzzling until one considers the fact that a clockwise and upwards departure from the nine o'clock position seems fairly unequivocally to suggest *increase* to most observers; whereas a clockwise departure from the three o'clock position is ambiguous, since those who perceive the pointer movement as *clockwise* will generally interpret it as *increase*, while those who perceive the pointer movement as *down* will generally interpret it as *decrease*.

A somewhat more complex perceptual problem is concerned with which element should appear to move when depicting movement of a figure against its background—in this case, an aircraft against a flight background. Subjects did better when the point of intersection, which represents the position of the aircraft—"fly from"—appeared to move, as contrasted to the situation where the aircraft would appear to re-

main stationary and the desired location (intersection of the true lines) be brought toward it. The vast majority of the subjects preferred the "fly-from" arrangement (21 of 24, with three expressing no preference). Unfortunately, instruments such as the artificial horizon are designed on the basis of the "fly-to" principle. Undoubtedly, this has led to many control reversals; i.e., movement of the control stick in the wrong direction in the operation of aircraft.

The literature in the area of displays, as in the area of controls, is enormous and we have touched on only a few examples. The interested reader is encouraged to consult such references as Woodson and Conover¹, McCormick², Chapanis, Morgan, and Garner³, and the *Human Engineering Guide to Equipment Design*, edited by Morgan, Cook, Chapanis and Lund,⁴ for additional information.

Workplace design and layout. Once it has been decided how individual controls and displays should be designed, there still remains the difficult question of how to arrange them in a particular workplace. Fitts, *et al.*⁵ used eye-movement recordings to assist them on this difficult task. Equipment for this experiment included a 35 millimeter camera, a mirror in which were reflected the eye movements of the pilot, a stop watch, and a hood which prevented the pilot from seeing outside the aircraft during blind flying maneuvers. During instrument flight, the pilots of this experiment spent an average of 29 per cent of their time looking at the gyro horizon. They fixated on this instrument an average of 26 times per minute and spent .70 seconds looking at it each time they referred to it. Obviously, the subjects considered the gyro horizon to be a very important instrument when trying to make level turns under instrument flying conditions.

In addition to conclusions regarding the frequency and duration of time spent on each instrument, one can obtain sequential data from the film strip. These "link values," as they are termed, are obtained by simply observing the order in which the pilot uses his instruments. For example, while descending under blind flying conditions, 21 per cent of the eye movements of the pilots in this experiment were between the directional gyro and the gyro horizon. Thus, it is concluded that, at least for this maneuver, a very strong link exists between these two instruments,

suggesting that they should be close together on the panel. (Also, they are placed side by side and not in vertical alignment; other research has shown that the human eye can scan much more efficiently horizontally than vertically.)

The results led eventually to the establishment of six central instruments as a unity which was termed the "sacred six." Each designer was required to maintain these six instruments in their same relative positions wherever possible, so that an Air Force pilot could take advantage of this consistency in transferring from one aircraft to another.

From an anthropometric point of view, one of the major problems with which one is faced in the design of workplaces is the matter of individual differences with respect to physical dimensions. One dimension, "sitting height," illustrates this problem. While an adjustment range of 4.2 inches will accommodate the middle 90 per cent (5th to 95th percentile) of the Air Force population with respect to sitting height, a range of 6.0 inches is required to accommodate the middle 98 per cent (1st to 99th percentile), and a range of 10.3 inches is needed to accommodate 100 per cent of them. Thus, an increase in adjustment range of 45 per cent is required to accommodate 98 per cent rather than 90 per cent of the male Air Force population, and an increase of 157 per cent is required to accommodate essentially 100 per cent rather than 90 per cent. Put another way, accommodation of the last ten per cent of the male Air Force population with respect to sitting height requires that the adjustment factor be increased approximately 2.6 times over what is required for accommodation of the central 90 per cent. (These adjustment factors would be even more astonishing if we were to accommodate females or even the general male population of the United States, since the Air Force population on which this study was based included no one under 59.45 inches in height or over 77.56 inches in height.)

Based on these and other anthropometric data, Kennedy and Bates⁶ have devised a set of standard sizes for consoles, considering such criteria as whether the operator should sit or stand, the necessity to see over the console, etc.

Sharp and Bowen⁷ have used a functional test to determine what man can do in a specific workplace situation. In a replica of

the seat for the Mercury space vehicle, with a subject seated in the blast-off position, Sharp and Bowen required the subject to reach and manipulate various types of controls (rotary knobs, toggle switches, push buttons) to some criteria of sensitivity. They used this apparatus very effectively to show the effects on reach and manipulation and, with the assistance of other apparatus, on workplace volume of protective garments, such as the pressure suit.

*Human Engineering Guide to Equipment Design*²⁷ has a wealth of information regarding many body dimensions, and a new report by Damon, Stoudt, and McFarland²⁸ is an excellent source of information on anthropometry, biomechanics (range of motion of the joints, muscle strength, speed of movement), human body composition, and tolerance to physical and mechanical force.

Population comparisons. The study by Warrick²⁹ may be considered a study of American population stereotypes. It is uncertain whether a sample of individuals from some foreign country would yield the same results as did the sample of American males that Warrick used. Much work needs to be done on this problem of interpopulation differences. It becomes increasingly important as trade and travel increase among the countries of the world.

As mentioned previously, very little has been done on the generality of human engineering design principles with respect to other cultures. This is unfortunate, because many of the readers manufacture for export. Hertzberg *et al.*³⁰ accomplished a classic

study in the area of international anthropometry when they measured a sample of 3,356 males in Turkey, Greece, and Italy. Oshima, Alexander, *et al.*³¹ did something similar in Japan. Table II is taken from these reports.

If we divide the USAF male population into four quartiles with respect to stature, we find, for example, that only five per cent of the Turks fall in the largest quartile of U. S. Air Force stature while 65 per cent fall in the smallest quartile. The Japanese figures are even more disparate. However, the dimensions for sitting height are not nearly so disparate, especially for the Japanese. The conclusion is obvious: With respect to USAF males, the males of these four countries generally have relatively short legs and relatively long trunks. This is especially true of the Japanese. Most of us must look very strange to those Japanese who have not seen many of us with our long, gangly legs! At any rate, factors such as these are extremely important to those exporting clothing, equipment and machinery to foreign countries. Such factors could have a profound effect not only on customer satisfaction but also on safety. It is important to note that a simple proportional scaling down of our sizes is, at best, only a partial solution to this problem. A completely adequate solution would take into the account the differences in body proportions.

Many authors have generated general lists of principles as to what "man can do best" and what "machine can do best." One of the latest and best is to be found in Woodson

TABLE II
Comparisons of Stature and Sitting Height
for Four Foreign Countries and the United States

Stature					
USAF Quartiles	Turkey	Greece	Italy	Japan	
Largest 25%	5	6	7	1	
Large 25%	10	13	13	3	
Small 25%	20	24	26	13	
Smallest 25%	65	57	54	83	
Sitting Height					
USAF Quartiles	Turkey	Greece	Italy	Japan	
Largest 25%	12	13	10	15	
Large 25%	18	23	18	21	
Small 25%	25	28	30	39	
Smallest 25%	45	36	42	25	

(Hertzberg *et al.*, 1963 and Oshima, Alexander *et al.*, 1965.)

TABLE III
Man vs. Machine

Man Excels In	Machines Excel In
Detection of certain forms of very low energy levels.	Monitoring (both men and machines).
Sensitivity to an extremely wide variety.	Performing routine, repetitive, or very precise operations.
Perceiving patterns and making generalizations about them.	Responding very quickly to control signals.
Detecting signals in high noise levels.	Exerting great force, smoothly and with precision.
Ability to store large amounts of information for long periods—and recalling relevant facts at appropriate moments.	Storing and recalling large amounts of information in short time-periods.
Ability to exercise judgment where events cannot be completely defined.	Performing complex and rapid computation with high accuracy.
Improvising and adopting flexible procedures.	Sensitivity to stimuli beyond the range of human sensitivity (infrared, radio waves, etc.).
Ability to react to unexpected low-probability events.	Doing many different things at one time.
Applying originality in solving problems: i.e., alternate solutions.	Deductive processes.
Ability to profit from experience and alter course of action.	Insensitivity to extraneous factors.
Ability to perform fine manipulation, especially where misalignment appears unexpectedly.	Ability to repeat operations very rapidly, continuously, and precisely the same way over a long period.
Ability to continue to perform even when overloaded.	Operating in environments which are hostile to man or beyond human tolerance.
Ability to reason inductively. (Woodson and Conover, 1964)	

and Conover². It is reproduced here as Table III. Such lists are, as Woodson and Conover clearly recognize, of value to a designer as long as he realizes that the conditions that affect the trade-off functions are never identical from one situation to another and that what man excels in today, a machine may excel in tomorrow. One must be very cautious in making blanket statements regarding those functions at which man excels over machines, including even the so-called "intellectual" functions. This leads rather naturally into a most intriguing area, that of human mental functions.

Higher level functions. In comparing men and machines one frequently hears reference to man's superiority with respect to such functions as thinking, reasoning, judgment, etc. For the moment, let's accept the proposition that man (or at least some men) is superior to machines in at least some of these intellectual types of activities. Even here, however, it has been shown that machines can assist man to perform better. The

Human Engineering Division has supported a series of studies at the Aviation Psychology Laboratory of Ohio State University for a number of years, aimed at determining whether or not such features of computers as (1) ability to process an enormous amount of data, (2) enormous memory capacity, (3) almost instantaneous computation, (4) sensitivity to subtle relationships (e.g., low but significant correlations), etc. could help man make better decisions.

It was found in experiments that included a wide variety of decision-making circumstances that these "computer-aids" generally increased man's effectiveness as a decision maker on the order of 10 to 15 per cent. Thus, it appears that, even in the intellectual realm, man and machine should be considered appositively and not as rivals or competitors; certainly not as systems elements that are operating independently of one another.

A pair of studies from the Ohio State series may make the above somewhat clearer.

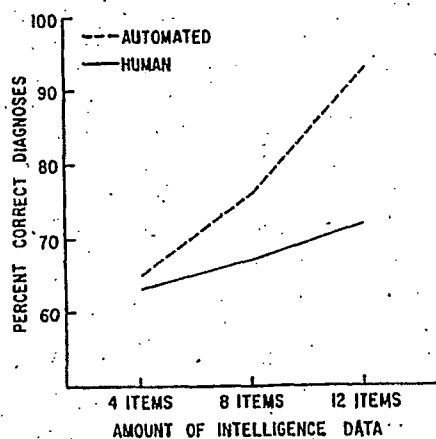


Figure 6

Figure 6 illustrates how helpful a computer can be when one has to handle many items of information. It appears, and this appeals to our common sense in the matter, that these functions will become even more divergent as more and more items are added.

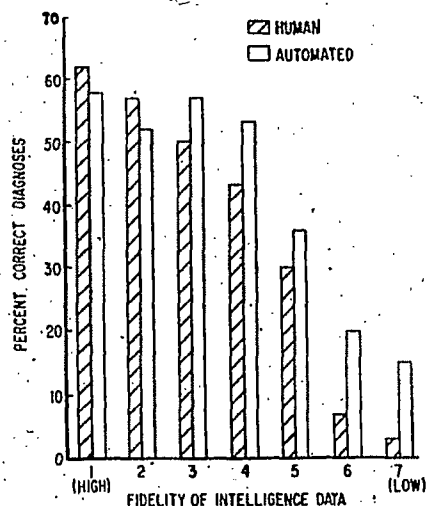


Figure 7

Figure 7 shows that high-speed computers can be particularly helpful when the fidelity of the data on which the decisions are based is low. Howell and his associates have found that computers can detect significant relationships that are below man's level of

awareness (or, at least, below a level on which he is willing to make a positive decision). It is certainly conceivable that consideration of these subtle relationships could often mean the difference between an outstanding decision and a poor or mediocre one. This area of how best and under what conditions to use a computer to help man the decision-maker is one that, to this writer at least, holds enormous potential.

Conclusions

Although the data of human factors engineering have not been used formally and extensively in designing for safety, it appears that such data could and should be so used. It is clear that to a greater and greater extent man's environment is becoming an engineered environment (in contrast to a natural environment). Presumably, man evolved in a manner that assured him a degree of compatibility with his natural environment, but it would be ridiculous to assume that the genetic structure can alter quickly enough to assure a compatibility with modern "engineered" environments—environments that are changing rapidly and drastically. Therefore, those responsible—the design engineers, industrial designers, etc.—must design the environment and its artifacts to fit man. To do this, they need information about man's capabilities and limitations and some knowledge of how to integrate this information with their other design considerations. In the final analysis, this is what human factors engineering is all about.

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APPLICATION OF HUMAN FACTORS ENGINEERING TO SAFETY ENGINEERING PROBLEMS

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One hundred and thirty-six years ago, a British physician wrote, "We see no plump and rosy tailors: none of fine form and strong muscle. The spine is generally curved . . . pulmonary consumption is also frequent. However, in regard to his present faulty working position, let a hole be made in a board of the circumference of the tailor's body and let his seat be placed below it—the eyes and hands will then be sufficiently near his work; his spine will not be unnaturally bent, and his chest and abdomen will be free."⁵⁰

Although Dr. Thackrah's interests lay in the direction of occupational disease and in the influence of working conditions on health and longevity, the paragraph just cited contains the suggestion of more than one of the advantages proposed for the application of human engineering principles and and data to the design of jobs, working procedures, and equipment used by workers. Among the benefits which might be expected from these newer approaches are: (1) more efficient operation, (2) fewer errors in operation, with fewer accidents resulting in injury, damage, or work spoilage, (3) reduced operating costs, especially through reduced necessity for redesign after equipment is put into production, (4) reduced training time and costs, and (5) more effective use of personnel, with less restrictive selection requirements.

The Analysis of Accident Causes.

Many have pointed out that research on the causes of accidents has been hampered by the lack of a satisfactory definition of what constitutes an accident, or an adequate delineation of the range of events in an accident continuum. For our purposes, however, the practical goal of accident prevention is easily defined; i.e., the prevention of death and injury to persons and, frequently, of damage to things.

In the analysis of accident causes and the design of specific preventive measures, the greatest advances have been made in regard

to relatively stable situations which tend to be repetitive, as in industry. In such instances, there are factors in common which can be identified and controlled. The majority of injuries, however, occur in the home, on the highways, and in a wide variety of activities such as recreational pursuits. These are less homogeneous in regard to common variables, and multiple causes and interrelationships between factors frequently need consideration. It is necessary to relate the characteristics of the persons suffering injuries, the predisposing factors of the environmental situation, and the agencies or forces capable of producing injury. Thus, accident prevention measures are being developed through the same epidemiological approaches which have brought about such striking advances in the study and control of disease.⁵⁰

It seems particularly appropriate to reiterate the observation that all accidental injuries (and damage) result (1) from the application of specific forms of energy in amounts exceeding the resistance of the tissues (or structures) upon which they impinge, or (2) when there is interference in the normal exchange of energy between the organism and the environment, (e.g., as in suffocation by drowning). Thus, the various forms of energy—mechanical, thermal, electrical, chemical, and radiation—constitute the direct causes of injuries in accidents. (See Table 1.) Also, prevention of injuries can often be achieved by controlling the source of the energy, or the vehicles or carriers through which the energy reaches the body.¹⁸

While the specific types of energy which give rise to injuries are quite limited in number, the forms in which they abound and the variety of the vehicles or carriers of energy are innumerable. Man himself is constantly compounding this situation as he develops more powerful sources of energy and puts the various kinds of energy to new uses.

The concept of energy as the cause of injury has the important implication that pre-

Table 1
*Descriptions of Injuries Due to the Delivery of Energy in Excess of
 Local or Whole Body Injury Thresholds^a*

Type of Energy Delivered	Primary Injury Produced	Examples and Comments
Mechanical	Displacement, tearing, breaking and crushing; predominantly at tissue and organ levels of body organization.	Injuries resulting from the impact of moving objects such as bullets, hypodermic needles, knives, and falling objects; and from the impact of the moving body with relatively stationary structures as in falls, plane and auto crashes. The specific result depends on the location and manner in which the resultant forces are exerted. The majority of injuries are in this group.
Thermal	Inflammation, coagulation, charring, and incineration at all levels of body organization.	First, second, and third degree burns. The specific result depends on the location and manner in which the energy is dissipated.
Electrical	Interference with neuromuscular function, and coagulation, charring, and incineration; at all levels of body organization.	Electrocution, burns. Interference with neural function, as in electroshock therapy. The specific result depends on the location and manner in which the energy is dissipated.
Ionizing Radiation	Disruption of cellular and subcellular components and function.	Reactor accidents, therapeutic and diagnostic irradiation, misuse of isotopes, effects of fallout. The specific result depends on the location and manner in which the energy is dissipated.
Chemical	Generally specific for each substance or group.	Includes injuries due to animal and plant toxins, chemical burns, as from KOH, Br ₂ , F ₂ , and H ₂ SO ₄ , and the less gross and highly varied injuries produced by most elements and compounds when given in sufficient dose.

vention may be achieved through environmental controls, which often may not require voluntary participation on the part of persons exposed to risk. Thus, barrier measures may be devised to prevent the delivery of specific types of energy to the body; e.g., machine guards. Or, the characteristics of the vehicles or carriers of injurious forces may be modified to prevent or attenuate the transfer of energy; e.g., grounding electrical appliances, rounding corners on children's furniture, padding surfaces in automobiles.

With regard to the potential of human engineering for reducing industrial accidents, there is implicit in the above statement a broader definition of accidents than is customarily associated with traditional safety activities. For the human engineer, an accident has been defined as "an unexpected and undesirable event which arises directly from a work situation; that is, faulty equipment or the inadequate performance of a person. There may or may not be personal injury and damage to equipment or property. Accidents, however, always interrupt the normal work routine and are associated with increased time delays or errors."²

In this paper, we will attempt to show how safety, in both the narrower sense of in-

jury and damage and in the broader context just mentioned, may be considerably improved through refinements in the design of all types of equipment and working areas in accord with the human capacities and limitations of the operators and workers. It is interesting to observe that, in a sense, this completes a full turn in the spiral of the development of industrial safety.

Initially, the approach was an engineering one with emphasis on machine guarding and protective devices. This brought about a rapid decline in machine risks, and significant gains were accomplished by the application of basic safety engineering principles to the design of machinery, plant layout, and working methods.

The initial engineering approaches were followed by a phase emphasizing the role of personal factors and the "human element." This involved, for example, the proper placement of employees, based on job analysis and evaluation of the functional capacities of workers, training, and the control of working methods. This approach also included a recognition of the importance of supervisory practices and of the mental and emotional adjustments of the workers.

While very substantial improvements have

been made in industrial safety through the above approaches, the rate of improvement has been slower in recent years. This suggests that methods previously used may be reaching the limits of their effectiveness, and newer approaches may be needed to effect further reductions. Now there are indications that an engineering approach may again be of prime importance in achieving control over accidents; an approach, however, in which there has been a reorientation, so that engineering is tied in with the findings of the human factors research developed in the past decade.^{28,38}

In the percentage distribution of compensable fatal and permanent disability industrial accidents in the United States in 1966, as reported by the National Safety Council, vehicular accidents, falls, and the handling of objects appear to be very important in the fatal accidents.³⁹ "Struck by falling objects" and "machinery" each give rise to approximately 20 per cent of the total of permanent disabilities. In regard to injuries resulting in temporary disabilities, approximately 50 per cent in 1966 were received in vehicular accidents and falls. Many of these fatal and serious accidents might be prevented by the introduction of principles of the field of human factors and safety engineering.

Before dealing explicitly with industrial safety, a simple illustration may be given to emphasize the point that, even with modern, standardized, automated equipment, variability in human performance can effect the output of a man-machine system. The "unexpected" and "undesirable" events in this illustration were not injuries or damages—rather, they were undesirable variations in the final product; in this case, nylon hosiery. It would seem that if the number of stitches and rows were pre-set in the machine, few errors would result. The operator's function was merely to pull certain levers as the machine completed each stage. However, many discards resulted from lack of uniformity in the finished product.

The question was raised as to whether the operator could in any way influence the weight of the finished stockings. Three different operators were asked to operate the same machines, pre-set for the same size stockings. The hosiery made by operator A were uniformly light and less variable than those made by B. C tended to produce light stockings, but they were as variable as B's.

Analysis of the workers' performance revealed there were at least 20 ways in which the operators could influence the weight of the stockings. In general, variations arose from such causes as the order in which machine controls were used, the way the operator set the controls, and the way he handled and inspected the hose during knitting.⁸ In this particular situation, redesign and standardization of the work procedures and retraining of the operators was an effective solution. In other situations, redesign of the machine to control or offset sources of variability among operators may often be required.

A few examples may be given to illustrate the point of view of human factors engineering, and to bring out the potentiality of this approach for increasing the safety factor. If an auditory warning signal is used to indicate the malfunction of equipment, would it not be best to select a frequency band to which the ear is most sensitive and which lies below the frequencies which older people hear poorly?

If muscular "feedback," as well as vision, is important in controlling the directional stability of a vehicle, should not the resistances in a power-steering system be related to information about human "muscle sense"?

If two control knobs are located close together on a console, might not designing them so that they can readily be differentiated by touch help prevent inadvertent operation of the wrong control?

Does the machine operator, while working, have a seat so designed as to insure maximum comfort and efficiency and to eliminate the back strain and fatigue so often present in contemporary industrial situations?

The questions of importance in the analysis of design of industrial equipment and systems will vary with the type and purpose of the operation. Usually they will include most of the following:

1. What sense organs are used by the operator to receive information? Does he move into action at the sound of a buzzer, blink of a light, reading of a dial, verbal order? Does the sound of a starting motor act as a cue?
2. What sort of discrimination is called for? Does the operator have to distinguish between lights of two different colors, tones

of two different pitches, or compare two dial readings?

3. What physical response is he required to make? Pull a handle? Turn a wheel? Step on a pedal? Push a button?

4. What overall physical movements are required in the physical response? Do such movements interfere with his ability to continue receiving information through his sense organs? (For example, would pulling a handle obstruct his line of vision to a dial he is required to watch?) What forces are required (e.g., torque in turning a wheel)?

5. What are the speed and accuracy requirements of the machine? Is the operator required to watch two pointers to a hairline accuracy in a split second? Or is fairly close approximation sufficient? If a compromise is necessary, what is more essential—speed, or accuracy?

6. What physiological and environmental conditions are likely to be encountered during normal operation of the machine? Are there any unusual temperatures, humidity conditions, crowded workspace, poor ventilation, unavoidable fumes, and so on? Will the operator come to work from, presumably, a normal good night's rest and work in well-ventilated, well-lighted, cheerful conditions? Or will he be working under various stresses imposed by aspects of the operation and its environment?^{7,26,15,29}

The Principles of Advance Analysis in Human Engineering for Safety.

The initial phases of a human-engineering program should consist of an advance analysis of all possible faults in the equipment and in the working area. If defects are present, it is only a matter of time before an operator fails and either shows a decrease in the efficiency of his performances or has an accident.

Advance analysis consists of an operational job analysis that should include a survey of the nature of the task, the work surroundings, the location of controls and instruments, and the way the operator performs his duties. A functional concept of accidents should be maintained throughout; i.e., the errors that may occur while the operator is working at the machine should be anticipated. The repetition or recurrence of near or real accidents clearly indicates a need for redesign. The following is an outline of the chief considerations in advance analysis:

1. *Operational job analysis:*

- (a) Requirements of the task
- (b) Working area
- (c) Displays
- (d) Controls

2. *Blue print phase:*

- (a) Analysis of task
- (b) Prediction of efficiency
- (c) Prediction of errors
- (d) Human limitations

3. *Mock-up stage:*

- (a) Task performance
- (b) Physical size of operators
- (c) Age of operators
- (d) Skill levels
- (e) Accessory equipment
- (f) Interfering structures or motions
- (g) Physiological changes
- (h) Errors
- (i) Near-accidents

It should be assumed at all times that no worker is perfect. In fact, he may be far below the ability adjudged by the designer. If his duties are too complex, the cumulative burden becomes too great and he may reach or exceed his limits of attention and ability. Therefore, a wide margin of safety should be provided to eliminate any possible situation that places the operator near his maximum ability with regard to aptitude or effort, especially when adverse factors are present.²⁷

The Contribution of Anthropometry and Biomechanics to Industrial Safety.

One basic approach to industrial safety relates the physical characteristics and capabilities of the worker to the design of his equipment and to the layout of his workplace. Where this is done, the result should be an increase in efficiency, a decrease in human error, and a consequent reduction in accident frequency. However, in order to carry out this approach several different types of information are needed; namely, a description of the job, an understanding of the kinds of equipment that will be used, a description of the kinds of people who will use the equipment and, finally, the biological characteristics of these people.

In general, the first three items—job, equipment, and users—can be defined both accurately and easily. Their biological characteristics, however, can often be determined satisfactorily only from surveys specially

planned to yield descriptive data on human body size and biomechanical abilities and limitations.

Anthropometric Data. The anthropometric data consist of various heights, lengths, and breadths which are used to establish the minimum clearances and spatial accommodations, and the functional arm, leg, and body movements which are made by the worker during the performance of his task.⁴⁷ For example, to determine the proper height of a chair one needs to know the range of popliteal heights (floor to under part of thigh immediately behind the knee) of the people likely to occupy the chair; the kind of leg movements, if any, that will be required; and whether or not a foot rest will be used. (See Fig. 1)⁸⁴

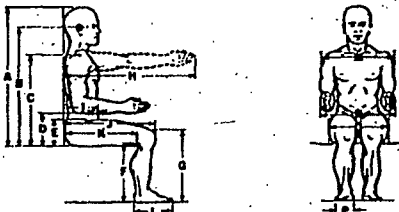


Figure 1.

Static and Dynamic Measurements.

Two kinds of body dimensions, static and dynamic, are pertinent to the anthropometric problems of human engineering. Static dimensions, taken on the human body with the subjects in rigid, standardized positions, are easily obtained and readily applied to equipment design. Dynamic dimensions—those taken on the human body at work or in motion—are more complex and difficult to measure. For example, functional arm reach, a dynamic dimension, is not a simple derivative of anatomical arm length, but is a resultant of such mechanical factors as shoulder height and breadth; length of the several segments of the arm and hand; and range of motion at the shoulder, elbow, wrist, and fingers. Functional arm reach, therefore, changes with each placement and motion of the body, arm, hand, or fingers. (See Fig. 2)¹⁰

The outer limits of the workspace at which controls, tools, or materials handled by the worker can be placed must be determined on the basis of the functional arm reach of the smaller workers. Factors in-

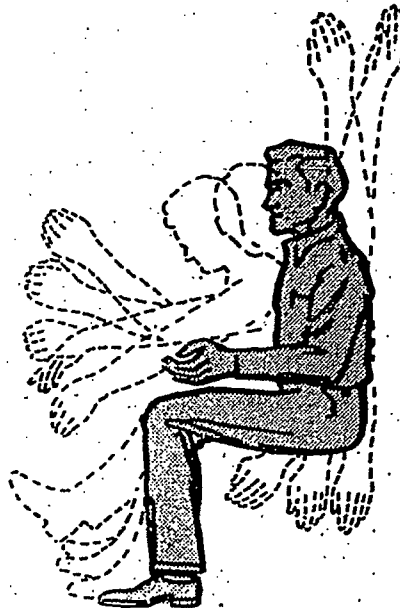


Figure 2.

fluencing functional reach which must be taken into account include arm length, shoulder height and breadth, the range of movement at the joints of the shoulder, elbow, wrists and fingers and, finally, the amount of permissible body movement that can be used to supplement arm reach.

Such information will permit the engineer to define the outer limits of the "space envelope" available for the worker's use. It will not, of course, necessarily tell him where the optimum locations are for placing controls or other items, nor can it tell him what kinds of equipment or controls should be used or the best way in which they can be operated. These questions can be answered only on the basis of additional descriptive data on the biomechanics of human physical performance, with reference to the specific population of workers under consideration.^{9, 10}

An interesting example of the sometimes critical role that body dimensions can play in accident causation is afforded by a U.S. Navy study that showed that "tall" pilots, i.e., those over six feet, had a significantly higher rate of involvement in jet aircraft accidents than would have been expected on the basis of chance ($p=0.01$). Similarly, "short" pilots, those below 5'9", had a lower

than expected accident rate (also $p=.01$).²³ This objective finding is supported by the opinions and experience of many Navy pilots, including one who has stated that: "I have observed from numerous, vociferous complaints from pilots . . . that anyone taller than six feet is liable to be so cramped and uncomfortable in the cockpit that his performance will be noticeably harmed."²¹

As a result of this situation, the Aerospace Crew Equipment Laboratory, U.S. Naval Engineering Center, undertook a detailed human engineering evaluation of cockpit dimensions with special attention to the distributions of body size of Naval pilots. As a result, an "Aircraft Utilization Code" was developed that would permit the assignment of Naval aviators only to aircraft in which they could be safely accommodated in terms of their body dimensions. It is interesting to note that, while the cockpits of some Naval aircraft can safely accommodate almost all pilots, the cockpits of three aircraft are so spatially constricted that only the smallest 15 per cent of the entire naval pilot population should be permitted to fly them, according to the Aerospace Crew Equipment Laboratory.¹⁷

An even more striking and obvious example of a safety hazard resulting directly from the lack of consideration of anthropometric data in establishing design dimensions is demonstrated by the escape hatches of certain multi-engine World War II aircraft. Here the hatch dimensions were of a size that effectively prohibited the passage of larger pilots wearing flying gear and parachutes. Again, certain kinds of hand controls have been designed in such a way that although they can be operated perfectly satisfactorily by the ungloved hand, they can only be operated with great difficulty, if at all, by larger hands wearing gloves—and gloves are normally worn when operating these controls.

In motor vehicles, various kinds of problems relating to safety have resulted from lack of consideration of the range of body size of the drivers. Examples of the more commonly occurring problems are lack of proper vision from the vehicle by short drivers (eye level too low); inability to reach and operate quickly certain controls (inadequate design compensation for short arm and leg reaches); crowding and cramping because of inadequate spatial clearances

around the body (especially for larger drivers); and seats too high or too deep for short drivers, and too low or too short for tall drivers (better adjustability needed.) In fact, it is unlikely that adequate vision and performance from the driver's position can be worked out for the entire population unless adequate adjustability is provided.³¹

Many examples can be given from the problems that are developing in the newer designs for automotive equipment. One relates to the use of shoulder restraining devices in certain vehicles. It is difficult to install such equipment in automobiles without considering the location of the three-point attachments in relation to the size of the driver. Also, head rests must be considered in relation to the height of the back seat. Finally, what should be done about the design of seat belts for pregnant women? The importance of this problem is emphasized by Dr. G. Anthony Ryan, who offers a preliminary estimate that about 5,000 foetal deaths occur each year in traffic accidents in the United States.⁴⁶ This is in addition to the 50,000 motor vehicle fatalities now recorded every year, and represents a hitherto unobserved part of the highway safety picture.

Biomechanical Data for the Prevention of Accidents During Lifting and Carrying.

The injuries resulting from accidents in the manual handling of objects and materials are especially prominent in the total of compensable injuries, as has already been mentioned. Furthermore, the National Safety Council suggests that the number of disabling back injuries suffered by workers each year seems to be increasing more rapidly than other types of injury, presently reaching an annual total of about 400,000.³⁰ This is obviously a problem of considerable concern to the safety engineer, and represents an area where the biomechanical data relating to lifting and carrying can be applied in the design of jobs and work layout which require this kind of handling of materials.

The relevant data concern: (a) the methods of lifting and carrying and, (b) what a worker can lift and carry in terms of how heavy, how high, how long, of what bulk, and the like. While probably all safety engineers are conversant with the basic principle of lifting with the legs rather than with the back, information relating to (b) above is less well known, and recommendations based

on the available data have been summarized¹⁰ and are reviewed briefly below.

Lifting.

1. *Location of Object.* The most important determinant of lifting force is the distance of the feet from the grasping axis. Lifting force is greatest when the weight lifted is in the same vertical plane of the body, and decreases sharply as the weight moves away from the body.^{5a}

The best height for lifting (vertical pull) is at or slightly above the level of the middle fingertip, measured with the subject wearing shoes and standing erect with arms hanging by his sides.⁴ Middle fingertip height averages about 28 inches, and varies from 25 inches in men 65 inches tall, to 31 inches in men 75 inches tall. Above middle-fingertip height, lifting power decreases very rapidly; below it, more slowly. With a load near the floor, lifting force may be only 75 to 80 per cent of that at the best height.^{11, 44, 51}

2. *Body Position.* In general, "leg lift," with back vertical and legs bent, affords a stronger vertical pull than "back lift," with legs straight and back bent⁴ although at lifting heights from five to 20 inches⁵³ there is no appreciable difference between the two methods. Leg lift entails so much less risk of back injury that it is certainly preferable.

3. *Maximum Weights.* The heaviest weights that can be lifted to various heights by men of the 5th percentile in lifting strength were calculated from tests on nineteen healthy young men.¹⁴ The weight, an aircraft ammunition case 25 inches long, 11 inches high, and six inches wide, with handles at either end, was lifted mainly with the legs. The tests were not carried to the point of fatigue.

The maximum weight of compact equipment (boxes 12 x 6 x 12 inches, equipped with handles) that can be lifted from the floor six times, one minute apart, without strain by at least 99 per cent of a young, healthy male population is as follows: to knee level, 62 pounds; to waist level, 38 pounds; and to shoulder or eye level, 27 pounds.⁴⁸

Women, when measured by their ability to lift a weight, demonstrate about 55 to 65 per cent as much strength as do men.¹

4. *Lifting Pattern for Repetitive Work.* For some tasks which involve continuous lifting, rest pauses can decrease the amount

of human energy needed. In lifting weights ranging from 4.4 to 22.0 pounds from one table to another, through vertical distances varying between 2.0 and 17.3 inches, the most efficient rate—in terms of mechanical efficiency—was about twenty to thirty lifts per minute. An 11-pound weight lifted 4.7 inches and back ten times in 17 seconds, followed by a 13-second rest, required only half the energy as the same work carried out in ten lifts evenly spaced over the same 30-second period. However, for smaller loads of 4.4 pounds or heavier loads of 22 pounds, or when the rate was increased to forty lifts per minute, no difference was found between the two techniques.⁴⁵ Thus, optimum rates and patterns need to be established for each distinct type of repetitive lifting task.

Carrying.

Handles. In general, objects weighing more than 10 pounds should have convenient carrying handles, located above the center of gravity and at least 4.5 inches long, with the inner surface of the handle at least two inches from the surface of the object.¹⁶

Size of Containers. The more compact the container, the more easily can it be carried. For bulky equipment, the center of gravity should not be more than 20 inches from the carrier's body.¹⁹

Maximum Weights. Solely by muscle power, a normal man can transport about 200 tons a day through a horizontal distance of one meter, or 50 tons through a vertical distance of one meter.³⁸ The maximum individual loads, if carried in either hand by means of handgrips, should be about 60 pounds for short distances and 35 pounds for longer distances.

The weight of bulky articles, around 30 inches to a side, should not exceed 20 pounds.¹⁰ In general, a weight is "heavy" when it reaches 35 per cent or more of body weight.³ Carrying one heavy weight a given distance costs less physiologically than carrying two weights, each weighing half as much, the same distance in two trips.³⁸

While the above statements on lifting and carrying are by no means as definitive and comprehensive as desirable, they represent a synthesis of the currently available data, and they illustrate the kind of potential contribution that human engineering, specifically biomechanics in this case, can make to industrial safety.

Design of Displays to Prevent Errors.

A machine operator can successfully control his equipment only to the extent that he receives clear, unambiguous information, when needed, on all pertinent aspects of his task. Accidents, or operational errors, often occur because a worker has misinterpreted, or was unable to obtain information from, his displays concerning the functioning of the equipment. Displays are usually visual in nature, though they may also be auditory (i.e., warning bell rather than a warning light), especially when there is danger of overloading the visual sensory channels. Typical errors which might be anticipated and the possible sources of such errors are brought out in Table 2.²⁰

Three basic types of indicators supply machine operators with information. They are:

1. The check display, which indicates whether or not a given condition exists; i.e.,

a green light, or no light, to indicate normality, and a red light to show failure, danger, or faulty operation.

2. The quantitative display, which indicates an exact numerical value to be read; e.g., speedometer, clock, thermometer.

3. The qualitative display, which indicates whether, and in what direction an operation has deviated from a desired level, without presenting precise quantitative data; some temperature gages are used in this way and, in fact, many quantitative displays could profitably be changed to this simpler type of indicator.

Any display or indicator, regardless of type, must possess the following basic characteristics if it is to be as nearly foolproof as possible: (1) It can be read quickly and in the manner desired; i.e., as a check, qualitative or quantitative display. (2) It can be read as accurately as is required (and, preferably, no more accurately). (3) There is no ambiguity or likelihood of gross reading errors. (4) The information is provided in the most immediately useful form and does not require mental translation into other units. (5) Changes in value are easy to detect. (6) It can be easily identified and distinguished from other instruments. (7) The information is as current as possible; i.e., lag is minimized. (8) If inoperative, it either cannot be read or the operator is properly warned. (9) When applicable, the instrument indicates which control to use, and in which direction to use it, when changing its reading.^{2, 27, 28}

The necessity of applying human engineering techniques to the design of displays is well illustrated by the frequent difficulties which even experienced operators have in correctly reading certain types of instruments. The conventional aircraft altimeter, for example, is equipped with three pointers, each requiring separate interpretation before the pilot can determine his altitude. Errors caused by this type of instrument have been frequently reported by pilots in confidential statements, and misreading of the altimeter has been cited as the cause or probable cause of a number of recent aviation accidents in the United States and Great Britain. The most common type of error reported has been that of misreading the altitude as either 1,000 or 10,000 feet too high. The design of the instrument has been improved by presenting altitude in thousands of feet by nu-

Table 2

Typical Human Errors in Equipment Operation²⁰

Type of Error	Possible Causal Factors
Failure to detect signal.	1. Input overload. a. Too many significant signals. b. Too many separate input channels. 2. Input underload. a. Too little variety of signals. b. Too few signals. 3. Adverse noise conditions. a. Poor contrast. b. High intensity of distraction stimuli.
Incorrect identification of signal.	1. Code form or typography unclear. 2. Lack of differential cues. 3. Inappropriate filtering set (expectation). 4. Conflicting cues. 5. Conflicting identification requirements.
Incorrect value-weighting or priority assignment.	1. Nonlinear predictions required. 2. Multiple or complex value-scaling required. 3. Values poorly defined or understood. 4. Contingencies vaguely defined.
Error in action selection.	1. Matching of actual and required patterns faulty. 2. Consequence of courses of action not understood. 3. Appropriate action not available. 4. Correct action inhibited. a. Cost considerations. b. Procedural prohibitions.
Error of commission.	1. Correct tool or control not available. 2. Action-control relationship not understood. 3. Action feedback unavailable or delayed.

merals in a window on the dial face, with interpolations between thousands of feet read from a single pointer. Studies comparing the errors made in reading the old and improved altimeters by both novices and experienced pilots have shown that the new design can be read much faster and with far fewer errors.

Even with good vision and excellent lighting, including high contrast between target and background, the size of the target, or pointer, in relation to the overall size of the instrument is important. During an experimental study, while watching one dial, it was found that subjects failed to report one-third of the pointer signals. It was noted, however, that the line of sight was directly on the dial at the instant the signal was given. The per cent of errors in form identification was clearly related to the width of the visual display in degrees from the fovea. What better example could be given of "looking without seeing", or in other words, making an error that was "built into" the design of the instrumentation.²⁵

Design of Controls for Operational Efficiency and Safety.

In regard to controls, an operator must decide upon the proper course of action and manipulate them in such a way as to produce any desired change in the machine's performance. The efficiency and effectiveness with which controls can be operated depends upon the extent to which information on the dynamics of human movement, or biomechanics, has been incorporated in their design. This is particularly true whenever controls must be operated at high rates of speed, against large resistances, with great precision, or over long periods of time.^{18, 37}

Controls should be designed so that rapid, accurate settings can be easily made without undue fatigue. If so, many accidents and operational errors would be avoided. This thesis is strikingly illustrated by the landing gear and landing flap controls of many modern aircraft. These two controls, having very different functions, are sometimes placed very close together, and sometimes have their locations reversed on different aircraft.

Industrial machinery until very recently has not been designed or evaluated according to basic principles in the field of human engineering. The suitability of various controls for different purposes in industrial situ-

ations has been shown by Provins.⁴⁸ Since there is a wide variety of machine controls ranging from the simple on-off action of push buttons to very complex two-dimensional graded effects, advance analysis must be made of the task requirements. On the basis of a considerable body of experimental evidence, it is possible to recommend the most appropriate control and its desirable range of operation.

In general, from the standpoint of human engineering, it is essential that the mechanical design of equipment be compatible with the biological and psychological characteristics of the operator. The effectiveness of the man-machine combination can be greatly enhanced by treating the operator and the equipment as a unified system. Thus, the instruments should be considered as extensions of the driver's nervous and perceptive systems, the controls as extensions of the hands and the feet as simple tools. In general, any control difficult to reach or operate, any instrument dial of poor legibility, any seat inducing poor posture or discomfort, or any unnecessary obstruction to vision may contribute directly to an accident.

Techniques of Measurement in Studying Impaired Performance in Relation to Environmental Stress and Accidents.

Before summarizing some of the experimental findings relating to environmental stress and accident causation, it is in order to consider the techniques of measurement. The more subtle influences may often be masked by the learning process or by "trying harder," making it difficult to detect such factors in gross measures of performance such as overall speed, number of errors, or total output. What appears to be required are tests of performance which reflect deleterious effects in spite of attempts to overcome them, or tests which detect increased effort at the task. Recently, techniques have been developed in sensory and perceptual research which may be of value in developing tests of both kinds.

Some of the primary features of such tests include: (1) a high degree of sensitivity, so that small changes can be readily measured; (2) precision of the physical measurements involved in the test; (3) independence of the results from the degree of conscious or unconscious effort which may be exerted; (4) stability of the function during control

experiments when the physiological stresses are not applied, and (5) for more complex performance including insight and decision making, tests which involve timing of perceptual response and information processing.^{32, 36}

Measures of Speed and Accuracy Combined. One way of adjusting one's performance to offset the deleterious effects of stress or specific environment might be to sacrifice factors, such as speed for accuracy, or vice versa. Such trade-offs, however, need not indicate degradation in capacity. Until recently, there was no way of combining these two measures. With the development of *information theory*, a nonarbitrary way of combining measures of speed and accuracy into a single rate-of-information-transmission measure is available.⁵ In this way, it is possible to determine the magnitude of a task-induced stress required to produce an environmentally interacting effect.

Tests That Detect and Scale Increased Effort. Two avenues of research offer tests of increased effort. One of these is concerned with capacity and/or peripheral attention. The deterioration of performance on a primary task with increased load at secondary task is a good example of this area of testing. The effects of environmental stress can be measured in terms of the steepening gradient of these spare capacity measures.^{42, 49} The other area of research relates to physiological measure of arousal, of tension, and so forth. A number of techniques for measuring not only muscular tenseness but also central nervous system activity, and even specific components of neural reaction to signals, have been developed.⁵⁴ Some of these measures appear to be promising for the study of varying degrees of impaired performance.

In studies of the effects of noise and vibration on human performance, there is evidence of strong interactions between such environmental stresses and task difficulty in determining the amount of performance decrement that will appear under a given amount of stress.⁵² Task difficulty is a major variable and failure to consider this fact has given rise to many of the discrepancies found in studies relating environmental stress to performance. These studies have resulted in the hypothesis that the most demanding aspects of a complex activity are those which will be most sensitive to the effects of environmental stress, and further

that the number of task elements affected by a given level of stress, and the extent of such impairment, depends on the total information processing load imposed by the task.

Control of the Physical Environment to Prevent Accidents.

In some instances, the control of accidents depends on the regulation of the interaction between the worker and the internal and external environments. The more important physical variables of the environment are temperature, humidity and ventilation, noise, vibration, and toxic agents such as carbon monoxide. Extremes of any of these variables will result in discomfort and lowered efficiency of the worker or driver. The ranges of comfort and discomfort and the extremes that may contribute to accidents have been reasonably well defined.

Temperature, Humidity, and Ventilation. A change in any one of these variables will affect the other two insofar as they influence comfort. Hence, all three variables must be considered as a unit.

The ventilation problem is concerned with the amount of fresh air and air movement provided. Low rates of air movement produce feelings of stuffiness and fail to prevent the accumulation of body odors and tobacco smoke. Optimally, 35 to 40 ft/min of fresh air should be supplied per individual, at velocities of between 20 and 60 ft/min in order to maintain an atmosphere of freshness without creating undesirable drafts. It should be remembered that increased air velocities tend to have a cooling-effect, which may be advantageous in summer but which may cause discomfort in winter. Poor ventilation causes lethargy and sleepiness and can contribute to accidents.

Composite curves have been developed to show the various comfort zones and the typical subjective responses to heat, cold, and humidity. The optimum temperature range is 68°-72°F (dry bulb) for winter and 74°-78°F for summer. A relative humidity of 30-70 per cent is acceptable in these zones. Excessively high humidities cause discomfort at high temperatures and result in feelings of coolness or dampness at low temperatures. When humidity is below 15 per cent, the membranes of the eyes, nose, and throat become uncomfortably dry. Experiments with industrial workers have shown that human performance deteriorates significantly at ef-

fective temperatures of about 85° and above.²⁴ (See Figure 3). Many of the skills that show deterioration are directly related to safe driving or safe working practices or conditions.²⁵

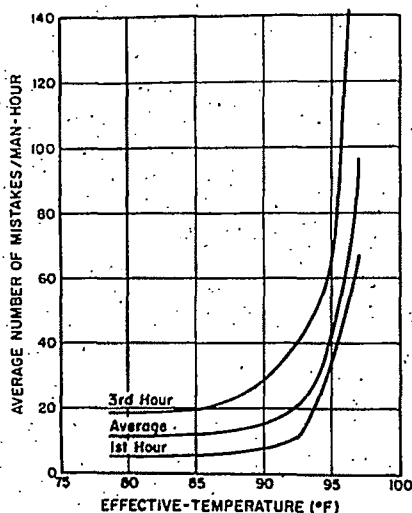


FIGURE 3

Noise. Environmental noise is now reaching alarming proportions in many phases of modern life. This is especially true in industry, and it has long been recognized that noise levels which interfere with speech communication give rise to many accidents. Suggested criteria for use by the safety engineer and industrial hygienist have been worked out by numerous authors. Every attempt possible should be made to reduce noise levels in working environment to below established recommended levels.²²

Carbon Monoxide. Carbon monoxide poisoning is an ever-present possibility in the operation of motor vehicles. The problem is becoming increasingly serious because of the amount of smog and the concentration of idling vehicles in metropolitan areas. Small amounts of carbon monoxide are absorbed rapidly by the blood stream resulting in an oxygen deficiency that may at first be unnoticed by the individual. The initial reaction to carbon monoxide poisoning consists primarily in lowered attention, difficulty in concentration and retention, slight muscular incoordination, sleepiness, and mental and physical lethargy. These effects could easily contribute to an accident. One of the earliest

demonstrable effects of carbon monoxide is the reduction of the sensitivity of the eye under low illumination. For example, chronic cigarette smokers are known to have four to eight per cent carboxyhemoglobin in their blood, an amount that corresponds in effect to an altitude of about 7,000 ft. If additional amounts are received from the exhaust system of the vehicle, a dangerously high level of oxygen deficiency may result. In motor vehicles, dangerous concentrations of carbon monoxide usually result from leaks in the exhaust system and from openings in the floor boards or other parts of the vehicle body. It is desirable to limit the amount of carbon monoxide to 0.003 per cent.^{27, 28}

A schematic interpretation of the various environmental stimuli encountered in industry is given in Figure 4 in terms of environmental comfort zones.¹² Because of the interdependence of the variables, these values should not be considered rigid standards. The difficulty in giving a single numerical value as a standard is exemplified by the limits indicated for carbon monoxide. The generally accepted maximum value for prolonged exposures is 100 parts per million (ppm) of carbon monoxide in circulating air. This amount may be satisfactory for a person sitting quietly at sea level, but it must be smaller if the amount of exercise, the degree of ventilation, or the length of exposure are altered. Linear scales or straight-line functions are not so adaptable to the study of human variables as are nomograms, in which one can ascertain the effects that the altering of any one variable has upon the other variables.

System Safety Engineering as a New Discipline.

In recent years, a great deal of attention is being devoted to system safety engineering. A system may be defined as "an assemblage of objects united by some form of interaction or interdependence; generally, a group of men and machines operating together for the accomplishment of a common objective."

In brief, the primary objective of systems safety engineering is the reduction or elimination of all hazardous consequences of equipment operation. It characteristically involves a systematic application of special analytical techniques, derived criteria, evaluation methodology, and management skills. Since it emphasizes prevention rather than

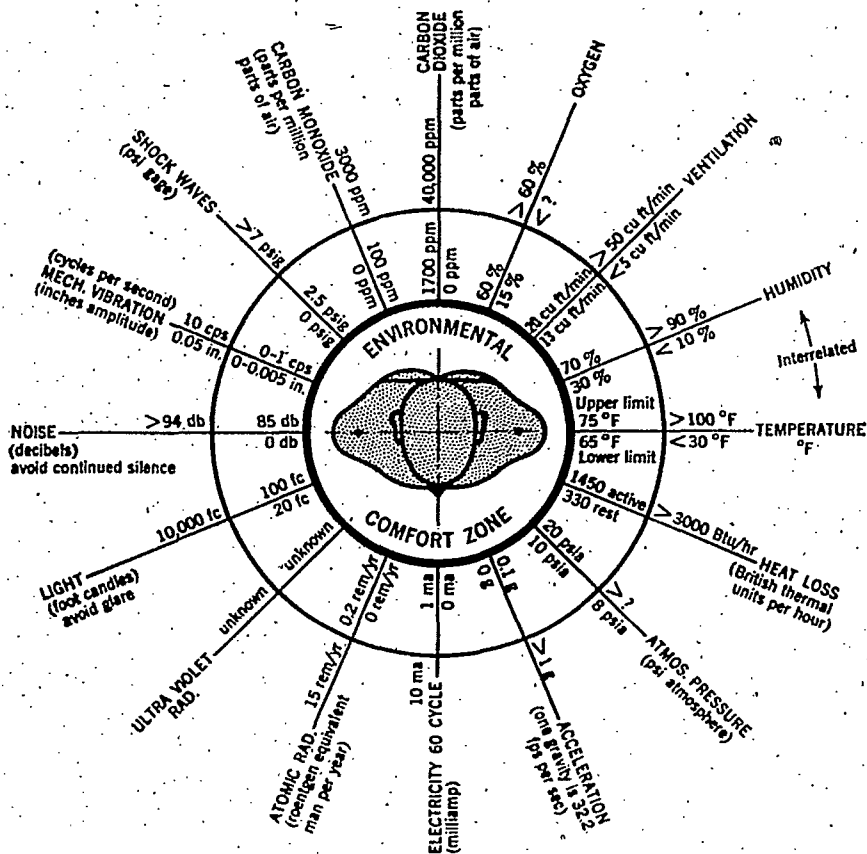


FIGURE 4

correction of problems; particular attention is placed upon early engineering design and procedural analysis. It is broadly conceived to take into consideration all aspects of the planning, design, development, fabrication, test, installation, maintenance, operation, and system evaluation of complex man-machine systems.^{40, 41}

System safety engineering can become a separate discipline and make a contribution to industrial safety only if safety specialists (1) participate in design functions from the mark-up stage, and not from making corrections alone, (2) assume responsibility for safety from the original inception of the design features, including the development, test, and operational phases, and (3) use all fields that are required in the development

of basic data for human factors engineering.

In various fields of public health and medicine, the basic disciplines of biostatistics and epidemiology are used to analyze the possible causes of disease and injury where numerous possible causative factors are involved. Many aspects of these approaches are essentially the same as now emphasized by systems engineers. Where nonspecific etiologies are involved, it is necessary to use techniques which consider interactions and multiple relationships.

Summary.

Many major problems in equipment and workspace design have resulted from the failure to give sufficient consideration to human capabilities and limitations. The ef-

fectiveness of any man-machine system depends upon the integration of the biological characteristics of the operator with the mechanical design of the equipment and working areas. The initial phase of a program in human engineering, or ergonomics, should always consist of an advance analysis of the equipment, including a survey of the nature of the task, the work surroundings, the location of controls and instruments, and the way the operator performs his duties. The basic data needed in human engineering include those which describe the range of human body size at rest and in motion; bio-mechanical abilities including range, strength, speed, and accuracy of motion; sensory abilities; and human reactions to the physical variables of the environment. Only by the application of these kinds of data to the design of the workspace, controls, instruments, and environment, can the worker be assured of maximum comfort, efficiency, and safety in the performance of his task. In conclusion, it is important to note that human factors engineers are in an unusually favorable position to assist in improving the accident rates in industry and in various forms of transportation.

FIGURE 1. Some of the primary static body measurements needed for the design of equipment for use by a seated operator.²⁴

FIGURE 2. The figure illustrates the need for dynamic as well as static measurements. The operator is functional, and may have to perform complex movements or assume unusual positions.¹⁰

FIGURE 3. Effect of high temperature and humidity on skilled performance (wireless telegraphy reception). The curves show both the deterioration in performance with increasing effective temperature, and with duration of the exposure to high temperature and humidity.²⁴

FIGURE 4. Physical variables of the environment which influence the comfort, efficiency, and safety of workers. The area between the circles indicates the range from comfort to the limit of tolerance. Beyond this limit great discomfort or physiological harm is encountered.¹²

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JUSTIFICATION FOR INTRODUCING HUMAN FACTORS INTO AN INDUSTRIAL SETTING

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My presentation will deal with the human factors engineering practice in the aerospace industry; techniques used by human factors engineers to influence design, operational, and safety aspects in system development; specific examples of human factors engineer-

ing application; and some benefits derived from use of the discipline.

Human Factors Engineering.

The nature of human factors engineering has already been defined during these pro-

ceedings. However, it is important to identify clearly the difference, as commonly designated in industrial settings, between the orientation of the human factors engineer and the functions of specialists in various related but distinctly different disciplines.

Traditionally, the industrial psychologist and personnel specialist are primarily concerned with selecting the best people for jobs and of fitting these people to jobs or to the machines. The industrial engineer is mostly concerned with how the job is done and the environment in which the work is performed. The safety engineer is concerned with assuring that the job is performed in the safest manner, without injury to the worker or hazard to plant or facility.

The human factors engineer is concerned with fitting the machine or system to the man. Human engineering involves the application of known principles of human behavior to the design of equipment so that it will be better adapted to the capacities and limitations of the human operators. Christopher Celent, in *Electronic Industries* magazine of February, 1960, states that

"Man, in many ways, is similar to a machine. He receives his inputs via sound, sight, touch, smell, taste, and the proprioceptive senses and, in turn, operates on the inputs with a complex of mechanical, chemical, and electrical systems, and delivers a workable output in terms of force or displacement to the system. He is often compared to a servo system. He receives an input signal, feeds back an output signal, and compares the results with the input.

"The human factors engineer wants to know which functions are best assigned to the man, and which to the machine. He wants to know how well man can do the job assigned to him and what factors influence his performance. He wants to know how many in a given population can do specific tasks and how to discover them. He knows that the reliability of a given system is no better than the weakest link and his job is to make sure that the weakest link in the man-machine system is not the man.

"The human engineer knows that machines are best at making rapid responses and computations, handling simultaneously many complex operations, applying force smoothly and precisely, and performing repetitive tasks. Man excels where inductive

reasoning, judgment, imagination, and broad memory are required."

The human factors engineer uses his knowledge of the characteristics of man and machines in recommending the assignment of functions to man and to equipment during the development of a system.

He makes use of knowledge developed by, or he works on teams comprised of, such specialists as industrial and experimental psychologists, industrial engineers, industrial designers, physicians, physiologists, biologists, biophysicists, anthropologists, life-support systems engineers, environmental engineers, toxicologists, simulation engineers, mathematicians, systems analysts, and physicists. Historically, the human factors engineer has been trained in psychology and has learned to use the tools of math, physics, and engineering. If he is successful, he has also learned how to convince the design engineer of the necessity of using human factors principles in a given man-machine design.

The Justification for Human Factors Engineering.

Over the last 20 years, there has been a growing demand for the knowledge and capability provided by professional and other personnel who can be categorized as "human factors specialists." This growth is dynamic, and all signs point toward an increasingly significant future for the discipline of human factors engineering.

It is my estimate that more than 3,000 persons, whose qualifications and responsibilities place them in the human factors specialist category, are currently employed in the United States by industry, business, universities, research organizations, and government agencies. If we can then consider as valid criteria for "success," these facts of (1) a dynamic existence and influence, (2) widespread use of the discipline by important segments of the industrial, academic, and government communities, and (3) a large number of human factors specialists in current practice, the justification for introduction of the specialty into a wider spectrum of industrial setting is substantially established.

The National Safety Congress is concerned with safety in its broadest sense, and since one of the objectives of the human factors specialist and the industrial safety spe-

cialist is to assure that man can perform his tasks safely, one assumes that the safety movement should benefit from human factors activities, and *vice versa*.

To return again to the nature of human factors engineering, one might ask how human factors engineering, as a specialty, differs from other design engineering practices, whether or not it really is only the application of common sense during the design process, and who really needs it.

Human factors engineering is, of course, an integral part of design engineering, differing only in that it concentrates on the human aspects of man-machine design. Too frequently, the designer becomes engrossed in developing a new piece of equipment to perform a given function and concentrates on the mechanical features, size, weight, power requirements, mean time to failure, and the relationship of the equipment to other equipment items. The man, and the nature and effect of his predictable behavior as a component of the system, have often been relegated to last place in the design deliberations, and the engineer frequently uses a "seat-of-the-pants" or self-testing criteria for his design choice. The "if I can do it, reach it, or read it, then it's O.K." philosophy has prevailed more times than we would like to admit. One does not have to look very far to find instances of the application of this questionable assumption. For example:

Can you readily tell which knob controls which burner on your kitchen stove, or the volume on your television set?

Can you shift gears in any U.S. or foreign automobile without some concentrated study?

Are the safety features on machine tools actually foolproof and do they help or hinder efficient operation?

Do you know what color combinations in highway signs are most easily detected from your auto or which automobile colors are most readily visible at twilight?

Have you ever been confused by expressway direction signs, on-and-off-ramp traffic patterns, yield-right-of-way signs, or other highway instructions?

Can you quickly and accurately read automobile dashboard instruments at night or locate critical car controls without removing your eyes from the road?

When your car's turn indicators fail to dis-

engage, have you ever failed to notice the malfunction because the flasher signal and auditory signal were too weak to command your attention?

Have you ever heard of an aircraft accident caused by a pilot activating the wrong control, misreading an important instrument, or being unable to actuate a control in time?

If you can't think of a single instance where a mishap, a serious accident, or an inefficient operation has occurred because of inadequate attention given in the design process to the human operator and his known limitations, you have been an unusually fortunate user of equipment engineered with exceptional concern for its human factors aspects; or, your critical or perceptive faculties may be somewhat insensitive.

With respect to merely applying common sense in the design process, human factors engineering does incorporate common sense to a considerable degree. In fact, much of human factors engineering is, essentially, the *organized* integration of information obtained from observation, experience, (direct as well as vicarious), and the application of human vision and creativity to project known data in order to anticipate action or results.

However, common sense alone may not always lead the designer to the right decision, particularly in man-machine systems involving relatively new technological environments for which human experience is too limited to provide a "common sense" basis for a design decision. Many of the facts he must know to make the right man-machine design decision are not commonly known, or if known, are frequently overlooked. Our knowledge of human behavior, the abilities and limitations of humans, and how a human responds under stress is, unfortunately, quite incomplete.

Even the human factors specialist will quickly admit that he doesn't have all the answers. He does have, however, some good ideas and some proven techniques for obtaining most of them. He also knows how to use and interrelate the knowledge of many other disciplines in order to arrive at valid and practical solutions to the man-machine interface problems.

In answer to the question, "Who needs human engineering?", my reply is, simply, that every designer of a piece of equipment

for which a man-machine interface exists, every builder of such equipment, every person who uses it and/or maintains it, and everyone who markets it needs human factors engineering, whether such service is performed by a trained specialist or by a well informed designer. It is needed for cost effectiveness, in order to keep redesign, retrofit, and modification costs down, to reduce the cost of selection and training, to improve operational efficiency and to prevent costly and, frequently, deadly accidents.

Human Factors Engineering Techniques.

How does the human factors practitioner participate in and, hopefully, improve the man-machine design process? In most industries, the human factors specialist is a member of an interdisciplinary team. He collects and synthesizes data pertinent to the human who operates or maintains a system.

His first responsibility is to understand the purpose of a newly conceived system. The operations research analyst or the mission-/system analyst hopefully have described the purpose and requirements in detail. Through a painstaking task-equipment analysis, the human factors engineer takes a first cut at the assignment of tasks in gross terms to the machine and to the human component. This task allocation is based on the human factor engineer's knowledge of the state-of-the-art capabilities and limitations of man versus machine.

Once this gross determination—the beginning of a highly iterative process—is made, the human factors engineer may review how similar systems have been operated. He interviews experienced operators to determine the manner in which tasks were performed; when and how frequently their performance was required; which tasks can be considered critical; what operating difficulties typically occur; which elements or circumstances cause discomfort, fatigue, or error; and the reasons for performing a task in a given fashion. He analyzes accidents associated with such performance, performs error analyses, or develops a theoretical model of the total task performance.

The next step is the development of a theoretical time-line analysis in which the human-factors engineer sets forth, for each required function, the separate tasks to be performed, identifies the elements of each task, provides an estimate of the total time

required for the function, and specifies the most productive sequence of performance. From this analysis, he establishes man-equipment interdependencies, operator-to-operator relationships and dependencies, critical events, environmental constraints, and personnel selection and training criteria.

The time-line analysis is developed in association with design engineers and systems planners with the human factors engineer serving as spokesman for the man in the man-machine system. As such, he makes recommendations concerning work-space; selection, location, and arrangement of controls and displays; seating and illumination requirements; protecting man in the system environment; safeguarding against hazards; operating and emergency procedures; visibility requirements; comfort and sanitation provisions; feeding, recreation, work-rest cycles, crew re-cycling, and personnel selection and training requirements; and any other aspect that may affect human performance and safety.

It is important to note that the human factors engineer makes recommendations, but that these recommendations must be accepted and implemented by the design engineer who must be convinced that the suggested human factors provisions are essential and practical. To help convince the design engineer of the soundness of these recommendations, therefore, the industrial designer and mockup developers are often called on to construct either a scaled-down mockup of part of the system in which manikins can be placed to establish man-equipment interfaces, or a full-scale soft or hard mockup of the system in which various test subjects can perform specific tasks required to fulfill important functions. A soft mockup can be constructed quickly and inexpensively of foamcor, a cardboard-like material, or plywood. If the mockup is to be used frequently in tests or demonstrations to the customer, it may be made of materials with greater structural integrity and with equipment which has greater "face validity," that is, the ability to look and even operate much like the system to be actually built.

We call this use of mockups and task simulation, "design verification," since it provides the designer and the human factors specialist with an opportunity for checking out design concepts through the use of human subjects. This part of the procedure

may well be one of the most cost-effective steps in the entire design process since it occurs before a design is frozen and permits redesign to take place at low cost. It is certainly an effective tool for the human engineer to use in establishing the importance of early recognition of human performance and reaction problems.

I recall a recent experience in which a customer could not be convinced that a given requirement was unrealistic and unworkable, despite engineering analyses, drawings, and "table-pounding." In desperation, the human factors engineer arranged for building a dynamic hard mockup to resolve the impasse. Only one demonstration to the customer representatives was necessary to make the point. This solution to such a problem may seem like an expensive way to make a design point; however, the cost of the mockup will, I am sure, eventually be saved many times over in view of the resulting important changes made in the design before it was frozen. Further, the developers of this mockup had sufficient foresight to build it as a design simulator, and it has been and will be used many more times in further design verification studies and, possibly, in operator training.

Mockups are also used for the systematic empirical study of man's performance and behavior. For example, a theoretical timeline analysis can be made more credible through a series of performance trials of the tasks to be performed. One such study was designed to develop estimates of the time required for a single space-suited astronaut to conduct a series of biomedical and behavioral experiments in a small spacecraft such as the Apollo Lunar Excursion Module. A full-scale mockup was built, and mockups of experimental equipment were constructed and installed. Subjects experienced in conducting the simulated experiments and subjects without such experience were observed while performing space experimental tasks in a shirt-sleeve environment or while wearing space-suits.

Theoretical estimates as well as computerized estimates had been made of the times to complete the tasks. When subjected to empirical analysis, however, significant differences between theoretical and actual data were found in performance times, in the logic of the sequences, and in the interrelationships among the experiments. New

sequences became apparent; techniques for experimental integration were discovered; and important design characteristics were developed to ensure that the tasks could be conducted efficiently. Further, we know that even more information must be gained from more sophisticated experimentation and simulation before the actual biomedical/behavioral experiments can take place in space.

I should like to emphasize that the foregoing steps do not need to be sequential or independent. They may occur in a different order or be accomplished simultaneously and still be of value, because of the need for many iterations in the design process.

A more complete and sophisticated simulation used in the human factors engineering process is system simulation. Man-in-the-loop simulation, for example, is another technique employed by the human factors engineer (as well as by a number of other disciplines) and is a considerably more expensive tool. The greater cost is incurred because an effort is made to achieve a higher degree of fidelity, that is, causing the simulation to resemble the actual system as much as possible in terms of appearance, accessories, environment, and equipment functioning and controls. The equipment is made functional through the use of flight-type hardware, analog, digital, and hybrid (analog/digital) computers, and elaborate computer programs that make the simulator behave much like the real system. Many of you are familiar with simulators used for flight training, but the human factors engineer also uses such equipment as part of the design process. These simulators may duplicate part of the tasks to be performed by the crew or virtually all of the aspects of a complete mission to the extent that these can be duplicated on earth.

A part-task simulator may be developed to study just one critical aspect of a space mission, such as how effectively an astronaut can maneuver his spacecraft; or to conduct a study of all tasks to be performed by the crew. Simulators also may approximate some of the environmental conditions to be found in space, such as weightlessness or the effects of the low lunar gravity.

In addition to the development and use of system simulation as a design tool, the human factors research specialist engages in a wide variety of behavioral experiments and

simulation studies in order to develop the principles of human behavior and to predict how man will perform under new and, frequently, high stress conditions. The results obtained from this research are both quantitative and qualitative. They are presented in technical reports, reference guides, and design handbooks and are applicable to system design and operations planning.

An example of an environmental simulation facility is the Lockheed Biotechnology environmental chamber which reproduces some of the environmental aspects of operations in space. The chamber is 18 x 18 x 36 feet and produces an altitude equivalent of 325,000 feet. It has a separately operated airlock which is 10 x 10 x 10 feet, and which is equipped with a Lockheed-developed two-gas, regenerative, environmental control system.

Human factors engineers are also interested in assuring that the equipment they use experimentally is well-designed in terms of human factors aspects. To this end, Lockheed's biotechnology specialists in human engineering, industrial design, aerospace medicine, human physiology, and environmental simulation designed the control console of this chamber to assure efficient and safe operation of the equipment.

The importance of safety to human factors and biotechnology specialists, not only in equipment and system design and operation, but in conducting hazardous experiments with human subjects, was dramatized in a recent program at the Lockheed biotechnology facilities in Sunnyvale, California.

The space environmental chamber had been scheduled for use in a series of tests to evaluate the two-gas, regenerative, environmental control and life-support system which had been installed in the airlock of the chamber (setup to represent an early lunar shelter), and to simulate selected aspects of lunar missions in the main chamber.

The test program provided for four volunteer subjects from Lockheed and Litton Industries living for five days in the airlock early lunar shelter at an 18,000-foot equivalent altitude and breathing an atmosphere of 42 per cent oxygen and 58 per cent nitrogen. This atmosphere was provided by the two-gas, regenerative, life-support system, and drinking water was obtained by reclaiming it from urine and atmospheric condensate.

During the fourth and fifth days of the

test, two of the subjects took turns in performing lunar tasks at $\frac{1}{6}$ gravity, through use of this partial-gravity simulator in the main chamber at an equivalent altitude of 100,000 feet. The test subjects wore Litton hard suits and simulated, personal, life-support back-pack systems which delivered pure oxygen for breathing at a 3.7 psi differential. A similar but shorter lunar surface simulation study had been conducted by Lockheed one year earlier.

Our biotechnology specialists had spent more than one year in the development of requirements and specifications for the space environmental chamber to assure that it could be man-rated for safe operation in manned testing. Nevertheless, when we planned to conduct this manned test after the Apollo fire tragedy, we learned that NASA did not consider our facility to be ready for manned testing in an oxygen-rich environment.

Although our study was not under contract to NASA, we were fortunate to have a NASA safety procedures review committee inspect our facility, evaluate our procedures, and advise us concerning safety of operations. This very competent group of seven highly trained specialists recommended mandatory or highly desirable steps to be taken to man-rate the facility. A considerable number of precautionary actions and changes were therefore completed by Lockheed before conducting the five-day manned test in June 1967. Some of these steps, typical of points to be considered in man-rating a facility and related experimental procedures, are as follows:

1. Special emergency lighting, independent of the building's emergency system, was installed for the chamber airlock, chamber, chamber control station, and medical room.
2. Additional back-up emergency voice communication equipment was installed.
3. Emergency oxygen-supply equipment for the life-support back pack was provided.
4. A nitrogen repressurization system was installed in the airlock.
5. A hyperbaric chamber was installed for treating bends.
6. A pull test was conducted of all environmental control system hoses and fittings to assure that they could not be inadvertently dislodged.

7. Special fire-protective clothing was provided for test subjects and rescue personnel.
8. Intensive training in emergency procedures was provided the test subjects and test conductors, and a detailed record was maintained of each step in the training process as a specific guide for future training.
9. A water-spray, fire-fighting system was installed in the airlock.
10. All equipment was disassembled or drawings checked to ensure that components could meet the new NASA specifications pertaining to nonflammability in oxygen-rich environments.
11. Components were replaced, as necessary, with materials which could meet the new flammability standards.
12. An extensive failure modes analysis was conducted for the airlock, chamber, environmental-control system, and emergency equipment to assure that no single or double failure could occur in a component critical to the life of the test subjects and experimenters.

The five day test was successfully concluded in June 1967. A valuable lesson re-emphasized by this experience was that the learning process never stops in any aspect of human factors, design, or safety engineering.

Experts in one field can learn a great deal from experts in another. There is little room for smugness or complacency in this business, particularly when human life or well being is at stake, whether it be in system design and operation, or in experimentation.

My purpose in describing the objectives, concepts, techniques, activities, and problems characterizing the application of human factors engineering has been to develop a greater understanding and appreciation regarding the nature of this discipline and its present influences and status. I have also tried to emphasize the potential it offers for producing maximum effectiveness, efficiency, and safety in man-machine systems.

The considerations I have presented do reflect somewhat the influence of the considerable system complexity and high development costs prevailing in the aerospace industry. However, many of the principles and techniques described can be applied by human factors engineers, with some modification and on a smaller scale where appropriate or necessary, to improve any man-machine system, operation, or relationship. This applicability exists for any area of technology or industrial or economic effort where man seeks to augment his strength, his skill, his perceptivity, or his productivity through the medium of the machine.

The Safety Specialist's Function

WHAT I EXPECT OF THE SAFETY SPECIALIST

By ARTHUR H. CHRISTIAN

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In this time of Big Science, in this era called the Space Age, in this generation growing increasingly accustomed to the luxuries of instant "everything" (including instant death), it is not surprising that some workers and, indeed, some management, expect instant industrial safety.

I say, "Humbbug!"

Like everything else in life worthwhile, industrial safety, and, for that matter, safety in any area of human activity can be achieved only by intelligent hard work.

Industry currently seems to have a number of vexing problems in the accident prevention area. Without question, processes and products are getting more sophisticated and exotic, there are more real technical problems. Even more challenging are the increasing demands by people—the heart of the accident or safety problem. As part of their desire for more security, they want both easier jobs and less effort required for the discharge of their personal responsibility for safety. Compensation laws are becoming increasingly generous and this, coupled with currently stylish third-party law suits for product liability, represents just one more ever present increase in the cost of doing business. Surely, all will agree that there is some risk in all human activities. It is difficult for me to imagine a totally safe enterprise—even Federal.

In the industrial community, when industrial safety and industrial accident prevention began to assume importance around the early 1900's as a result of the adoption of compulsory Workmen's Compensation Insurance in many of the states, attention was focused on the hazards created by the various types of machinery which were being developed and installed and used to produce goods. Because the accidents and injuries which resulted from these accidents were usually dramatic, and also very serious, primary emphasis was devoted to "guarding" the equipment. Exposed gears, belts, pulleys,

and other moving machinery were gradually closed to prevent people from coming in contact with this moving equipment. *This was good.*

As the mechanical equipment became better protected, and yet accidents and resulting injuries continued to occur, emphasis was placed upon the importance of the individual's behavior and its contribution to these events. *This was good.*

About this time, someone came up with a theory that all accidents could be attributed either to "unsafe acts" or "unsafe conditions," and that accidents could be categorized as primarily the result of either one or the other of these. *This was bad.* It made a nice simple package, and if true, all accidents and the resulting injuries or loss could be put into one compartment or the other—and sometimes in both—but it was an oversimplification.

Concurrently with these developments, there has come into being a number of individuals who specialized in finding ways and means of preventing these accidents and their injuries or loss. Gradually, as knowledge was increased in this field as well as others, and as our own civilization has become more complex, there came an increasing realization that accidents are not simple occurrences but, rather, are very complex indeed insofar as identification of the causes is concerned. At the same time, it also has become generally accepted that there is some risk or hazard to practically all undertakings, and that the word "safe" is not an absolute term but rather a relative term. It merely describes something as being either more safe than something else, or less safe than something else. It is not a "go" or "no-go" situation.

The American Society of Safety Engineers firmly believes that preventing accidents and injury or loss by developing control mechanisms is a specialized field. Loss prevention is a sophisticated business and requires a

scientific approach. Nothing less will do. If we are to remain competitive as individuals, plants, corporations—yes, even as a nation and possibly as a planet—safety must be included, and given a fair share of attention. ASSE, therefore, embarked upon a program which is designed to identify the work that these specialists should be doing—the kinds of knowledge and abilities that they should acquire to perform the task; and to develop ways and means whereby individuals can be given the kind of education that will enable them to perform this work more effectively in the future.

Phase 1 of a three phase program, defining the scope and the functions that the individual should perform, has been completed. The essential elements of these functions are presented with the thought that this is the way the Society sees this field of specialization as it should develop in future years.

There are four major areas:

1. Identification and appraisal of accident and loss producing conditions and practices, and evaluation of the severity of the accident problem.
2. Development of accident prevention and loss control methods, procedures, and programs.
3. Communication of accident and loss control information to those directly involved.
4. Measurement and evaluation of the effectiveness of the accident and loss control system and the modifications needed to achieve optimum results. Along with this must be feedback to be used for modifications at any step of the procedure.

Identification and Appraisal of the Accident Problem.

The first function is described as "identification and appraisal of accident and loss producing conditions and practices, and evaluation of the severity of the accident problem." Certainly, identifying the kinds of hazards and the magnitude of the hazard insofar as its potential results are concerned is the first and most important step. This is like any problem solving situation where the most important thing is to identify and clearly state the problem. Only then have you made a beginning.

Identification of Hazards. Hazard analysis of existing facilities, operations, and products represents a modest investment in time and

effort in carrying out job safety analysis (both of proposed operations as well as existing ones) yet it yields quite impressive and worthwhile returns. Certainly, it is a far better approach than flag waving and poster posting or, for that matter, even periodic five minute talks using a shotgun approach. Often it represents a refreshing change in pace, since it uses specifics as opposed to generalizations. While there are a number of ways of doing this, basically it is merely breaking any job operation down into the essential elements, identifying the obvious and not so obvious hazards, and then deciding how these hazards either are going to be eliminated, mitigated, or safeguarded. For existing facilities, certainly, I would recommend no crash-basis program, but instead a gradual and ongoing program, beginning either with one segment of a very hazardous process or a widely used operation that lends itself to the technique.

As recommended, the procedure hopefully uncovers hidden hazards that well might not be realized until after an accident or injury. Obviously, it is completely undesirable to take a post-mortem approach to safety and correct either unsafe practices or unsafe acts only after a loss occurs. Moreover, this process enlists the active cooperation of employees, often in a greatly more effective fashion than many other approaches such as general promotion or even emphasis on overly-detailed departmental safety regulations. It lends itself to use as a training device and safety orientation of new or transferred employees. Most important, the first draft should be done initially by the first line supervisor on each shift (if it is done by someone else, such as the safety engineer, it would be comparable to someone else eating your dinner for you). It should be reviewed with each operator to establish valuable two-way communication about safety or the specifics of the job done every day, with the same equipment, and with the same materials—the only difference, theoretically, being people.

A composite then should be made, possibly utilizing the staff services of safety personnel, or even the well-educated, well-trained, well-experienced industrial engineering staff. Eventually, a final draft should be made after review either in a group or individually with all concerned, so that the single best way of doing the job with the same

process, equipment, and working environment is firmly established by agreement. Subsequent periodic review well may reveal startling "Saturday afternoon short cuts" and innovations.

Evaluation of Losses. The economic losses that result from accidents need to be presented in a fashion which make them easily understood, and need to be developed with a high degree of accuracy. Again, there have been certain "rules of thumb" which have been talked about in general terms, but there is ample evidence to indicate that there is very little factual data to support some of these rules of thumb. It is extremely probable, in my judgement, that two different industrial establishments in the same city might sustain different economic losses from an industrial accident which results in an injury, depending on the kind of operation or the kind of process that is being conducted in the two establishments. Even off-the-job injuries can fool you—with today's employee benefits, they are just as expensive as work injuries, just as disruptive to orderly conduct of business, and almost without exception there are vastly more off-the-job injuries than work injuries.

Probability of Human Error. If we utilize the concept of systems along with some of the more recent information that is available on the probability of human error in performing certain tasks, we can develop some evaluation of both the probability of error and the result that it will produce. The error that humans make may be the error of the worker, supervisor, or—would you believe—the manager! Some errors will result in rather minor problems or minor injuries, but others obviously may result in the loss of an entire production facility. Certainly, we ought to spend the greatest time and effort and most money eclectically on problems and areas that will do the most good and give the greatest return on money. Concentrate on the important.

Valid Data of Causative Factors. One of the most important functions to be performed is the development of methods of determining the multiple causes that contribute to the occurrence of an accident and the resulting injury or property damage. This presumes the obtaining of valid, reliable information, in depth investigation, and development of specific categories and factors which have relevancy to the accident so that the

causes can be more clearly defined and thereby controlled.

An example of this would be the thorough investigation that is made on all aircraft crashes. Pieces of the aircraft are gathered together and may even be reassembled; instruments have been developed which will shed information on what was occurring immediately prior to the accident. Similar procedures are used in chemical explosions.

Often, the most glaring apparent cause has the least to contribute. It takes real research. This specialism also would include providing the kinds of advice and counsel that would be necessary to insure that the industrial establishment was in compliance with the applicable laws, regulations, or codes existing throughout the area in which it was located. This is becoming increasingly important.

The Need For Other Disciplines. One of the important attributes of any specialist is to recognize that there are others with certain specialized knowledge who can assist in the solution of the problems that are presented. Certainly, in this area, the safety specialist would recognize the need for consultation with medical personnel, perhaps industrial hygienists, psychologists, fire protection engineers, etc., who could assist in the solution of a particular problem.

Included in this area would be keeping abreast of the technological developments and the problems that these would create insofar as the safety and health of personnel and the protection of property were concerned. The conduct of research studies of technical safety problems—i.e. establishing the true safety parameters of complex chemical reactions is an excellent example of a vital activity that might be a full-time job for a safety professional.

Development of Accident and Injury Controls. Having evaluated the kind and severity of potential loss-producing situations, it now becomes necessary to develop methods of control. At this stage, the job is to develop a system or method or protective device that either will eliminate the probability of accident occurrence or reduce its severity to the point where it can be tolerated.

Standards, Policies, Systems. Develop policies, codes, safety standards, and procedures that become part of the operational policies of the organization. It should be realized that it is practically impossible to develop

rules and regulations that would cover every conceivable situation. The rules and regulations that exist should be reasonable and practical, and management should be prepared to enforce them unwaveringly. Regardless of what policies, codes, standards, and procedures are officially issued, there should be great emphasis on the fact that each person must discharge his personal responsibility for safety.

One concept that has been successful is that of "positive control." The approach is to try to emphasize to supervisor and worker alike that they must view each job situation with a personal evaluation as to whether or not safety is under positive control. This can range from such highly technical approaches as recommending that safety parameters of safety processes be established by in-depth study of the same type that reactions, quality, yield, profitability, and other factors are given, down to such simple precautions as having office filing cabinets and shelves positively fixed to walls to insure that they can't fall over regardless of unstable loads or other strains imposed on them.

In carrying out this function, the safety professional uses his specialized knowledge of accident causation and control to prescribe an integrated accident and loss control system designed to:

1. Eliminate causative factors associated with the accident problem, preferably before an accident occurs.

2. Where it is not possible to eliminate the hazard, devise mechanisms to reduce the degree of hazard.

It should be emphasized here that the safety professional should not be expected to devise and carry out all the loss prevention activities himself, but rather should recommend and participate in the approach. The safety engineer, himself, is not totally responsible for the prevention of accidents!

The safety engineer's primary emphasis is going to be attempting to foresee the situation in advance and, utilizing his knowledge of the multiple causative factors that are involved, taking such measures as will eliminate as many of those causative factors as possible. If it isn't possible, as it may well not be, to eliminate them, he may take some intermediate step to at least reduce the hazard or even reduce the severity of the results of an accident, utilizing specialized equipment designed for that purpose. A good ex-

ample of the latter point is the provision of eye protection or head protection, which is not in fact preventing the occurrence but is in essence providing the individual with protection so that he will not be injured as severely as he would without it.

The safety engineer should consult with those who are involved in the modification or the design of new equipment or procedures or operations to assist in focusing attention upon those operations or facilities that would create a higher degree of hazard than can be accepted under the present state of knowledge.

By working with those who have the responsibility for selection and placement of personnel, he could assist in the placement of personnel in the kinds of activities which are best suited for the capabilities of the individual in question.

He would continually keep abreast of the technological developments and equipment designed to eliminate or minimize hazards and determine whether these have application to those operations or activities with which he is directly concerned.

He may and should become involved in the safety of the product that is being manufactured, because of his specialized knowledge in the area of accident causation. This is an increasingly important area.

Communicate Loss Control Information to Decision Makers.

After identifying the hazards and the severity of the accident problem that exists and then developing methods, systems, and techniques whereby these hazards can be kept under control, it is now vitally important for the safety specialist to be able to communicate this information to those directly involved and who have final responsibility for the operation.

Thus, he would compile and analyze and provide interpretation of the data that is available and would prepare reports that would be meaningful to those who have ultimate responsibility for taking action. However, data should not be gathered for data's sake. The intelligence from such data should be used in the plant or in the department or in the group where it is generated at the earliest time possible.

Recognizing the need for specialized education and training programs for those directly involved in the operation, he would

assist in the development of this material with the purpose of reducing the probability of human error.

He must persuade, using every means at hand, those who have ultimate decision making responsibilities to adopt and use those controls which a preponderance of evidence indicates are best suited to achieve the desired results and the end objective.

A variety of communication methods would be utilized to demonstrate useful alternative methods and their application to those who have the ultimate decision making responsibility. The communication techniques he will need develop are those which are going to be timely and readily understood from the frame of reference of the particular type of activity involved.

The safety engineer provides advice and counsel on the type and channels of communications to insure the timely and efficient transmission of useable accident prevention information to those concerned. One approach I like is total loss prevention. Total loss prevention is not an unrealistic goal. While difficult of accomplishment and long range at best, it is a worthy objective. For example, we must be interested in prevention of all hostile fires, not just those that might level the plant. Similarly, we should strive for prevention of injuries of the slightest degree, not just disabling or lost time injuries.

To do this, it is necessary to develop social pressure in behalf of accident prevention—that is, to get the individual worker to the point where he thinks accident prevention is his idea. Social pressure can best be increased in the direction of total injury prevention by competition; for example, between shifts in a particular department on the basis of total injuries, rather than serious or disabling only. The favorable total results achieved by such an approach far outweigh any possible small percentage of injuries that go unreported. Moreover, this small percentage lends itself quite well to disciplinary action for non-reporting in the event they are uncovered later, as by infection.

Another practical and productive approach is by personalizing safety—counseling those individuals who have greater than their share of total injuries in any given period of time. For example, in comparing industrial truck operators operating the same truck on the four shifts, it is astounding to

find that one of the truck drivers might have been there for twenty years with never a disabling injury and possibly six first aid cases; whereas at the other extreme, another operator has one or two disabling injuries a year and a first aid case almost every week. This approach best can be done in a low-pressure fashion without a formal announcement, doing it on the basis of "What can we do to help?" Effort put into programs of this type will be most rewarding.

Measurement and Evaluation of Accident and Loss Control System.

Lastly, the safety specialist should evaluate and measure the results of the effort and the control methods that have been instituted to determine whether they are producing the desired results. In other words, the best program or the best controls that can be devised may not be producing the kinds of results that are needed; if so, there should be some way by which they can be evaluated and measured so that changes or modifications can be made to make them more effective.

Thus, the specialist would develop some type of measurement technique to fit a particular operation, so that he could determine at any particular time whether the control system is effective or not. He would also develop a method that would determine the cost of the control system in terms of its effectiveness and its contribution to the reduction of accidents and losses and injuries. He would provide a means whereby information concerning the effectiveness of these control measurements would go back to those who have ultimate decision making responsibility and would include with these those recommended modifications or changes that would be indicated by such analysis.

It may appear to you that this would require a great deal of talent. We firmly believe that it will and that this is the objective towards which those in the safety field should strive. As you can see from this, the specialist will have a broad understanding of the physical sciences as well as the behavioral sciences. He will recognize the inter-relationship that exists between human beings and the environment in which they find themselves.

Because this will require knowledge in more than one discipline, it is quite probable that there will develop specializations within

this field that will make it possible to approach the problem from a team point of view, utilizing the many disciplines that are involved so that they will result in less accidents, injuries, and loss of material and property; and thus, the safety professional will become a reality.

With the wide variety of industrial operations carried on today, in some instances some of the functions which we have described may not be applicable to the particular operations. The underlying principle,

however, is that the fundamentals of this approach would apply in whatever activity the specialist finds himself. He might have to learn the specific application of some of these techniques and methods, but having been well trained in the fundamentals, he would be able to apply these fundamentals to the particular problems which exist.

The best qualified practitioners will be truly safety professionals with broad educational background, training, and talents for broad administration.

SCOPE and FUNCTIONS of the PROFESSIONAL SAFETY POSITION

Professional Development Project—Phase One

(Adopted by the Board of Directors, American Society of Safety Engineers, October 22, 1966)

In 1963 the executive committee of the American Society of Safety Engineers initiated a project which was designed to identify the type of work safety personnel should be doing, and to establish a plan for their growth and development which would give them legitimate claim before management and the public as practitioners of professional standing.

The project was recommended by the Colleges and Societies Committee under the chairmanship of Dr. W. E. Tarrants. An outline of the project was prepared by Dr. Tarrants, submitted to the Society's Executive Committee, and subsequently published in the February, 1965, issue of the *Journal of the American Society of Safety Engineers*. In the outline, it was proposed that the project be undertaken in three distinct phases.

Phase One is to describe the scope and functions of the position; Phase Two is to develop a curriculum or formal course of study leading to a university degree which will prepare the safety professional to perform the functions that were described in Phase One; and the third phase will be designed to establish procedures leading to the acquisition of some form of certification or registration as a means of demonstrating competence in the field.

This is Phase One of the project. It describes the scope and major functions of the professional safety position. It was prepared by the Project Review Board, and approved by the Executive Committee for distribution to the membership of the Society for their

study and comment. As a result of that distribution, during the summer of 1966, more than 700 members responded, of which almost 200 offered specific comments. This document embodies many of the most thoughtful suggestions.

This description has been approved by the Board of Directors. It will serve as a guide to those who have need for professional safety services to utilize those services more effectively, and furnish the basis for the development of a field of study for the individual member of the Society while the development of a formal curriculum is under way. It is contemplated that this will be a live document subject to change or modification as the project progresses.

(NOTE: In safety work today a large variety of position titles are used, including safety director, safety manager, safety engineer, safety supervisor, safety officer, safety consultant, and safety specialist. In some cases the title used is consistent with other position titles used in the organization. In other cases the title is one of individual choice. Recognizing that there is a wide difference of opinion and, in many cases, strong personal preference for a particular safety title, the generic term "safety professional" will be used throughout this document.)

The Future of the Profession.

During the past 50 years there has been an orderly development of a substantial body of knowledge which, when applied

with sufficient skill and judgment, has produced significant reductions in many types of accidents and accidental injuries. However, further advancement demands clear concepts regarding the work that must be done in the future by those who wish to achieve professional status.

Accidental occurrences, whether they are fires, motor vehicle accidents, or occupational injuries, for example, are extremely complex and involve many contributing factors involving human beings and their physical environment.

The tremendous increase in scientific knowledge and technological advancement during the past 20 years has added to the complexities of safety work. Future application of this knowledge in all aspects of our civilization, whether in industry, transportation, or recreation, makes it imperative that those in this field of endeavor be trained to utilize scientific principles and methods to achieve adequate results.

There are several important trends in the pattern of the safety professional's development which have emerged and which appear to indicate the future of the profession.

First is an increasing emphasis upon the need for greater effort towards analyzing the loss potential of the activity with which the safety professional is concerned. Such analysis will require greater ability to predict where and how loss and injury producing events will occur in the future and the means of preventing such events.

Second is the need for increased development of factual, unbiased, and objective information about loss producing problems and accident causation so that those who have ultimate decision-making responsibilities can make sound decisions concerning the appropriate action they must take.

Third is the use of the safety professional in a more direct role in support of the development of safe products. The application of the principles of accident causation and control to the product is becoming more important because of the increase in products liability cases, the sudden emphasis in law of the entire field of negligent design and the obvious impact a safer product would have on the overall safety of the environment.

The Scope of the Professional Safety Position

It is proposed that work in the field be separated into three levels of service; the entrance level, professional level, and the ad-

ministrative level. The entrance level could be analogous to the intern in the medical profession representing an individual who had completed a course of study in the field and was now gaining necessary experience. It could also represent a careerist who might specialize in one segment of the field.

The administrative level could represent the manager or administrator of a large unit in a governmental agency or substantial industrial organization. In many cases the professional safety position could represent the administrative level as well. The scope and functions described are those of the professional safety position.

The safety professional brings together those elements of the various disciplines necessary to identify and evaluate the magnitude of the safety problem. He collects and analyzes the information essential to the solution of the problem. He is concerned with all facets of the problem, personal and environmental, transient and permanent, to determine the causes of accidents or the existence of loss producing conditions, practices, or materials.

Based upon the information he has collected and analyzed, he proposes alternate solutions, together with recommendations based upon his specialized knowledge and experience, to those who have ultimate decision-making responsibilities.

The functions of the position are described as they may be applied in principle to the safety professional in any activity.

Functions of the Professional Safety Position.

The major functions of the safety professional are contained within four basic areas. However, application of all or some of the functions listed below will depend upon the nature and scope of the existing accident problems, and the type of activity with which he is concerned.

The major areas are:

1. Identification and appraisal of accident and loss producing conditions, and practices, and evaluation of the severity of the accident problem.
2. Development of accident prevention and loss control methods, procedures, and programs.
3. Communication of accident and loss control information to those directly involved.
4. Measurement and evaluation of the ef-

fectiveness of the accident and loss control system and the modifications needed to achieve optimum results.

Identification and Appraisal of Accident and Loss Producing Conditions and Practices and Evaluation of the Severity of the Accident Problem. These functions involve:

1. The development of methods of identifying hazards and evaluating the loss producing potential of a given system, operation or process by:

- a. Advanced detailed studies of hazards of planned and proposed facilities, operations, and products.
- b. Hazard analysis of existing facilities, operations and products.

2. The preparation and interpretation of analyses of the total economic loss resulting from the accident and losses under consideration.

3. The review of the entire system in detail to define likely modes of failure, including human error, and their effects on the safety of the system.

a. The identification of errors involving incomplete decision making, faulty judgment, administrative miscalculation, and poor practices.

b. The designation of potential weaknesses found in existing policies, directives, objectives, or practices.

4. The review of reports of injuries, property damage, occupational diseases, or public liability accidents and the compilation, analysis, and interpretation of relevant causative factor information.

a. The establishment of a classification system that will make it possible to identify significant causative factors and determine trends.

b. The establishment of a system to insure the completeness and validity of the reported information.

c. The conduct of thorough investigation of those accidents where specialized knowledge and skill are required.

5. The provision of advice and counsel concerning compliance with applicable laws, codes, regulations, and standards.

6. The conduct of research studies of technical safety problems.

7. The determination of the need of surveys and appraisals by related specialists such as medical, health physicists, industrial hygienists, fire protection engineers, and psy-

chologists to identify conditions affecting the health and safety of individuals.

8. The systematic study of the various elements of the environment to assure that tasks and exposures of the individual are within his psychological and physiological limitations and capacities.

Development of Accident Prevention and Loss Control Methods, Procedures, and Programs. In carrying out this function, the safety professional:

1. Uses his specialized knowledge of accident causation and control to prescribe an integrated accident and loss control system designed to:

a. Eliminate causative factors associated with the accident problem, preferably before an accident occurs.

b. Where it is not possible to eliminate the hazard, devise mechanisms to reduce the degree of hazard.

c. Reduce the severity of the results of an accident by prescribing specialized equipment designed to reduce the severity of an injury should an accident occur.

2. Establishes methods to demonstrate the relationship of safety performance to the primary function of the entire operation or any of its components.

3. Develops policies, codes, safety standards and procedures that become part of the operational policies of the organization.

4. Incorporates essential safety and health requirements in all purchasing and contracting specifications.

5. As a professional safety consultant for personnel engaged in planning, design, development, installation of various parts of the system, advises and consults on the necessary modification to insure consideration of all potential hazards.

6. Coordinates the results of job analysis to assist in proper selection and placement of personnel whose capabilities and/or limitations are suited to the operation involved.

7. Consults concerning product safety, including the intended and potential uses of the product as well as its material and construction, through the establishment of general requirements for the application of safety principles throughout planning, design, development, fabrication, and test of various products, to achieve maximum product safety.

8. Systematically reviews technological developments and equipment to keep up to

date on the devices and techniques designed to eliminate or minimize hazards, and determine whether these developments and techniques have any applications to the activities with which he is concerned.

Communication of Accident and Loss Control Information to those Directly Involved. In carrying out this function the safety professional:

1. Compiles, analyzes and interprets accident statistical data and prepares reports designed to communicate this information to those personnel concerned.

2. Communicates recommended controls, procedures, or programs designed to eliminate or minimize hazard potential, to the appropriate person or persons.

3. Through appropriate communication media persuades those who have ultimate decision making responsibilities to adopt and utilize those controls which the preponderance of evidence indicates are best suited to achieve the desired results.

4. Directs or assists in the development of specialized education and training materials and in the conduct of specialized training programs for those who have operational responsibility.

5. Provides advice and counsel on the type and channels of communications to insure the timely and efficient transmission of useable accident prevention information to those concerned.

Measurement and Evaluation of the Effectiveness of the Accident and Loss Control System and the Needed Modifications to Achieve Optimum Results.

1. Establishes measurement techniques such as cost statistics, work sampling, or other appropriate means for obtaining periodic and systematic evaluation of the effectiveness of the control system.

2. Develops methods that will evaluate

the costs of the control system in terms of the effectiveness of each part of the system and its contribution to accident and loss reduction.

3. Provides feed back information concerning the effectiveness of the control measures to those with ultimate responsibility, with the recommended adjustments or changes as indicated by the analyses.

Conclusions.

The safety professional, in performing these functions, will draw upon specialized knowledge in both the physical and social sciences. He will apply the principles of measurement and analysis to evaluate safety performance. He will be required to have fundamental knowledge of statistics, mathematics, physics, chemistry, as well as the fundamentals of the engineering disciplines.

He will utilize knowledge in the fields of behavior, motivation, and communications. Knowledge of management principles as well as the theory of business and government organization will also be required. His specialized knowledge must include a thorough understanding of the causative factors contributing to accident occurrence as well as methods and procedures designed to control such events.

The safety professional of the future will need a unique and diversified type of education and training if he is to meet the challenges of the future. The population explosion, the problems of urban areas, future transportation systems, as well as the increasing complexities of man's every day life, will create many problems and extend the safety professional's creativity to its maximum if he is to successfully provide the knowledge and leadership to conserve life, health and property.

THE SAFETY ENGINEER — WHAT I EXPECT FROM HIM

By **PAUL A. STEWART**

Vice-President, Manufacturing, The Maytag Company, Newton, Ia.

I strongly suspect that far too many times the effectiveness of a safety engineer is hampered by the fact that there is no clear understanding as to what is expected of him.

The job of the safety engineer can be no more effective than the emphasis a company places on the importance of safety and this, in turn, can be no stronger than the attitude

the management of the company itself towards the program.

Therefore, it follows that what is to be expected from the safety engineer and his staff can be no more than what plant management expects from the program.

Much has been said and written about the importance of safety. The pain, the anguish, and all the other negative aspects of unsafe practices and conditions and their resultant injuries are known to all of us. Statisticians have set forth data on costs, frequency, and severity. Information and printed materials of all kinds are readily available, along with other aids for the promotion of the idea of safety.

Safety devices, ingenious and effective, are available and are being constantly refined and improved. I submit, however, that all the facts, all the devices, all the promotional material, and all the exhortations will be most ineffective without the proper environment, which must be created by management itself.

What has been said is in no manner to be considered as an excuse for the safety engineer or to provide him with rationalizations for his inability to solve the problems he faces. It is rather to say that, as is true with all staff relationships to the line, the safety engineer must have the genuine endorsement and support of management because it is from management that an effective safety program must evolve. The engineer plays a most important role, but we, in management, cannot really delegate to the engineer in part or in whole the responsibility for doing that which we, in management, must do ourselves. The responsibility to improve safety performance does not rest solely with the safety engineer, it does not stop at the production worker level, it doesn't include only operating supervision, it is the sober responsibility of everyone, including management at all levels.

In light of these comments then, what do I look for in a safety engineer?

In the first place, I look for a man who possesses the desirable characteristics of anyone who sets out to do a job. These characteristics embrace confidence, enthusiasm, dedication, perseverance, and professional stature. We could add others that you are as familiar with as I, which go into the makeup of any person who does an effective and successful job.

However, if I were to list the above characteristics in order of importance, I would select a person's ability to earn stature as the result of his performance to head the list.

This stature must be genuine. Any organization can give over to the safety engineer all the formal authority it wishes to supply to him and can spell out certain responsibilities, but it isn't enough. It is here that I think the statement of a well-known student of management techniques, Mary Follett, is most appropriate: "While authority vests in the function, it is earned by ability and it is maintained by performance."

In other words, an effective safety engineer—the kind of man I want to see in the safety engineering assignment—is the one who earns the authority of his office by virtue of his ability and maintains that authority by virtue of his performance on the job.

May I be permitted to criticize the safety engineering profession, and, at the same time, criticize the management function in this area of safety? My criticism is well intended and I know that it does not apply in all situations. In too many instances, however, management does not accept the safety engineer far enough up the line and the safety engineer, in turn, does not perceive himself as being a responsible member of management, who must work effectively with management at all levels.

Certainly, the safety engineer is involved with the plant superintendent, the manager of manufacturing, or the vice-president when a serious accident occurs. Sure, he is called into meetings when a legal problem arises relative to safety. Of course, the safety engineer is at the table when a grievance with respect to safety goes all the way to the last grievance step, or arbitration.

My criticism, rather, is directed to the day in, day out operation of the plant. Does management consider the safety engineer, as it should, as a specialist whose ability and other resources cannot be ignored if the objectives of a genuinely safe operation are to be attained? Does the safety engineer see himself as a meaningful technician and manager, who shares with major management the responsibility for an effective safety program? Or does the safety engineer look at his job as one that is successfully discharged as long as he keeps reasonably well out of trouble?

Perhaps I have been a little harsh to this point. If so, it has been in order to drive home my conviction that the function of the safety engineer cannot properly be discharged unless there is a two-way meeting of the minds, and an effective working relationship between top management and the safety engineer.

I do not believe that the safety engineer, under any circumstances, should consider his position to be of a conference-room role. It must be a very practical, on-the-scene kind of responsibility. At the same time, there must be more than a cordial relationship with top management. It must be an effective, conscientious, meaningful, and productive relationship, or else the job of safety engineer can be nothing other than frustration on the one hand and an ineffective exercise on the other.

It seems to me that management must also look to the safety engineer as a resource. Reports prepared by the safety department must be more than statistical summaries of what has happened. While such reports are important, and while they can be helpful in some respects, I think that too often the safety engineer becomes enamored with statistics and passes on to management masses of statistics that leave the manager in a somewhat confused state. How much more effective it would be if such reports carried with them a cover sheet interpreting these statistics. "What do these facts mean? What do they indicate? What is to be done to correct the problems?" In my company, I insist that reports of conditions, in the area of safety or elsewhere, carry with them recommendations as to action which should be taken and justification for such action.

Consider the importance of innovation. Our manufacturing techniques constantly are changing. New equipment is coming at us with ever greater acceleration. Is it, therefore, unreasonable to expect a safety engineer to respond to these changes with innovations of his own that are appropriate to the changing scenes? Isn't it the responsibility of the safety engineer to keep abreast of change, not only in his own plant, but in other plants? Shouldn't he anticipate the future and bring it into the present so that we can avoid unforeseen developments? This is what I mean by innovation coupled with "creativity".

Management also should look to the safety

engineer, assuming that he is given the proper environment and support, to exercise a high degree of initiative. He must be, at times, a policeman. He must be an inspector. He must be a disciplinarian. He must be a reporter. But he must never be these things in an exclusive sense. His activities embrace all of these functions but beyond that, much more. He has to be the sparkplug, the initiator of new ideas, the needle.

He must be a human relations expert. He must be able to work effectively with all types of people and develop within them an attitude of enthusiasm for safety. As part of his ability to perform as a human relations expert, he must be able to cooperate with others and listen to their side of the problem. He must accept the fact that most problems have more than one solution and that his answer might not always be the best at any given time.

There are many other qualities that a safety engineer should possess. He must be able to create and direct a program that will create a favorable image in the community towards his company's safety and plant protection policies. One might say he is, in this assignment, an adjunct to the company's public relations department. This favorable image is important for many reasons, not the least of which is the fact that it has an effect on the personnel department's ability to recruit help from the community.

There is a growing importance in the ability of the safety specialist to work closely with Federal, state, and local government representatives in order to make certain that meaningful industrial safety laws and regulations are passed, and that meaningless restrictions are not created through lack of understanding.

The safety engineer cannot rest as long as there is any possibility that his activities in these many areas of responsibility fall short of providing adequate protection for all employees.

I think one way to sum up my expectations toward a safety engineer would be to say that I expect him to be the conscience, along with management, of the organization in fulfilling the responsibility of providing the opportunity for all employees to work safely and to avoid accident and injury.

No activity in industry has more justification for existence from the moral and ethical

standpoints. The safety engineer must, if he is to be the conscience of the organization, be a man of competence and stature, one who enjoys the respect of all. This can come

only if his function is genuinely important to management and can come only if he is qualified to fill such a role, once he is given the opportunity.

WHAT LABOR MANAGEMENT EXPECTS OF THE SAFETY SPECIALIST

By J. GEORGE EICHHORN

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We of the union movement firmly believe that the professional safety engineer needs practical help if he is to do the job we would like to see him do. While we want our safety engineers or specialists to be professionals, we feel that in all too many cases they are failing to be as effective as they could be because they are not allowed to have, as a part of their staff, trained craftsmen who have worked for years on machines and/or equipment and who have an intimate understanding of the problems that arise that no professional can be expected to have. From our experience, we believe that management is being short-sighted when they don't provide the money and permission to use this type of devoted skilled tradesmen to supplement the staff and implement the programs of the professional safety engineer. In solving concrete on-the-job safety problems, titles and academic degrees are too often not an adequate substitute for real on-the-job experience.

Organized labor would like to find that with every safety engineer there is a policy that guarantees this professionally trained individual complete independence of judgement and expert opinion, and along with such a policy we hope that the individual, so equipped, has the integrity and the guts to make his judgement stick in the face of adverse opinions to the contrary and pressures to have him change or modify his original position.

We, of the organized labor union movement, want to believe that today's professional safety engineer is no longer just looking for donkeys to pin the tail on. We hope that today's professional safety man is look-

ing way beyond the investigation of an accident that has happened and for a victim to be blamed. We hope that he will take into consideration and have professional assistance in all matters dealing with the problems of physiology and psychology. We feel that he should be looking for everything that is destructive to the human anatomy, and we feel strongly that the Safety Engineer should recognize the need for complete knowledge of the environmental effects of machines, metals, gases, noises, lighting, and processes that affect the worker mentally or physically.

The safety engineer today should no longer be content with pre-employment physical examinations; he should be an advocate of physical check-ups on a periodic basis for constructive repair and preventive action. But such a program must not be used as a device to invalidate the worker's contractual rights or protection. Constant checks on the workers' health, physical and mental, is called for in this day of exposures to such hazards as the x-ray, gamma ray, beta ray, beryllium, the exotics in rocketry fuels, thoriated nickel, high frequency noise levels, and a whole host of other working conditions which for the most part were unheard of as industrial hazards to the working force twenty or fifty years ago.

We of organized labor firmly believe that it is management's obligation to provide a safe and healthy place of work. We further believe that to effectively carry out any safety program, the union and the company should be jointly working together to bring about the desired results. Further, while we expect management to have and comply with good, effective safety standards and

part of our staffs principally because for all too long a time now we have been content with saying that management had the sole responsibility for workers' health and safety. While we still say that management has that responsibility we are adding full time specialists to our staffs, not so much as policemen but as individuals who will be constantly on the alert for changes in technology and changes in materials that will have an adverse effect on the workers' health and safety. These individuals will be striving to develop adequate protection and timely warnings against the constantly developing threats created by new developments in the use of the earth's supply of energy and materials.

The safety goals of labor and management are, in reality, identical; saving lives, avoiding crippling or maiming accidents, and reducing production costs. Good safety spells

economy—management making more profit per man hour can more easily share their gains with the worker. The worker, free from lost time in accidents, has the additional bonus of no loss of wages. Eliminating worker fatalities pretty well assures the educational needs of the workers' children—our next generation of workers.

The safety specialist, whether he is employed by a union or by management, must be dedicated and have stars in his vision, he truly has to be possessed of a driving dedication to people.

In conclusion, both labor and management should work together to develop the status of the professional safety engineer or specialist. By all means, let us upgrade the standards and eradicate the incompetents and, while we are doing this, let's provide the policy and the money to make such an ideology a reality in fact and deed.

MIDDLE MANAGEMENT

By HARVEY E. JONAS

Superintendent, International Harvester Co., Chicago, Ill.

I have always believed that the success or failure of a plant's safety program rests not only on the efforts of the specialist but, to a large degree, on the cooperation of the middle management group.

The specialist, therefore, must be sure that he knows what support this group expects from him. The importance of knowing this should be apparent to the specialist when he realizes that usually the remainder of the management group is under the immediate supervision and direction of the superintendent.

The more the specialist can do to assist the superintendent in organizing and administering his division's safety and good housekeeping program, the more importance he will attach to the program and the more effort he will apply to it.

The superintendent's cooperative attitude and the importance he attaches to the program is bound to reflect down to his subordinates and employees, setting the guidelines necessary for the success of any program.

I don't mean to imply that the specialist should treat the superintendent like a tin god, or do all the work for him; not at all. I am only pointing out that the specialist must have a good relationship with the middle management group, or he is missing a key link in the successful administration of his company's safety program.

To develop this relationship the specialist must understand that the superintendent is usually held responsible for large areas of a plant, and as such he is concerned with production schedules, costs, budgets, manpower, breakdowns, unions, etc., as well as safety.

The specialist must realize then that safety is an element in the superintendent's daily duties and must be scheduled in the same manner as are all the other duties he performs. Unless this can be done, safety can be, and possibly is, relegated to a secondary role.

Let's get down to specifics of what the safety specialist must be and do in order to develop a good working relationship with me.

The specialist must be a person with whom I can intelligently and rationally discuss the operating problems of my division, as related to the safety and good housekeeping program. By this, I mean the specialist must be familiar with the area under my supervision and especially knowledgeable as to the type of machines being used, material movement, work area, type of parts being manufactured, and the type of employees working in my division.

I expect the specialist to make periodic scheduled visits to the departments of my division with the express purpose of talking with the employees about safety and good housekeeping. Usually, the safety supervisor commands a lot of respect and the employees feel honored to be able to express their views on safety and good housekeeping to him. By being a good listener and commenting on their questions and recommendations truthfully and objectively, the value of the program and whether it is being applied properly and accepted can be quickly determined.

The specialist must be a person who not only brings my attention to a safety hazard or practice, but recommends the action needed to correct it and assists in seeing that it gets done.

His efforts to help me will soon result in a spirit of cooperation that will become as contagious as a case of measles, and result in new ideas and practices that may otherwise remain hidden until an accident happens.

I expect the specialist and his committee to have a dramatic, interesting, and rewarding safety and good housekeeping program.

Many of the techniques being used today have lost much of their effectiveness and must be updated. Signs posted around the plant spelling out Work Safely—Safety Pays—Are You Working Safely?—etc., have come to be expected by the employee. These signs do very little to remind me of the heavy responsibility I have to make my division a good, safe place to work.

More graphic examples of the injuries caused by carelessness or unsafe practices should be more widely exhibited. This can be done thru the use of pictures and mannequins which realistically depict accidents in their true, ugly form. I don't think I have ever seen a more sobering reaction to an unsafe practice than that of a picture of a finger torn off because a person was working

with a ring on his finger. In a matter of minutes after that picture was hung on the shop bulletin board employees were taking their rings off like they were going out of style.

The use of mannequins showing the area of the body on which an injury to an employee occurred and a sign telling why it occurred can be and is a sobering and lasting reminder to us all. I am not saying that all safety signs except the type I have outlined should be eliminated. I am simply recommending that the specialist make the safety displays in my division effective and controversial.

The safety and good housekeeping program must want to make the employees and management participate. This can be done by making the program competitive and rewarding. Most people enjoy competition when they are rewarded for their efforts and are envied by their fellow man.

The rewards for the winning group do not have to be expensive, but every one of the winning group must get a prize for their efforts, and their winning effort must be publicized. I have found that probably the best awards are something the employee's wife can use—a bread board, a cookie jar, a knife set, a flyswatter, or even a noodle strainer. Believe me, that employee's wife will remind him of safety, because she wants another prize. I would also like to see the names of the winners displayed on the bulletin boards. Not only does this make him feel proud of winning, but it also makes him feel he has a reputation to uphold.

The specialist who maintains the employee's interest in safety and good housekeeping is well on his way in getting my division's full cooperation and support.

I expect the specialist to designate a safety deputy in each of my departments. These deputies would assist my departmental supervision in administering the safety and good housekeeping program. The specialist, in periodic meetings with these deputies and departmental supervision, should discuss common problems and solutions. They should make every effort to standardize procedures in all of my departments. Too many times a good solution to a safety problem is not applied to other departments because of poor communications.

I would expect the specialist to have a strong orientation program for all new employees. These orientation sessions should

not only outline the safety and good housekeeping program, but also stress the penalties for indifference or nonconformance to the program. Too many times this is overlooked or not emphasized by the specialist. I would also expect the specialist to explain and emphasize the need and requirements for certain types of safety equipment such as safety shoes, glasses, gloves, aprons, etc.

The new employee should be made to understand that if he feels his job is being performed unsafely or that the equipment he has been issued seems unsafe, he should report it to his foreman or deputy immediately.

The importance of this initial safety contact cannot be overemphasized. The specialist must impress new employees with the value and seriousness the company places on the safety and good housekeeping program. The job the specialist does will either minimize or make more difficult the efforts shop supervision will need to keep these employees safety minded.

I would expect the specialist to schedule a monthly managerial meeting in which all supervision would be appraised as to the progress of the safety and good housekeeping program. At these meetings he should have the Works Manager express his support for the program and re-emphasize the importance he and the company places on safety and housekeeping. The specialist should pinpoint the types of injuries being incurred and how they happened. He should also outline the type of safety violations being noted throughout the plant and what corrective action should be taken to eliminate them. Winning departments of the safety program should be announced and the supervision of the winning departments introduced. The meeting should be informal and informative so that all supervision can go back to their departments knowing what they should be looking for and doing to improve their safety and good housekeeping position.

I would expect the specialist to be available when I need him. If he is unable to come at once, he should specify when he can. The specialist that must be called repeatedly can very easily lose the respect of the management group as well as destroy interest in the program.

The specialist should schedule a meeting

with me at least once a month. In these meetings, we would discuss the safety and housekeeping problems in my division and determine the corrective action required. Prior to the meeting I would expect the specialist to have provided me with reports of department inspections, as well as results of meetings with departmental deputies and supervision. The specialist should recommend that specific safety deputies or supervisors be invited to attend these meetings, especially when their help in determining what corrective action would be of value.

What are some of the things the specialist may require or do that I feel are not particularly useful or conducive to a good relationship?

Don't require my subordinates or myself to make reports or fill out forms that will not contribute much to the program. This is probably the fastest way to create a loss of interest and encourage indifference.

Don't try to embarrass the management group in front of top management or in front of employees during inspection tours or visits. The specialist who practices this approach not only loses the respect of the management group, but also causes the employees to lose respect for the program.

Don't make a mockery of safety by displaying symbols of good or bad practices that can be taken as a big joke or cause embarrassment. (I have seen some pretty bad examples of this. It accomplishes nothing but contempt for the specialist and indifference for the program.)

Unless it is an emergency, don't try to get the shop supervision to talk safety while they are performing other duties. Your efforts will be resented and more than likely will fall on deaf ears.

Above all don't ramrod your opinions or ideas down supervision's throat. The specialist who uses the power of his office or the threat of top management to force action will soon be identified as having a weak program or not being qualified for his position.

Safety and good housekeeping problems are similar in practically all companies and can be greatly minimized if the specialist establishes a sound, interesting program which enables him to develop a good working relationship with the middle management group and, of course, maintains it.

Off-The-Job Safety

Joint Session with Home Conference

Opening Remarks

By **ROBERT F. BEESON**
Personnel Representative,
Perfect Circle Div., Dana Corp., Hegerstown, Ind.

Our purpose is to try to give you some practical ideas and suggestions about how you can strengthen your Off-The-Job Safety Program, and some suggested programming methods and techniques.

We intend to accomplish this by allowing you to participate in the development of a simulated program with a hypothetical safety director. He will take you through the steps of collecting injury reports, determining employee activity interest, investigating

the help available in the community, and developing a program. During the course of this session, you will also be the employees of our non-existing company who will attend a safety meeting and observe a safety glass demonstration.

The second phase of our "Be In" will be presentations concerning three important phases of the overall Off-The-Job Safety Program.

DEVELOPING AN OFF-THE-JOB ACTIVITY

By **ROBERT B. REGAN**
Supvr., Safety & Plant Protection,
Celanese Chemical Co., Pampa, Texas

Our company's safety program is not much different from any other company. The plant manager has let it be known by word and deed that safety is the responsibility of every level of line management. We have a management safety committee with the plant manager as chairman. Each departmental supervisor holds monthly safety meetings with his employees and we have special campaigns and activities to keep the people interested.

While there are things that could be improved and we do continue to have injuries, our disability frequency rate is below the industry average and the program is under control.

A few weeks ago, one of our employees was injured in an automobile accident, and it occurred to me that several people had been injured in off-the-job accidents since the first of the year.

I checked the absentee records and the

claims for the non-industrial insurance program and was surprised to see just how many employees had been injured in accidents away from the job.

I noticed that there had been two disabling off-the-job injuries in one department. One case involved an employee walking through a plate glass patio door, resulting in five days lost time; the other was an automobile accident resulting in 16 days lost time. I checked with the departmental supervisor to see if he could remember if these two cases had affected the operation of his department. The first case involved a machine operator, and because there was not enough time to train a replacement the supervisor had to shift his operators around each day to work on the orders which had priority. Just two days after the operator came back, a material handler was injured in the second case. This time, the supervisor borrowed a general laborer from another department as a replace-

ment, but he had to spend time training the replacement. The replacement never did reach the expected efficiency before the regular employee returned.

When I talked about this problem of off-the-job injuries to the boss he agreed that we should look into it further, and we decided to keep records of our off-the-job injuries. I discovered that finding out about the off-the-job injuries was not as difficult as I had anticipated. It took a little more work, but actually most of the data was already available in our present records. The serious long-absence type of injury was picked up from the insurance claims. The short term cases, one to five days, were picked up from the attendance records and the return to work medical exams. It was just a case of setting up a procedure and making sure all the employees understood why we were trying to get this information.

Once I had become involved in keeping records of off-the-job injuries, I realized this would not mean anything unless I developed a program of activities to try to reduce them. I did not particularly want to wait the time required to build up a record from injury reports, and remembering seeing something about a "family safety" questionnaire in the off-the-job page of the *National Safety News*, I wrote for a sample copy. This seemed to be what I wanted; the questions covered the area of family interest.

During the next month, part of each departmental safety meeting was spent in filling out the questionnaire. I was really surprised to find out just how little the employees thought about safety in their out of plant activities. As an example, one-third of the employees said that they or members of their families were hunters, yet only a handful had taken a safe hunter course; a very large majority answered "no" to the question, "Have you disposed of all outdated prescription drugs in your home?"

The summary to the questionnaire gave me several leads as to areas I could give attention, but time was a factor and I would need help to develop a program.

The place to start is the National Safety Council Office and the local safety council. I did not realize the amount of material that is available. In addition to *Family Safety* magazine, there are employee booklets, fact sheets, slide series, and special kits for pro-

grams on subjects such as babysitter training and home fire safety, etc.

I discovered that many of the subjects and activities I had been using for the plant safety program could be applied to off-the-job safety. As an example, when we talk about lifting and material handling in the plant, we could include activities off-the-job. After all, you can get the same kind of back injury lifting a chair incorrectly at home as you can lifting a tote box or a piece of pipe incorrectly at work. Keeping the guards on home work shop tools is just as important as keeping guards on the machines at work.

As usually happens when you become aware of a fact, you then notice it everytime you turn around. Since one of the employees had been injured in a glass door accident, I discovered there were many such cases in the community. While they varied in degrees of seriousness, there was hardly a day when there was not a story in the newspaper about such a case. I began to hear about some cases involving members of employee's families and "close calls." Checking with the health department, I learned that they had participated in a study of such injuries and that the increased use of large pieces of glass in home and commercial buildings had resulted in a national problem.

Through the cooperation of architects, contractors, and legislation, the use of safety glass in public buildings is becoming general practice, but there is still a problem in private construction. The health department has a demonstration, available for showing to groups, which dramatically shows the value of safety glass. This sounded like it might be a program I could use.

I found there are presentations available in many communities on other subjects. As an example, a number of electric utility companies have electrical safety demonstrations as part of their public relations program; some local fire departments and fire chiefs of industrial plants have developed home fire safety demonstrations; and outlines for outdoor power equipment and home poisons presentations are available from the National Safety Council.

While I was aware that the National Rifle Association had instructors available on both hunter safety and home firearm safety, and the Coast Guard conducted water safety instruction, I did not realize that it was so easy to take advantage of their services. A

call to the National Rifle Association gave me the names of the instructors in my area, in a matter of minutes. Another call gave me the complete information on when, where, who, and how for safe boating classes. I also found there were many other organizations interested in safety, particularly in their fields, such as the skiing club, camping club, and medical association (for traffic), all of whom proved to be very helpful in developing ideas and activities.

I did not really expect to find a ready-made program that I could adopt, although I have to be honest and say that, like most safety men, I was kind of hoping that there might be one. With the material and help that was available, it was not difficult to block out an outline of a program that could be worked into the company's present safety program.

While the boss had indicated his support for extending our safety program to include the off-the-job aspect, I knew he would be asking about cost before long—not only the cost to the company due to off-the-job injuries, but the cost involved in extending the program.

The cost for the extra effort would not be too difficult to determine because it was easy to determine the price of booklets, film rental, and any other materials I might want. This could be set up as part of the budget the same as any other expense.

The cost to the company from off-the-job injuries would be more difficult. One of the items I got from the National Safety Council

was a form for a cost study of an individual injury. This would not show me the total cost for the company, but it would give cost information for representative off-the-job injuries and give us an idea of the total cost.

While a company is really only concerned with the safety of the employee, it is very difficult to separate him from his family. What happens to his family affects his ability to work, and the family members can be very helpful in getting the employee to be safe in his off-job activities.

I decided to see if the boss would buy the idea of a family safety night so we could explain to both the wives and the husbands why the company was concerned and what we wanted to do.

We would have a couple of homemade exhibits on such subjects as poisons in the home and winter driving hazards; some books, fact sheets, and other take home materials on tables. The plant manager and I could explain why the company is concerned about the safety of the employee when he is away from the job, and how we intended to include off-the-job activities in the company safety program. Then, instead of the usual film, the representative from the Public Health Service would present the safety glass demonstration. The whole thing would take about an hour, and wind up with coffee and cake. There could be one meeting for the entire plant, or a series of meetings covering several departments at a time.

We have a pretty smart boss. He bought the idea.

SAFETY GLASS DEMONSTRATION

By THOMAS C. KLAPPERICH

Regional Program Chief, Injury Control, Region V,
U.S. Public Health Service, Chicago, Ill.

Technological advances since World War II have made the potential applications of glass and glass products in modern society almost unlimited.

One of the results of this "glass revolution" has been a new trend toward what we might call "indoor-outdoor" living. By the extensive use of sliding glass doors, glass panels, patio doors, storm doors, etc., more

and more Americans are able to participate in a more "panoramic" way of life.

This new pattern of living has brought with it, however, a serious new injury problem.

The visual quality of glass today is so good that it is, for all practical purposes, invisible. Consequently, more and more people are walking, running, falling, or hurling

themselves through these large fixed glass panes. The result has been, as you might expect, an alarming increase in injuries, disfigurements, and deaths throughout the nation.

The injuries that occur are of the piercing-cutting variety—severe lacerations of the elbow, arm, wrist, and hand being most common. There are also many cases of disfiguring facial cuts. The fatal injuries which occur generally result from severed arteries and uncontrollable hemorrhaging.

The Division of Accident Prevention, U. S. Public Health Service, has several reports of such cases where death occurred in less than 22 minutes after the initial cut. One such case involved a 27 year old mother of two small children in Kentucky. She bled to death in 20 minutes after falling through a glass door at a restaurant.

An example of a non-fatal case involved the noted singer Kate Smith. During a visit to a private home, Miss Smith slipped in the bathroom and fell into the glass tub enclosure. She suffered severe lacerations which required over three hours of surgery to repair.

Because non-fatal accidents are not routinely reported to health departments, we do not know the full extent of the problem. In 1960, however, a west coast medical journal reported there were 40,000 insurance claims filed each year by glass door accident victims. Although this figure has not been substantiated, it has become apparent that the problem is a serious one, and of considerable magnitude.

A National Study Group on Glass Injury, composed of representatives from the Division of Accident Prevention of the U. S. Public Health Service, The National Safety Council, door manufacturers, and glass manufacturers, has attempted to define the problem and find a solution.

A pilot survey was conducted in 16 communities involving over 400 health department personnel. By means of a special questionnaire, the details surrounding 110 glass door injuries were recorded.

Here are some of the major findings:

1. Sixty-eight percent of the injuries occurred to males.

2. Thirty per cent of all the injuries studied, happened to persons between five and 44 years of age. One-third of all these accidents happened within the age group 5-14.

3. Hurrying was reported to be the prime factor more often than slipping, crowding, or "horse-play" combined. A typical case involved a mother running through a patio door to rescue her child from the swimming pool.

4. Reflection, glare, or "dazzle" did not appear to contribute to failures in seeing the glass.

5. Going from inside to outside a building accounted for over 74 per cent of the injuries. Persons simply thought the door was open and walked through.

6. One out of seven of the 110 injuries studied required hospitalization.

7. Seventy-four per cent of the accidents were reported as occurring at home.

8. Twenty-one of these 110 injuries occurred where there were designs or decals on the glass or where there were divisions or separation bars visible.

9. Physical condition prior to the accident did not appear in this study to be a contributing factor.

And the last extremely important finding:

10. Had safety glass been used, all of the 110 injuries could have been prevented or limited:

Safety glass is available and is actually being installed where new building codes require it; but we're still faced with the millions of homes, shops, and offices that are not so equipped. At the present time, we must assume that virtually all the large panes of glass now in our homes are of regular glass (annealed glass).

The ideal would be for all of us to replace the regular glass panels in our homes with safety glass. This, however, is not practical in every case, and we must resort to other precautionary steps.

We can make glass doors safer by decorating them with dividing bars, pressure tape, or decals. Remember that decals should be at two eye levels—one for adults and one for children.

Furniture or potted plants can be placed so as to direct traffic away from the glass. Door checks to keep storm doors from slamming are also good.

In the bathroom, devices such as hand-rails, rubber mats, and skid proof mats should be standard equipment. This is especially true where there are non-safety glass tub enclosures. One must remember, however, that these are merely expedients—ways

and means of lessening the risk, not eliminating it. There is no real substitute for safety glass itself.

(Displays a piece of 3/16 inch regular annealed glass.)

Non-safety glass, when it breaks, produces jagged edges—many cutting surfaces are exposed. The larger the piece of glass, the larger these potential daggers can be. There is also a possibility of the glass hanging in the frame for a split second, then falling like a guillotine onto the individual.

For something less depressing, let's look at the three types of safety glass!

(Displays 3/16 inch tempered glass.)

This is the kind of glass used in your automobile side and back windows. It's safer, not only for its thickness but, when it breaks, it crumbles into fine pieces resembling rock salt. This is fully tempered glass. It is not what we call "heat strength," which is stronger but can still break into jagged pieces. When tempered glass breaks, it breaks immediately into small cubes. These pieces have relatively dull edges, thus minimizing the danger of serious personal injury.

A second type of safety glass is referred to as *laminated glass*. It is merely a sandwich of two or more regular glass plates bonded together by a resilient plastic interlayer. When this type is broken the glass is held together by the plastic, preventing sharp pieces from dropping or separating when broken. Laminated glass is used in automobile windshields.

Finally, there is the type of safety glass known as *wired glass*. This is simply regular annealed glass that contains a wire screen incorporated within the body of the glass. The wire serves a similar retaining type of function as does the plastic interlayer in laminated glass, and is commonly seen in fire doors.

With this type, there is more actual breaking and more sharpened edges that can cut. But the wires usually retain the broken glass and offer some resistance to the penetration of the colliding body.

Of these three safety glasses, tempered glass has been found to exhibit the greatest resistance to impact. With the quality of tempered glass that is available today, both aesthetic and functional values of the glass can be retained at reasonable cost.

For example, average retail cost for a typical size sliding glass door with tempered

safety glass is \$124.50 compared to \$94.95 for the same door with ordinary glass.

The price difference between regular and safety glass varies greatly across the country. Generally, however tempered glass runs about 1.6 times as expensive as regular glass—laminated and wired glass somewhat more. Because tempered glass comes only in standard sizes and cannot be cut, custom sizes mean a 15 per cent addition to the regular price.

If you're planning on building a new home, be sure to specify safety glass for the appropriate "high risk" places—especially where there are six square feet of glass or more. A great many areas of the nation are still allowing new homes to be built without it.

There are, however, a number of forces at work to remedy this situation. The U. S. Public Health Service is working to this end, along with the National Safety Council and the Architectural Aluminum Manufacturers Association. The Glass Tempering Association and many glass manufacturers and processors are also involved in the total effort. Three large building code organizations and several thousand communities are drafting safety glass provisions. All F.H.A. insured homes now require large areas of glass to be of safety glass.

We're also happy to report that machinery is presently in motion for the establishment of an American Standard in the use and placement of safety glass.

The outbreak of glass injuries and deaths that have occurred across the nation can be compared to a disease epidemic. Prevention and control comes not in the form of a vaccine, however, but in the form of modifications in our home environment. Through the use of the proper glass we can still enjoy the beauties of indoor-outdoor living, but in full safety and security.

QUESTIONS

Question: Is the Glass Demonstration Kit available from all Public Health Service offices in the country?

Answer: There is at least one kit available in each Regional Office for free loan to any group or organization that may wish to borrow it. The only charge would be the return postage. The list of Regional Offices and addresses are available from both the Home

and Industrial Departments of the National Safety Council.

The kit is also available from our Central Office. Requests to this office should be directed to:

Richard E. Marland, Ph.D.
Chief, Injury Control Program
Public Health Service, DHEW
222 East Central Parkway, Room 507
Cincinnati, Ohio 45202

Question: Are blueprints available to build the shatter box, and where can you get the glass?

Answer: At present, blueprints are not available to build the shatter box, but could very easily be made for anyone who wished them. A person could also borrow a shatter box and make his own from his measurements of it.

Equipment that a person or group would need to purchase, beside the material necessary to build the shatter box, would be a pair of safety goggles, adequate gloves for handling broken glass, a rubber hammer, and a steel hammer and punch to break the tempered glass, or a glass cutter.

At present, we do not have a commitment from the Glass Door Safety Committee regarding the source of the necessary glass for the demonstration. I would suggest that any inquiries concerning the glass be made to:

Mr. William Mathews
Chairman, Glass Door Safety Committee
Architectural Aluminum Manufacturers Assn.

through
Mr. Frank Fitzgerald
Executive Director
Architectural Aluminum Manufacturers Assn.

35 East Wacker Drive
Chicago, Ill. 60601

The recently released film "Accidentally Yours" which gives a demonstration of the break patterns is available from all our Regional Offices, as well as our Central Office and the Public Health Service Audio-Visual Facility at Atlanta, Georgia.

The Architectural Aluminum Manufacturers Association also has a film strip with recorded narrative regarding the use of safety glass and large fixed panels and patio doors.

THE PSYCHOLOGICAL POINT OF VIEW

By HOWARD KLOPP
Consultant, Evanston, Ill.

In talking about the psychological aspects of industrial safety, it seems to me that the same problems exist in off-the-job safety as exist in on-the-job safety.

I was interested in the remarks made by Mr. Klapperich as he presented the safety glass demonstration. He used the term *should*—"people *should* install"—and this word implies at least the recognition by others that there is a necessary consent from people to do something about dangerous situations and, furthermore, that the response will be positive. I am afraid we have been using *should* without receiving the appropriate response to our safety efforts, particularly in the off-the-job aspect.

The first problem I see is taking knowledge of on-the-job safety and applying it to off-the-job safety. This problem is generated by the atmosphere of the individual com-

pany. Listening to Mr. Regan discuss his company's program, I would suggest he has a marvelous organization and a marvelous boss. I do not always get the same impression from the people I talk with, at Safety Council training programs, relative to the adaptability and willingness of top management to involve themselves in anything other than a routine in-plant program; sometimes even then only on a lukewarm basis.

It seems to me that what actually develops on too many occasions are negative, impersonal, reluctant attitudes on the part of all individuals, including the safety director. It also seems to me, from Mr. Regan's description, that he involves all the employees, which is one of the most important principles I can develop—namely, that of "participation." Mr. Regan suggested that he first developed a procedure and then explained,

to the individual employee, why he was engaged in gathering that kind of data. In other words, he developed a one-to-one relationship, as I see it, between off-the-job and on-the-job safety. With tactics like these, the atmosphere of the individual company will develop a positive relationship and a positive response on the part of the individual employee. Without this atmosphere, the employee carries away the idea, "Why are they interfering in my business away from the job?" Or, "It is bad enough I have to think about safety while I am here, because the company insists upon it, but I don't have to do this off the job!"

This, I think, is a problem of the atmosphere of the individual company and, in a large part, the climate created by the individual safety director. Participation, as a psychological motivating "force," is a powerful one because it "ego" involves the individual and secures the employee's acceptance of responsibility for effectiveness of the safety program. One of the problems in off-the-job safety is to develop this same kind of ego involvement and participation so that the employee develops a sense of responsibility away from the job for himself and others. This is an interesting problem and one that has to be resolved one way or the other.

Another facet of the problem is that the individual company management and the individual supervisors, the ones on the "firing line" who have to develop these kinds of programs, have to be people-oriented. It has been my experience, while working with companies in the Chicago area (and they are no different than companies in other parts of the country), that there is a rather marked unwillingness on the part of supervisors—who are part of management in the eyes of the employee—to become involved with and concerned about the individual worker on the job. If the atmosphere is one of lukewarm appreciation for these programs or direct hostility, then this atmosphere will carry over from the job safety program to the off-the-job activities of the employees. The degree to which the supervisor has negative feelings is directly related to the employee's negative response.

I am more interested in the safety director who uses motivation factors other than money. Money does not always satisfy our psychological needs. One major factor in our sense of security and self fulfillment is our

involvement in and the ability to give of ourselves above and beyond the x number of units per hour which determines our pay. We want to give of our creative thinking, and when we feel that we are a part of the organization because we have contributed our ideas, we will then be willing to carry forward the ideas of that organization. This is what Mr. Regan apparently has done. He has made the people feel they are an integral and important part of the organization.

Another major problem we face is finding the motivating forces to get people to practice, follow, and learn away from the job the safe procedures and attitudes which make them safe workers on the job. This is a matter of how much on-the-job training transfers to the off-the-job activities. I tend, perhaps, to overemphasize this factor of motivation, but how motivated is the individual to be concerned about the safety of himself and his family? How great is his concern to take ideas which he learned on the job and apply them to new situations? The degree to which he sees a similarity between, or the meaningfulness or applicability of, the principles and methods used for safety on the job to those of situations off the job will determine the degree to which he will utilize them.

If the machine tool operator engages in an activity off the job similar to his work (e.g., puttering around in his home work shop), then he will probably quickly and easily relate his safety training to the outside activity. However, suppose instead he is a boating and water skiing enthusiast. This relates not at all to his job activity, and if he does not perceive the applicability of the safety principles to his hobby, he may be very unsafe on the water. While he may vaguely realize he is not always following safe procedures or taking advantage of the safety training available to him he will, no doubt, find ready excuses. We all use the rationalization, "This can't happen to me," but it does happen to me, sometimes. Management people have to overcome these problems of meaningfulness and generalization in new situations if the employee is going to transfer his on-the-job training to his off-the-job activities.

Another question is, "How do the off-the-job activities meet the needs of the individual?" If companies are going to be concerned about off-the-job safety, they are

going to have to approach it from the same viewpoint as they do for safety in the plant. They are going to have to emphasize for the individual how being safe is to his advantage and how he will benefit.

Just as the everyday stress of living affects our susceptibility to accidents on the job, it also leaves us open to accidents in our off-the-job activities. A person has to be able to "ventilate" his feelings to relieve this pressure. It is possible to educate or train people to recognize this condition in themselves and to take corrective action. All people must find socially acceptable and safe ways to relieve the tensions and anxieties and hopefully this is part of each company's safety training.

If the foreman is going to have a safety-

mind work force, he has to be willing to take the time to fully participate in the program with the employee. The employee who in off-the-job safety not only preaches safety to his family, neighbors, and community but practices it himself, will see results in direct proportion to the motivation and behavior shown by the leader—himself.

I am more concerned about the psychological cost of accidents and injuries, because I believe many people are lulled into a false sense of security because of protective insurance. Perhaps we need to emphasize more the personality disruptions and changes, the interpersonal problems, the psychological alterations which can result from accidents, whether they happen on or off the job.

THE COMMUNITY VIEWPOINT

By JANICE R. WESTABY

Asst. Prof., School of Public Health, The University of North Carolina, Chapel Hill, N.C.

We're in a new ball game. The name's the same—OTJ—but with a new meaning, from On-The-Job to Off-The-Job. It's a game with additional players, in a new ball park. This is a safety program that's no longer confined to the industrial environment where we can exercise considerable control. Our ball park now is the community, where we're only part of the complex demands on people's time and attitudes. When a worker leaves his industrial environment, he enters a new environment of highway, home, and recreation, all with accident potential.

We now must compete for his attention, and we have to play with a new set of rules. We can, in essence, control his working environment and his behavior in it by a variety of means. But we can't follow him into his automobile, his home, and his boat and exercise the same control. We hope there'll be transition from work attitudes and behavior to off-the-job attitudes and behavior, but "t'ain't necessarily so." We're now competing for ways of reaching him and his family through community channels, not work channels.

We have two objectives in OTJ:

1. Find out what the major problems are in off-the-job accidents.

2. Combine community interests and resources into a concerted and effective effort to combat the problem or problems.

What can the community do to help us meet these objectives? In order to talk about the community's role, we first have to look at the community itself to see what it is. The community isn't just a conglomeration of dirt, noise, and flower gardens—that nebulous non-embraceable mass of buildings and streets. Most essentially, the community is warm, human, lovable people—individuals who are taxpayers, consumers, workers, neighbors, families. The community is fathers, mothers, children, individually and in groups. Some are interested in safety, some are not. Some have accidental injuries. Many do not. They all have beliefs, attitudes, habits which contribute to community action of any kind.

So how do we as safety educators mobilize the interests into meeting the objectives of an off-the-job safety program? Unless we mobilize we probably won't have a program,

or at least not a very effective one because, as I have said, this is a different ball game, played in a new ball park.

The worker has two basic loyalties, both of which influence how he behaves and what he believes. One of these is his work and the people and things that make up that environment; the other is his family. Surrounding his family are many other individuals and groups which influence the development and strength of his attitudes toward health and safety. Influences from his work must be compatible with influences from his community. Since we represent his work contact, we should seek compatibility with family and, more broadly, community influences. Since we can't discuss both family and community resources here, I'll discuss only briefly the broad community viewpoint—the organized community.

We're all very much aware of the part that organizations play in our lives. We're also aware of the great variety of organizations, clubs, and groups that exist in our communities. I wonder, though, just as you must have wondered, if we're utilizing this tremendous resource in our safety efforts as much as we should or could be doing. Sure, we know that our community is full of clubs of various sorts, but have we ever stopped to think that these clubs aren't just taking up time and space; that they are made up of people, and many of these people are the ones with whom we work every day? Seeking their help could be another way we could strengthen and re-emphasize our safety message. Are we really making the effort to do so?

This country is the most organized country in the world. Very few people don't have any contact with organized society. Every community has a common variety of resources, and some have additional ones of an ethnic, religious, or educational nature, depending upon the community. Every organization has specific goals it wishes to achieve. Many even have safety committees with active chairmen looking for programs.

All of these organizations lead to the family, which really is our target group in OTJ. Safety begins at home, is strengthened at home, is implemented at home. The organized community reaches into the home. Our job is to recognize community resources, to understand their goals, and determine how

we can persuade them to help us achieve our goals.

As I have stated, perhaps our first objective is to define our problem. How can the organized community help us with this? Aside from our own absentee and medical records, we also have groups which can give us insight into the injury problem—physicians, dentists, hospitals, police, firemen, insurance companies, health department. By combining your data with theirs you may be surprised at what turns up as your major problem.

In off-the-job programs, we're adding the family to our safety program. We can't add it unless we know its injury problems. Then we can move toward our second objective with more confidence, because we know what our problem is and planning is not being done on an assumption. None of us can afford to waste effort in planning for safety; we don't have either the time or manpower to waste.

Once we know our problem, we can decide who our target groups are, how we can reach them, and what we want to tell them. Involvement of community groups in both planning and implementing our off-the-job safety program will give us ideas and program strength, and help us avoid duplication and utilize programs already in action. Many groups already are active in safety, and we could encourage our employees to be active in these programs, such as first aid classes, defensive driving courses, swimming and boating instruction, gun safety, and arts and crafts, etc.

We can't do the job alone anymore, nor should we have to, with the resources available in all of our communities; organizations which, if they put their membership into the fight against accidents, would make a very impressive group to work with us.

In summary, then, here are some of the resources. Planning groups can help and advise us as we're developing our OTJ program, both in defining the problems and determining implementation: medical society, health department, hospitals, city government, insurance companies, safety council. There are groups with technical and authoritative information, such as insurance companies, electrical contractors, gas and electric companies, highway and roads department, police and traffic control, fire department, building department, architects, medical so-

ciety, health department, visiting nurse association, social agencies, extension service, and many others. These too, can give us many suggestions for programs. We have resource groups for educational materials, such as the public library, Red Cross chapter, colleges and universities, safety council, and various utilities. Then we have audience groups as varied and as extensive as we wish to make the list, such as labor unions, churches, youth groups, parent-teacher associations, civic groups, clubs for the elderly, business organizations, fraternal organizations, recreational groups, and so forth. And we mustn't forget our communication channels for supplementing and emphasizing our safety message such as radio, TV, newspapers, theaters, clinics, and schools. Most importantly, we need to gear our program to the groups with the greatest stake in the problem.

As you can see, our biggest job is to realize that we can't combat accidents alone, that our workers are members of the community, that our workers have families, and that all of them belong to community groups. By combining forces and resources, we can strengthen the total effort in our off-the-job safety program.

Question: All the publicity for non-work injuries is given to traffic safety, which is understandable, yet there are far more injuries in the home. In view of this, how can we get the public to give more attention to home safety?

Answer: Most of the organized community action and attention is directed toward traffic for two obvious reasons, I think. First, there are full-time people working in the traffic field—police, highway patrol, sheriffs, etc. They are uniformed and obvious to everyone. Second, traffic accidents occur in obvious places where everyone can see them and their results. Home accidents, on the other hand, are private events and, except for fires, occur out of sight of the general public. We just don't see the falls, burns, poisonings, lacerations that occur at home. And we have no full-timed uniformed personnel (except for firemen) to call attention to the tragedy. Many groups are interested in home injuries and are conducting programs in this area, but there is no one group or individual responsible for bringing attention to this problem and coordinating efforts. Perhaps we need to seek ways of bringing more public attention to the private event of home accidents.

Question: Do you feel it is easier to promote an OTJ program in a large company or a small company?

Answer: I feel that the smaller the company, the easier the program ought to be. There are fewer workers and fewer channels of communication needed. The problems of the workers are easier to determine, and with smaller groups educational programs are easier to arrange and carry out.

INDUSTRY RESPONSE

By WILLIAM J. KERNS

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Back in 1956, when we were having reasonable success in our industrial safety program, we made a study of our off the job disabling injuries. Then, as now, our employees continue to receive full pay when they are disabled while away from work, be it sickness or accident. This benefit continues without any waiting period for a period up to six months, and then even longer at half pay.

The study revealed that for that full year

employees were hurting themselves 20 times more often away from work than when at Bayway. Together, they lost nearly 3,400 work days at a direct cost of well over \$100,000.

Just as important was the implication that our industrial safety program could be strengthened by attacking the off the job problem area. Employees do not suddenly become conscious of safety when they put on their safety hats and go to work—any

more than they become reckless violators of good safety practices at the end of the work day.

We embarked on a Safety Around the Clock program, and a giant sign painted on one of our storage tanks was one of our first efforts emphasizing our concern.

To get our program under way, our refinery manager sent a letter home to all employees, outlining his concern for their welfare and our off the job problem, and inviting them to attend our first Home Safety Carnival. This technique of involving the family has been continued through the years, with appropriate safety pamphlets and other educational material included at intervals, as well as safety awards earned by the employee.

Since 1961, we have offered all employees free subscriptions to *Family Safety* magazine, published by the National Safety Council. Each year we send one issue to all employees and ask them whether they wish to continue receiving it for the year. Interest in the magazine has held up well through the years and the comments received each year, as well as the high percentage of subscribers, justify to management the magazine's continued use for those asking for it.

We have found letters from management and educational material, sent to employees in their home, to be an essential and effective tool in reducing off the job accidents.

Another effective tool is to treat employees as individuals, recognizing their individual safety accomplishments on and off the job and counseling those employees having excessive accidents.

A historical study made in 1957 revealed that a very substantial majority of our employees were working year after year with no injuries at all, not even first aid cases, and no off the job disabling injuries. At the same time, a small group of employees, year after year, were having problems. An arrow sign was pasted on all mirrors so the employee saw himself above it; it also was sent to all employees.

Our employees like to wear decals on their safety hats. We adopted a program of individual recognition for 5, 10, 15 and 20 years without any injury on or off the job. When an employee reaches 20 years without an accidental injury on the job or an off the job disabling injury he is given special recognition and presented with a gold tie pin in recognition of his achievement (with suitable ceremony). His family is invited to attend whenever possible.

Periodically, these outstanding employees are honored, along with their wives, at a safety dinner. They receive their invitation through a personal letter from the manager. Naturally, every effort is made to publicize their achievement of no on or off the job injuries through our daily bulletin, our company newspaper, and the local press.

Since the middle of 1957 we have had, with variations, an individual employee safety award plan. To qualify, an employee must have no industrial injury, including first aid cases, and no off the job disabling injury during the contest period. He receives at home a congratulatory letter from the refinery manager, along with his award.

We believe individual responsibility for and individual recognition of safety performance on and off the job is important. People want to be recognized as individuals. In today's structure of unions, seniority, and rate of pay for the job, and the insecurity developing from new methods and automation, this is one way excellent performance can be recognized. The employee, who at work is only a member of a craft, a department, a section, is something else when he walks in his front door. He is the husband and our dad and he yearns for individual recognition.

We, as a company, gain in many ways when we involve the employee and his family as individuals. We reduce accidents and we improve employee relations and our company's image in our community.

There are many other ways to involve the family, to offer them safety education and demonstrate your company's concern for their off the job safety.

For example, for years we have had safety demonstrations at our company outings. These outings can be a good time to put line management and employees to work organizing committees for each show.

In addition to our own resources there is much outside expert help available. Reach out for help to the Power Squadron, the Bureau of Navigation, the Red Cross. We have found local safety councils, other companies, and sportsman clubs cooperative. They will be glad to help. So will the local fire and police departments. Publicize the activities to come and you gain added mileage for your

program by stories and pictures in your company publications or the local press.

Another way to involve the family is through safety contests. As part of our safety carnivals, we have held home safety essay and home safety poster contests for employee children, by grade level, enlisting a staff of grade teachers to act as judges. Winners received cash prizes.

We gained added benefit from the contest by making an annual calendar from the winning posters. Again, a letter from the manager accompanied the calendar, which was sent to all employees.

We also held a home safety contest for our employees' wives. Approximately 45 per cent entered, describing how they keep their families safe. Some 60 employees, guided by staff of the New Jersey State Safety Council, acted as judges. We made calendar pads with each day of the month giving a safety thought from a wife. These were mailed monthly to all employees.

Finally, we have held a safety contest for the whole family, with some 600 families entering. I believe this to be most effective. This contest was in two parts; first, the families finding the most unsafe situations in a cartoon received prizes; second, each family described the steps they were taking to keep their family safe. All members of the family signed their list. Where the child was too young, the employee signed for the child, also. Again there were grand prize winners.

What results can we expect from such activities? We made our biggest improvement in home injury frequency in 1957 and 1958, the period we introduced individual recognition. Our best year of 1962 followed the family safety contest of September, 1961, but we again plateaued in the following years. The severity of home accidents measured in days lost/million man-hours declined with the reduction of home injuries in these same years. An outbreak in severity in 1964 and 1965 was due to several very serious home injuries.

The upswing so far this year in home injury frequency is causing us concern, even though the severity of these injuries is down. We have reached the conclusion in retrospect that safety contests such as I have described are very valuable in sustaining an off the job safety program but do not necessarily result in long term improvement for the total employee group. We are now making a

long-term study of the effect of participation in these contests, comparing the nonparticipant's change in off the job accidents with the participant. This study is similar to one I would now like to describe:

In 1960, we held a successful off hours defensive driving program for our employees, their wives, and teen-age children. The justification for this program was based on an analysis of direct traffic accident costs off the job in 1959. We could have made the estimate even larger if needed for management justification by including overtime, extra board, production delays, etc., resulting from the employee's disability. The program we developed involved an in-depth exposure to attitudes and their modification and defensive driving techniques. More important for this discussion—what kind of long term results have been achieved?

First and most important, we recovered the investment for the program through reduced traffic accident costs in 1960. We have analyzed our employees' performance over the past twelve years, comparing the 1960 defensive driver participants with the wage employees not participating, which we call our control group.

There was comparability of educational level attained, with the majority of employees achieving high school. Years of company service also matched with identical exposure to our safety philosophy and practices. The percent married in each group matched. A distribution of the distances employees live from work shows 85 per cent living within 10 miles. It is interesting to note that of 86 disabling traffic accidents since 1957, only 13 could be identified as commuting accidents, with nine of these heading home.

We were able to obtain from company credit card purchases the gasoline consumption for the defensive driver and the control group. Again there was comparability. We even checked on the number of credit cards per family, but there was no significant difference. So we felt in the areas explored we had two matching groups. What happened to each of these employee groups before and following our defensive driving program?

In the five year period preceding the program, the group who later was to take the course had averaged a somewhat lower traffic accident frequency than did the control group. In the seven years following the pro-

gram, the control group achieved a 31 per cent reduction in their traffic accident frequency. Why did the control group improve? Rub-off from the defensive driver? Exposure to other Esso programs? Exposure to mass media? More mature? Frankly, we don't know. However, the defensive driving group of employees reduced their traffic accident frequency from 1.8 to 0.6 or 67 per cent—a significant long range improvement.

The defensive driver participant not only markedly reduced the frequency of his traffic accidents but quite dramatically reduced the severity of them when measured by days lost per accident. Even if the average severity of their accidents had been the same as the control group prior to the course, they would have achieved over twice the reduction that the control group did. Does this mean defensive driving training reduces the severity of an accident if it cannot be avoided? We believe so.

When we examine the effects of the defensive driving program on other types of off the job injuries we found little result. The employee taking the defensive driver course already had a lower frequency for home and public accidents than the control, and both groups showed about the same improvement immediately prior to the program. We have concluded that a program such as this can impart lasting skills leading to a reduction in traffic accidents and their severity but will not necessarily affect basic safety attitudes; it will, however, result in over-all reduction in off the job accidents.

We have been working hard at Safety Around the Clock for a number of years. We have had some success, but also disappointments, as we have felt our way. Problem areas received special emphasis programs. Much of our extra efforts have sustained a relatively low off the job accident frequency through the years after our initial breakthrough, but we have not yet found the formula for a further major reduction. We do know, from analysis, that participation in safety contests and our defensive driving program has helped employees with high accident rates on and off the job to achieve a marked reduction. This is particularly significant when we compare their performance to the nonparticipant high accident rate employee. However, with voluntary employee participation generally attracting the employee with a demonstrated lower off the job

accident frequency, we are planning more in-plant programs to better reach all of our employees.

Let me close by offering some suggestions based on our 12 years of experience in combating off the job accidents. First, make use of statistics and costs to secure your management's support. Remind management also that there are tangible employee benefits to be secured through off the job safety activities as well as the image your company displays to your community.

Second, most of us feel under staffed with the complexities of the present day safety job; so get real help by putting line management actually to work on the problem. Form committees to develop particular ideas. They will have the added benefit of this exposure.

Third, we are not expert, so reach out for help. We have always found that this expert help is waiting and ready.

Establish communication channels into the employee's home and let him and his family know of management's concern for their safety. Provide them with educational material. Recognize often the individual employee's accomplishment for his safety and involve his family.

Last, but also tying in with enlisting management support, continue to hit your worst problems, whether they are associated with the home, traffic, or public, and keep hitting them.

Question: Do you think your employees resent the company effort in the off the job safety field?

Answer: The question of possible employee resentment has never seemed to us to be a problem. When we send educational material to the employee's home, he and his family can treat it as junk mail or respond to it. I have already mentioned the excellent response to *Family Safety* magazine. Through the years, approximately 40 per cent of the subscribers have taken the time to write enthusiastic and constructive comments about this magazine to us.

When we have safety demonstrations at our outings, the employee and his family can walk over and watch, participate or not. Entry into contests and programs is on a voluntary basis; when we have discussions on work time, or the employees are watching a safety film, they are being paid just the same as if they were performing a rigging job.

As for reporting of off the job injuries to

management, our employees are required to account for absences; we get a very good story when the employee, his wife, or child calls our medical department to report that dad broke his leg falling down the steps. Our medical department usually asks a few questions to better clarify the incident. When the employee returns, the supervisor discusses the accident with the employee and usually the story is a confirmation of what was originally told the medical.

No employee has ever been penalized for having an off the job accident regardless of its cause; although in reviewing an employee's over-all performance with him, his off the job accidents would be discussed along with other performance. We have always made a point of not using costs of off the job accidents as a point to our employees.

No, I do not believe our employees resent the company effort in the off the job safety field.

Question: How do you overcome management's feeling that they should not be con-

cerned about the employee's safety off the job, especially in the area of home safety?

Answer: We surround them with statistics and cost studies. An alert management will also recognize the employee relations benefit and public relations value of such interest.

Also, managements are interested in a stable, efficient, productive work force. Absenteeism means added costs through direct and indirect payroll costs, extra people, overtime, production delays, and so forth. These result from off the job accidents.

Home accidents usually predominate in a work force—certainly ours and also for national statistics. Home safety to us is the most logical area to attack because it is usually the area of highest cost. It is also the area where you can discuss wife safety, children safety, family safety, product and equipment safety, as well as employee safety most comfortably. This is more difficult to accomplish when discussing employee driving habits or his recreation.

Research Session

HAZARDS OF USING URETHANE FOAM IN ENCLOSED SPACES

By EDWIN M. MURPHY, Technical Research Engineer;
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The Bureau of Mines investigated the hazards during use of rigid urethane foam in confined spaces. Many of the tests simulated conditions in an operating mine. Numerous urethane foam formulations were sprayed in the laboratory, in the Bureau's experimental coal mine, and in several operating coal, copper, potash, and uranium mines. As a direct result of the research, procedures were developed for the application of urethane foam in mines. Many of the findings apply also to surface applications in confined spaces.

Rigid urethane foam is a solid cellular plastic made by mixing liquid diisocyanate and polyol resin. The mixture, when sprayed, foams and expands up to 30 times in volume, solidifies within seconds, and adheres to most clean surfaces. The solid foam has a low thermal conductivity and is highly resistant to air and water vapor transmission. It is a very stable product. Its protective properties are unaffected by contact with common chemicals, weathering, or vermin.

Rigid urethane foam has almost unlimited potential use in industry because of its high insulating properties, adequate soundproofing, and sufficient compressive strength to form nonload-bearing walls. Also because of its expansion qualities, rigid urethane foam is an excellent filler and sealant. The liquid chemicals contain volatile irritants, however, and the cured foam may present a fire hazard.

Most of the Bureau's studies were made with proprietary formulations using diphenyl diisocyanate (MDI). Initial studies showed that tolylene diisocyanate (TDI), *n*-butyl isocyanate (BI), and phenyl and chlorophenyl isocyanates (CPI) were unsuitable for mine use because they are more toxic than MDI or polymethylene polyphenol isocyanate (PI).

Physiological Hazards

Liquid chemicals—Research and industrial experience indicates that the raw liquid chemicals are moderately irritating to the skin and prolonged or repeated skin contact should be avoided. The chemicals are moderately irritating to the eyes, but if the eyes are flushed immediately with copious quantities of water, permanent injury will not result. However, repeated inclusions of the chemicals may cause eye damage.

The polyol resin is water soluble and can be washed from the eyes, skin, and clothing. The isocyanate is insoluble and reacts with water or even moisture in the skin. When it contacts the skin, black, unsightly stains form. These cannot be washed off but wear off within a week; the time can be shortened by scrubbing with a scouring powder. Acetone and similar solvents should never be used because they cause the isocyanate to enter the blood stream through the skin.

At the experimental coal mine, more than 10,000 pounds of urethane chemicals were handled without gloves, protective creams, or immediate removal of materials splashed onto the face, hands, or arms. None of the men experienced primary irritation of the skin.

Vapor and mist—The resin vapors when inhaled are neither irritating nor cause organic disorders of the body. The isocyanate vapor irritates the respiratory system, but does not cause organic disorders of the body. The vapor causes temporary dehydration in the respiratory tract and produces coughing that may last for two or three days.

The isocyanate hazard comes mostly from the mist liberated during spray applications. The mist concentration depends on type of equipment and application techniques. Increasing the airflow through the spray head to increase rate of application or distance of spray projection raises the mist concentra-

tion. Aerosol photometer and cascade impactor samples indicated that mist contains unreacted isocyanate droplets approximately four microns in diameter. The concentration was highest within 25 feet of the spray and decreased rapidly with distance.

Isocyanate also vaporizes from open containers, spillages, contaminated clothing and rags. Storage and locker areas should be well ventilated. The isocyanate concentration is dependent on temperature and ventilation. Data from laboratory tests in an unventilated chamber show that above 95° F the vapor from low volatile isocyanates such as MDI and PI exceeds 0.01 parts per million (ppm). These data indicate also that high volatile isocyanates such as TDI have vapor concentrations 10 to 20 times higher.

Solid foam—Excessive concentrations of isocyanate vapor are evolved from cured foam subjected to temperatures above 210° F. Data was gathered for a foam heated in a closed chamber. Similar concentrations could develop where foam is exposed to heated air downwind of a fire.

Industrial experience indicates that exposure to isocyanate vapor concentrations of 0.02 ppm during an 8-hour shift does not result in respiratory irritation or induce sensitization. However, because of confinement in underground mines, dependence on forced ventilation, and the possibility of higher concentrations in local areas, the Bureau recommends that the maximum allowable vapor concentration in areas without respiratory protection be considered as 0.01 ppm.

Fire Hazard

Urethane foam will burn if subjected to a sufficiently strong igniting source. Burning foam produces a black, acrid smoke. The foam presents a fire hazard if flame propagates beyond the ignition source or if the fire burns through the foam. Some foams exhibit intumescence when exposed to flame; this insulates the underneath portion from further degradation. Some foam burns through rapidly or flame spreads rapidly along the exposed surface.

Evaluation of these properties of the foam were made in the experimental coal mine, a 150-foot-long steel gallery, and in the laboratory. The mine passageway is 10 feet wide by 7 feet high; the gallery is 10 feet wide and 5 feet high. Foam was applied onto coal, gunite, concrete, and corrugated steel surfaces

for wall and roof tests and on cardboard, brattice cloth, metal lath, and cinder block for barrier tests. Air velocities through the test zone ranged from less than 100 to 1,300 feet per minute (fpm); most tests were conducted at velocities of 200 to 300 fpm.

Ignition sources—The ignition sources used in the research had relatively high rates of heat liberation. Initial trials indicated that the rate of heat liberation had a more marked effect on ignition of foam than the total heat developed. Nine fires, which liberated 9,000 to 640,000 British thermal units (Btu) per minute and burned 2 to 25 minutes, were started against the foam.

By comparison, a furnace in a six-room house gives off about 1,500 Btu per minute, and a mining-machine fire involving hydraulic oil, coal dust, and rubber tires gives off approximately 50,000 Btu per minute.

Fire endurance tests—The ability of foam to resist flame penetration was studied. Four foam types were evaluated. Foam A was satisfactory for mine use when applied to barriers and on either the walls or the roof. Foam B was unsatisfactory for mine use because it failed to prevent flame and heat from penetrating to the substrate. Foams C and D were inadequate for any application.

Barrier tests—The barriers covered with foam A resisted penetration of flame, heat, and smoke in 38 of 38 tests. Other tests with a foam similar to foam A, on brattice cloth, metal lath, and fiberboard-backed barriers gave the same results. Barriers covered with other materials failed. For example a plaster coating on concrete block barrier prevented penetration of flame, but not smoke and contaminated air. Brattice cloth disintegrated, nylon melted, and the reinforced plastic-coated fiberglass burst into flame within seconds.

Wall and roof tests—The flames did not penetrate foam A or char the substrate. With foam B, the flames charred only the substrate in the ignition zone. Foams C and D were entirely consumed and the substrate set afire.

Flame propagation—Some foams burned along their surface at rates ranging from 20 to 100 fpm, depending on the speed of the ventilating current. This flame-spread hazard was evaluated with foam applied to walls, roofs, and in combination of walls and roof.

Wall tests—Flame did not propagate beyond the ignition zone in the 73 tests in

which either foam A or foam B was on the walls and on 6 or 12 inches of adjoining roof. With foam A on the walls in the metal gallery, heat and flame from fire source nine caused 60 feet of the uncoated steel roof to glow and deform. The walls coated with foam were not damaged, presumably because the foam resisted flame penetration and insulated the steel from the intense heat. Flame propagated along foams C and D.

Roof tests—Flame did not propagate in tests with foams A or B applied to 200 feet of roof, overlapping 6 inches of the adjoining walls. Flame propagated along foam D.

Wall and roof tests—Flame propagated along all foams covering the walls and across the roof. With a continuous application of foam A on the walls and alternating 40-foot sections of foam-covered and bare roof, flame propagation stopped after reaching the bare roof.

Spontaneous ignition—Three instances of spontaneous ignition of foam barriers in operating mines were reported. Laboratory investigations showed that spontaneous ignition can only develop in a thick mass of urethane foam made from inadequately mixed chemicals. Foams less than six inches thick or those made with adequately mixed chemicals have not ignited spontaneously in industrial use or in the research.

Spontaneous ignition can be demonstrated by spraying foam into a container 1 foot by 1 foot by 2 feet. While spraying the chemical, hoses are alternately partially closed for short periods. After spraying, a 1-inch breather hole is put through the foam mass and container. Smoking and flame usually occurs within two to three hours.

Comparison Of Mine And Laboratory Tests

Large-scale investigations in the mine provide a direct measure of the potential fire hazard of urethane foam. However, the time and expense involved limit the use of this research tool. To determine if laboratory studies could evaluate the fire hazard, foams A, B, C, and D were subjected to ASTM tests E 84, E 162, and D 1692, the Forest Products Laboratory (FPL) 8-foot tunnel test, and the "Fire Endurance" test.

Comparison of data indicates that the combined results of the Bureau of Mines fire-endurance test and either the ASTM E 84 or E 162 tests can be used to predict foam flammability. Foams with a rating of

more than seven minutes in the laboratory test have consistently provided adequate protection against flame penetration in full-scale tests. Foams having ratings of less than three minutes in the laboratory test have consistently failed to protect the substrate in the large-scale tests.

ASTM tests E 84 and E 162 measure the rate of flame spread across a foam specimen. The acceptable value of less than 75 for ASTM E 84 is that specified in most building codes for "Class B" construction. The acceptable value of less than 140 for ASTM E 162 is based on research previously reported.

ASTM D 1692 and FPL tunnel tests were inadequate for evaluating foam flammability. The D 1692 ratings of "nonburning" and "self-extinguishing" can be confusing; the data obtained from it and the FPL test were inconsistent with those from the mine tests.

Conclusions And Recommendations

The hazards of applying urethane foam can be minimized by using low-volatile isocyanate chemicals, keeping the equipment in factory-recommended condition, and protecting the operator against inhalation of the mist and vapors.

The Bureau recommends use of air-line respirators supplied with adequate respirable air. Where this is not feasible, the operator and others in the vicinity should wear combination organic-vapor and dust and mist respirators. These are described as Type BE devices in the Bureau's list of approved respirators.

As a result of the Bureau's research, foam criteria and application techniques for mines were published. That mine operators have recognized the benefits of foam is shown by their successful use of more than 500 tons per year. Surface application of foams similar to those developed for mines is about 50,000 tons per year.

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HAZARDS AND CONTROLS IN THE INDUSTRIAL USE OF LASERS

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Laser, an acronym for "Light Amplification by Stimulated Emission of Radiation," has become a household word not because many people know what a laser actually is nor for direct benefits the laser has made possible but probably because of the many predicted uses of the laser. In 1958 Dicke¹, Schawlow and Townes² and others proposed ways in which optical masers (lasers) might be constructed. In 1960 Maiman³ was successful in constructing and operating a laser. Since the operation of the laser by Maiman, the predicted uses and possibilities of lasers have been numerous, with these possibilities varying from the use of a laser for special illumination to its use as a military weapon. Probably this latter use, or predicted use, is one of the big factors in the public's awareness of lasers. Lasers which are available today would not be called weapons; however, the high voltages and other factors associated with some lasers can cause them to be hazardous if not properly designed and used.

While the laser which Maiman was successful in operating was what is commonly called a pulsed ruby laser, lasers available today are quite varied. All lasers consist of three basic sections: the pump (energy) sources, lasing medium, and the Fabry-Perot cavity or resonator. The pump or energy source may be a high intensity arc lamp, an arc discharge within the lasing medium, a glow discharge, a chemical decomposition, or any of several other energy sources. Laser mediums available today may be gases, liq-

uids, glasses, single crystals, or semi-conductors. The third major portion of the laser, the Fabry-Perot cavity, normally consists of two mirrors parallel to each other and perpendicular to the axis of the lasing material, with one mirror at each end of the lasing material.

In the operation of a laser the pump source supplies energy to the lasing medium and raises atoms or other particles in the medium to energy levels above the ground or normal energy state. These atoms then lose energy by thermal effects until a metastable energy level is reached (atoms in the metastable energy states tend to remain in this state for long time periods). If a photon (light wave) of the proper wavelength passes the excited atom, the atom will give up its excess energy in the form of a photon having the same wavelength, phase, and direction as the stimulating photon. As the initial photon and any stimulated photons pass out of the cavity, they would be lost from the system if it were not for the mirrors of the Fabry-Perot cavity, and the output would be a result of random generation of photons in the lasing material (plus what little light might be stimulated in a single pass). This output would be what is normally called fluorescence of the material. With the Fabry-Perot cavity present, photons leaving the lasing material are reflected and pass back through the lasing material, thus stimulating more photons. Very quickly the photon wavefront reaches an amplitude where it is stimulating atoms to radiate their

energy at a rate at least equal to the rate at which the pump source is raising atoms from the ground state to the lasing level. With this situation the laser is said to be lasing. In order to use the laser, some of its energy must be removed from the system. This is accomplished by using one mirror in the Fabry-Perot cavity which is not 100 per cent reflecting, but will instead allow part of the energy from the cavity to escape.

Since the stimulated photons in the laser have both the same wavelength and the same phase as the stimulating photons, the output from the laser has two characteristics which make it unique. First, the output is essentially monochromatic, that is, all of the energy is at essentially one wavelength. Secondly, the light energy from the laser is coherent, that is, each photon has a direct phase relationship to each other photon.

Because of the characteristics of coherence and monochromaticity, lasers look promising as tools, and these characteristics are also the reason that lasers can present some unusual hazards. Those familiar with optics are aware that to focus light energy to the minimum spot size (and consequently to the maximum power density) the light should be completely coherent. Since the laser output can approach this condition, it is possible to focus the laser's energy to a spot size near the theoretical minimum (approximately one wavelength of the light)⁴, thus making it possible to obtain very high power densities over small areas. For instance, as an example, assume that the radiation from a small helium-neon laser, approximately 3 milliwatts, is focused to a spot size equal to approximately twice the diffraction limited case. Under these conditions the power density in the focused spot will be approximately 300,000 watts per square centimeter. Granted this power is obtained only over a very small area, but this area may be sufficiently large to produce noticeable damage.

The electrical, chemical, and similar hazards which may be present with a laser are much more likely to cause injuries than the coherent laser radiation. For instance, most lasers used in the industrial environment have power supplies capable of delivering fatal shocks. If these power supplies are not properly shielded and interlocked, they may become the most dangerous part of the laser. Also, there are lasers presently being used in laboratories which use toxic chemicals as the

lasing medium. With these lasers it is necessary that the personnel associated with them use the proper chemical handling techniques. While these electrical and chemical hazards, etc., are usually the most dangerous hazards in lasers, they are similar to those present in other industrial equipment and can be handled in the same manner.

Hazards resulting from the coherent output of the laser, while usually much less dangerous than the other hazards, are relatively new to most safety people and thus need further explanation. Injuries which result from the coherent radiation may usually be divided into two categories; thermal damage resulting from the heat rise caused by absorption of radiation, and photodynamic effects such as damage occurring as a result of shock waves generated when very large energies are absorbed over short time periods.

While it is expected that exposure to laser radiation will normally result only in burns, if anything, the possibilities of photodynamic effects must be considered, for photodynamic effects may produce fatal injuries. McCartney⁵ and others have observed that it is possible to fatally injure mice with 20-40 joules of focused energy or 100-200 joules of unfocused energy from a pulsed ruby laser. These fatal injuries manifested themselves as hemorrhages within the brain and may have resulted from mechanical shock waves generated when the laser energy was absorbed. It is known that under the proper conditions extremely high powered laser pulses can generate mechanical shock waves⁶. While the mice used in the experiments are apparently much more sensitive than man would be expected to be (ruby laser exposures of 800 joules to the heads of squirrel monkeys were not fatal), with extremely high powered pulse lasers this type of injury to humans must be considered and protected against. Lasers which may have sufficient output to cause such injuries are being developed in some laboratories; however, such lasers are not being used in industry.

The thermal effects of the absorption of laser radiation, which can occur at much lower energy levels than the photodynamic effects, can be important in any part of the human body; however, because of its construction and function, the eye is normally the most sensitive to permanent damage. Be-

cause of this, normal safety programs attempt to reduce or control the laser radiation so that sufficient energy cannot get to the eye to cause damage. It is then assumed the level has been limited to a level too low to damage other parts of the body. Several workers such as Zaret, et. al.⁷; Ham, et. al.⁸; Flocks, et. al.⁹ have made studies of laser energy required to cause permanent damage to ocular tissue. Here it is necessary to divide the types of damage which may occur into three areas, for different wavelengths of light affect the eye differently. For instance, lasers operating in the visible portion of the spectrum normally damage the retina of the eye long before power densities sufficient to damage other portions of the eye are reached. Eye damage due to ultraviolet laser outputs will normally manifest itself as cataracts on the corneas of the eyes; while lasers operating in the infrared portion of the spectrum, depending on the portion of the infrared spectrum involved, may cause cataracts, damage the retina, or damage the aqueous or vitreous humors of the eye.

Since most lasers in commercial use have outputs in the portion of the spectrum where the retina is most sensitive, we will consider retinal damage first. Ham, et. al.⁸ made studies of the powers required to cause damage to the retinas of rabbits (in previous work they have found rabbits' eyes similar to humans'). As a result of their work, they found that with an exposure time of 30 nanoseconds (30 billionths of a second) 0.07 joules per centimeter squared is sufficient to cause damage; with an exposure time of 0.2 milliseconds (two ten-thousandths of a second) the energy required is 0.85 joules per centimeter squared; and with an exposure time of 20 milliseconds, approximately 3.9 joules per centimeter squared is required. Ham also found that for the longer pulses, 200 microseconds and longer, there was good agreement between the results found for lasers and for non-coherent light sources such as xenon flash lamps. Extrapolating the data given, in "Ocular Effects of Laser Radiation" and considering the data which presented at the I.E.E.E. Conference on Laser Engineering and Applications¹⁰, it is estimated that for an 800 micron spot diameter continuous energy of 10 watts per centimeter squared or 2.5 million watts per centimeter squared for 30 nanoseconds is sufficient to cause observable eye damage. Ham and his

associates have also found that the size of spot and time of exposure are related. They found that for times below one millisecond, the spot size was not important; however, for times appreciably greater than one millisecond, not only is power level important but also the area which is being illuminated. They felt that one watt per centimeter squared was probably a safe continuous power level.¹⁰ In order to make absolutely sure permanent damage does not occur, and also to anticipate the fact that repeated exposures over long periods of time may cause damage at lower levels, the accepted safe level for continuous radiation should probably be set one to two orders of magnitude below the one watt per centimeter squared level or 10 to 100 milliwatts per square centimeter; however, it is too early to suggest a safe exposure level with any degree of confidence.

While formation of cataracts on the cornea of the eye is different from damage occurring to the retina, the setting of exact levels not to be exceeded is, again, almost impossible. As with the retina, the energy required to cause damage is a function of factors such as time of exposure, area of exposure, and wavelength of the laser light. Hirsch¹¹ has documented a case where repeated exposures over a long period to microwave energy at an estimated power level of 100 milliwatts per square centimeter was sufficient to cause the formation of cataracts on the eyes of a worker. It appears reasonable to expect that laser radiation at this level could also cause cataract formation if a large percentage of the energy were absorbed in the cornea. Here, as with retinal damage, it appears that the acceptable level to be considered safe should not exceed 10 to 100 milliwatts per centimeter squared.

Damage to the aqueous and vitreous humors of the eye is again unpredictable, as is the case with the cornea damage. With this type of damage, the amount and rate of damage is a function of the temperature which the aqueous (vitreous) humor reaches and the length of time at this temperature. Thus, with the variation in absorption by the aqueous humor at different wavelengths and the variations of power density by the focusing of the eye, it is almost impossible to set limits on what power levels would be low enough to avoid damage to the aqueous humor. Here again the safe power level

should be assumed to be no greater than 10 to 100 milliwatts per centimeter squared.

When the levels of laser radiation which might be considered safe are considered with respect to radiation levels which are presently available from lasers, it is found that almost all lasers can be considered unsafe under certain conditions. For instance, there are lasers available which can deliver over 100 joules of energy in 30 billionths of a second (peak power approximately three billion watts). For this type of laser it is impossible because of time considerations for natural eye protection mechanisms to be effective. Furthermore, using the technique outlined by Burnett¹² and assuming the following conditions—laser beam divergence equal to $\frac{1}{2}$ degree, no energy lost in atmosphere, a pupil diameter of three millimeters, a focused spot size of approximately 17.6 microns, and an energy density of 0.07 joules per square centimeter to cause damage—it is found this laser is capable of causing damage at a range of approximately 8.6 miles. Assuming that the assumption of no loss in the atmosphere was in error by an order of magnitude, the dangerous range would still be approximately a mile. At the other extreme, we have small continuous lasers, such as helium-neon, having outputs of approximately one-half milliwatt. Again using the 17.6 micron spot size and assuming all of the laser's energy is focused in the spot, the power density is found to be approximately 190 watts/cm², which is probably sufficient to cause eye damage.

It is likely that under the proper conditions most lasers can cause damage, especially to the eyes. Therefore, it is felt that any laser must be treated as a potential hazard and steps taken accordingly. The steps which should be taken with a particular laser system vary widely; however, they normally fall into four basic categories: education, medical surveillance, individual protection, and system isolation.

While at first education may appear to be of secondary importance, often it is found that education is the most important factor in laser safety. As people who design systems know, it is possible to build a system which is completely interlocked such that it should be impossible for a person to hurt himself when using the system; however, it is also known that almost invariably the interlocks and safety devices fail at some point, due ei-

ther to equipment failure or improper actions of the operator. Under these conditions it is mandatory that the operator recognize the potentially hazardous situation and take appropriate action. Education can also be extremely important in the use of small lasers, such as the small continuous helium-neon lasers which deliver at the most a few milliwatts of power. Such lasers are being used more and more in surveying and similar equipment, and it is mandatory that the people using the equipment and anyone working around such equipment be aware of the danger as well as what can be done to avoid or reduce the danger. With such lasers a very short exposure of the eye to the direct beam should not create permanent damage; however, prolonged exposure may do permanent damage. To someone familiar with lasers, it is quite apparent when he is looking directly into the laser (that is, the laser beam is striking the eye directly) and by the simple expedient of closing the eyelid or turning the head slightly he can probably prevent permanent damage. Laser light is extremely brilliant and there is a human fascination with it much as occurs with the arc of an electric welder and other very bright light sources. Because of this human fascination and tendency to stare at brilliant light sources, those working around lasers must be aware of the dangers and train themselves to look away as soon as they find themselves looking directly into the laser.

Medical surveillance, like education, is quite important in laser safety programs and such a program has been in effect in the Western Electric Co. since the laser was first used in manufacturing¹³. The periodic medical examination of the eyes points up very well why medical surveillance is important. While one small burn of the retina may not cause sufficient impairment of vision for the person himself to be aware of it, multiple burns could cause a serious loss in vision. By periodic examinations it may be possible to discover eye damage before any serious loss of vision occurs.

With the low power laser systems proper education, coupled with the warning signals which the person receives from his own senses, will probably be sufficient to reduce injuries to a minimum. In the case of industrial laser systems, however, this is usually not the case, for a large percentage of the industrial systems produce power levels

which are sufficient to cause injuries in a few thousandths of a second. Under these conditions, even if the person should recognize the danger his reaction time is so slow that he would be unable to take any action before the injury occurred. In these cases education is important to aid the person in not doing things which could be potentially hazardous, but additional safety measures are also necessary to prevent the occurrence of an injury even with an improper action of the person. The safety equipment which may be used can range from the use of goggles by the operator to the total enclosure of the laser beam with a light-tight, interlocked box.

The use of goggles by operating personnel is at best only a secondary means of protection for the person, and their use by people who are not extremely familiar with lasers and the characteristics of "laser safety goggles" might create more of a hazard than they prevent, by giving the people a false sense of security. For instance, those aware of the capabilities of some lasers know that it is difficult to make goggles which can be seen through and still stop 100 percent of the laser light incident on the goggles. In fact, many lasers are so powerful that in all likelihood, if the direct beam struck the safety goggles, the goggles themselves would be shattered. Another problem occurring with goggles is that normally they are effective only at one or at best at a few laser wavelengths. Again, the person may believe he is wearing goggles which will protect him where, in reality, his goggles may furnish no protection. Within our company and within most other companies goggles and similar safety devices are used only for experimental systems by highly qualified individuals.

While it is recognized there will be special situations where the laser's output cannot be totally enclosed and safety measures such as education and goggles must be relied upon, laser installations which will be used in manufacturing plants should be designed such that all of the laser's output is contained within a light-tight box. While this often presents some design problems, they are seldom, if ever, insurmountable, and normally it is probably no more difficult to design a safe work station for a laser than it is to design a safe work station for rotating machinery. When designing a work station for a laser, two major criteria are usually used.

First, it must be light-tight to the laser's wavelength when the laser is operating. Second, the operator must be able to view the workpiece while it is in position. The first criterion is met by making the box light-tight and interlocking all doors or access ports so the laser cannot operate while the doors or access ports are open. The second criterion can be met any number of ways; however, the most popular techniques appear to be the use of a mechanically apertured microscope system or a closed circuit television system.

Normally, laser viewing microscopes are incorporated with the laser so that the same lens which focuses the laser's energy on the workpiece is used as the objective lens of the microscope system. Between the objective lens and the eyepiece of the microscope is a mechanical shutter, movable mirror, or prism arranged so that in order to view the workpiece with the microscope, the laser's beam must be blocked. An electrical interlock may also be incorporated, so the laser cannot operate while the work is being viewed.

A closed circuit television system (CCTV), has been used extensively in the Bell System for viewing work performed by a laser.¹⁴ It has been found that there are several advantages of the CCTV over the microscope. For instance, it is possible to completely shield the laser and its output from its surroundings; second, because of the construction of the system, it is possible to view the workpiece while the laser beam is impinging on it; and third, it is possible to obtain a quicker and more consistent focusing of the laser's energy on the workpiece.

As a result of our studies and work with lasers and laser safety, it is concluded that:

1. Any laser should be considered as a potential source of injury. However, with recognition of hazards present and by engineering the system to cope with these hazards, the laser can be safely used.
2. So far as is known, the eye is most sensitive to permanent damage from laser radiation and, normally, systems which completely protect the eye may be considered safe.
3. Education to the potential dangers of lasers is an essential part of any laser safety program.
4. The ideal method of protecting personnel from the effects of laser radiation is the

complete shielding of the personnel from the radiation.

5. Normally, in industrial applications, it is possible to design the system so that all of the laser radiation can be contained within the system.

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MAXIMUM ACCEPTABLE WEIGHT OF LIFT*

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Great concern about manual lifting is reflected in the following excerpts from a recent U. S. Department of Labor booklet entitled "Teach Them To Lift."

"The problem of injuries resulting from the manual handling of materials continues to plague industry. The accident preventionist still seeks to reduce the toll of this type injury by setting broad brush restrictions on how much a person should be permitted to lift. . . . Everyone is searching for a solution. . . . Unfortunately, there is no easy way out."

There are no Federal regulations concerning maximum permissible weight of lift, and only 20 of the states have laws governing manual lifting or carrying. Most state regulations are directed at females and minors. The need nevertheless exists for guidelines that can be used in designing lifting tasks to fit the individual. Presumably for this reason, the U. S. Department of Labor has included in its booklet the maximum permissible weights recommended by the International Labour Office (ILO)* (Table I).

Although presenting the ILO recommendations, the U. S. Department of Labor takes a position of caution with respect to their application. The department apparently feels that it cannot support the recommendations without further specifying and considering some of the many variables that affect maximum weight of lift. This paper supports the Department of Labor's position of caution and attempts to (1) identify what the major variables are, (2) review several investigations which have considered these variables, and (3) present new data recently collected at Liberty Mutual Research Center.

*From AIHA Journal.

TABLE I
Maximum Permissible Weight to be Carried by One Worker

Age	Male	Female
Adult	88 lb	55-44 lb
16-18 years	55-44 lb	26-33 lb

Seven variables affecting the weight of lift are listed below. These are not the only variables, but they appear to be the major ones. They can conveniently be classified into human variables and task variables.

Human Variables:

1. Sex of worker.
2. Age of worker.
3. Training of worker.
4. Physical fitness or conditioning of worker.

Task Variables:

1. Size of object to be lifted.
2. Height from which and to which the object is lifted.
3. Frequency of lift.

Body dimensions, such as height of the worker, are other human variables. Variations in worker height, however, can be compensated for if the height of lift is classified in terms of the worker's own body. For example, one type of classification is based on muscles that actually perform the lift.*

Most of the recommendations or regulations about maximum permissible weight have been based on opinion and have considered only two of the above variables: age and sex of the worker. Six investigations of maximum weight (including that of the ILO) were found which are more objectively based, and which consider three or more of the seven variables listed above. These investigations are summarized below in terms of the above variables, the criteria used, and the segment of the population which was considered.

1. International Labour Office (ILO):²

In March 1964, under the auspices of the ILO, an international committee of experts convened in Geneva for the purpose of setting a maximum permissible weight to be carried by one worker. This committee consisted of four government experts, three experts designated by the employers' group, three experts designated by the workers' group, and two physicians appointed by the director-general. Their criteria were the physiological capacities of the individual.

Recommendations of the committee (Table I) are given in terms of age and sex. For the adult male, the recommendations apply to "workers normally employed in operations requiring lifting and carrying of weights" (indicating some degree of fitness and training), and to workers of "normal constitution" (the average man). Size of the lifted object is considered in the discussion but is not reflected in the recommendations. Height of lift is not mentioned, but a lower

lift (below the waist) is implied throughout the report. Frequency of lift is not specified but is to be varied according to "environmental conditions, the worker's state of nutrition, his constitution, etc." The recommendations were "deliberately chosen in the lower range of reasonable weights" to enable handling by "less favored workers."

TABLE II
Reasonable Weight Limits for
Occasional Lifting^a

Age (years)	Male	Female ^c
14-16	33 lb	22 lb
16-18	42 lb	26 lb
18-20	51 lb	31 lb
20-35	55 lb	38 lb
35-50	46 lb	29 lb
Over 50	35 lb	22 lb

^aFrom the Swiss Accident Insurance Institute.⁴

2. Swiss Accident Insurance Institute.

An excellent investigation of lifting and carrying was completed by this organization in 1961. The report was subsequently translated by the International Occupational Safety and Health Information Centre (CIS) and disseminated in 1962 as CIS Information Sheet No. 3.⁴ The weight limits recommended by this report are based on a biomechanical criterion: the amounts of stress imposed upon the spinal disks. Recommended values are given in Table II.

Consideration of age and sex variables is obvious in Table II (lifting ability of women is assumed to be 60 per cent that of men). The values apply only to "smooth" lifting and lifting close to the body (indicating training), but represent the worst possible conditions of a bent back and a 90° angle of inclination of the trunk (indicating no training). Values are doubled for individuals of 20 to 35 years of age if lifting is accomplished with a straight back. Fitness is briefly discussed but is not reflected in the recommendations. A compact load is assumed. Height of lift is not discussed, but again the implication is a lower lift (below the waist). Recommendations apply specifically to occasional lifting and must be reduced by 25 per cent in instances of frequent lifting. "Workers lifting heavier loads than those indicated in the table should be specially selected and correctly trained."

3. Danish National Association for Infantile Paralysis.

In 1965, Asmussen *et al.*⁵ reported on a quantitative evaluation of back muscles in

lifting. A relationship between integrated EMG's (electromyograms) and isometric backward pulls was established, and a value of 40 to 55 per cent of isometric back strength was recommended for specifying allowable weight of lift for repeated lifting.

TABLE III
Allowable Weight for Repeated Lifting*
(40% Isometric Back Strength)

Age (years)	Male ^b	Female ^c
15	55 lb	40 lb
20	64 lb	42 lb
25	68 lb	43 lb
35	71 lb	44 lb
45	71 lb	42 lb
50	—	40 lb
55	66 lb	35 lb
65	60 lb	—

*From the Danish National Association for Infantile Paralysis.⁴⁻⁷

^bBased on a 65-inch body height (representing approximately the 10th percentile for men under age 55).

^cBased on a 59-inch body height (representing approximately the 5th percentile for women under age 55).

This recommendation was based on Molbech's⁴ performance criterion of "steady state" maximum isometric force at ten to 30 contractions per minute. On the basis of this criterion, and with the isometric muscle strength measurements gathered by Asmusen and Heeboll-Nielsen⁷ from 360 men and 250 women, the values in Table III were calculated.

Values in Table III are for straight back lifting, inclined 45° forward (indicating some degree of training). No mention is made of the conditioning variable, except to say that isometric muscle strength measurements were obtained from a representative urban population. The lifted object used by Asmusen *et al.* was a "box with two handles, about 40 cm (15.7 inches) apart." No lifting height is specified, but a lower lift is implied. The recommended values are intended to apply to frequent lifting. Notice that values in Table III were derived from men and women of shorter body height (the tenth and fifth percentiles, respectively).

4. Human Engineering Guide for Equipment Designers⁸

Woodson and Conover recommend weight limits for objects of varied sizes and lifts of varied heights. However, no criterion is reported, and no specific investigation is referenced. Recommendations are given in Table IV, which represents "weights which could be lifted by the average man over and over

again." The variables of training and fitness are not discussed.

5. U. S. Air Force (Emanuel *et al.*)⁹

In 1956, the U. S. Air Force reported a lifting study that used a subjective criterion. Nineteen young male subjects (16 of them college students) were instructed to "lift the greatest weight possible without a feeling of possible injury." Subjects varied the weight of the object lifted by adding or subtracting 10-lb bags of lead shot. Results of this study, shown in Table V, are given for different segments of the population sample.

Ages of subjects ranged from 17 to 28 years. They were required to lift with a straight, although not necessarily vertical back. With this exception, subjects were classified as untrained, and presumably unconditioned to the lifting task. The object lifted was an F-86H ammunition case: 10¾ inches high, 25½ inches wide, and 6¾ inches deep. There were two handles at the top of the ammunition case. No mention is made of whether the subjects considered frequency of lift when judging maximum weight.

6. U. S. Air Force (Switzer).¹⁰

A second Air Force lifting study based on a subjective criterion was reported in 1962. Seventy-five male college students (average age: 19.5 years) were instructed to find reasonable weights that men can be expected to lift without excessive strain or discomfort. Subjects varied the weight lifted by adding or subtracting 5, 10, and 20-lb bags of lead shot. Results, shown in Table VI, are given for different heights of lift and for different segments of the population. These results are not based on the entire sample of 75, but only on the 33 shorter men who represented the first to 15th percentile stature range. Also, Switzer calculated only what 99.87 per cent of this shorter population could lift; the 99 per cent, 95 per cent, and 90 per cent values were calculated by the authors from Switzer's data.

Subjects were trained in correctly performing the three lifts, but as college students they were probably not conditioned to the task. The object lifted was a sheet-metal box, 6x12x12 inches, with 4½-inch handles. There was no mention in the instructions as to frequency of lift, except that the work "might be carried on for some time."

TABLE IV
Recommended Weight Limits for Males^a
(Pounds)

Height of Lift	Size of Object (inches) ^b		
	12 x 12 x 12	12 x 12 x 18	6 x 8 x 36
3 ft	75	95	110
4 ft	55	75	95
5 ft	40	50	50

^aFrom Woodson and Conover.⁸

^bNo handles.

TABLE V
Weight-Lifting Capacity for Males (Pounds)^a

Height of Lift	SD	Per cent of Sample				
		95	75	50	25	5
1 ft	47	142	199	231	268	301
2 ft	40	139	165	190	217	259
3 ft	31	77	97	114	137	172
4 ft	19	55	67	81	96	112
5 ft	16	38	46	57	71	83

^aFrom Emanuel et al.⁹

TABLE VI
Weight-Lifting Capacity for Males^a (Pounds)^b

Height of Lift	SD	Per cent of Population			
		99.87	99.0	95.0	90.0
18 in	20.8	62	76	90	97
42 in	11.6	38	46	54	58
62½ in	8.6	27	33	39	42

^aRepresenting 1st to 15th percentile range.

^bFrom Switzer.¹⁰

It can be observed that not one of these six studies investigated or held constant all seven of the variables identified above. It was for this reason that an additional lifting experiment was designed and conducted at Liberty Mutual Research Center. This experiment followed the Air Force approach by using a subjective criterion to determine the maximum acceptable weight which 90 per cent of the male industrial population should lift. All variables except height of lift were held constant. The technique of letting the subject adjust the weight lifted according to his own feelings is actually a variation of the psychophysical method of magnitude production.¹¹ In magnitude production, the experimenter states or indicates a series of sensory magnitudes, and the subject adjusts a stimulus to produce them. This experiment deals not with a series of magnitudes, but with only one magnitude—the maximum acceptable weight of lift. To reduce potential errors often found in psychophysical experiments, the subject was given a greater number of trials, he was allowed to approach the critical weight from both the heavy side and the light side, and several of his visual cues were eliminated. The median instead of the mean was also used to obtain the point of central tendency for each subject. (Stevens¹¹ recommends the use of either the median or geometric mean instead of the arithmetic mean because they are not as greatly af-

ected by extreme values.) For greater application to industry, older subjects were used. These subjects were industrial workers, trained and thoroughly conditioned to the lifting task.

Apparatus and Procedure.

The object lifted was similar to an industrial tote box 13½ x 19 x 5½ inches, with two 7 x 1½-inch handles. The subject varied the weight of the box by adding or subtracting loose lead shot with a small scoop. Partitions in the box prevented a shifting load. The box weighed 10 lb and contained a false bottom which could hold a maximum of 40 lb of lead shot. Weight of the "empty" box was varied systematically between 10, 20 and 30 lb. The loose shot and varying weight of the "empty" box were intended to minimize visual cues which could possibly influence judgments of weight. Nine male subjects, between 25 and 37 years of age (average: 30.1 years), were given the following instructions:

"Imagine that you are working on a production line which requires you to fill this box every 15 minutes. When the box is full, you must lift it onto a rack or conveyor belt.

"Adjust the weight of this box until you feel that it is the maximum amount that you can lift *comfortably*; the maximum amount that you can lift *without straining yourself*; and the maximum amount that you can lift once every 15 minutes.

"Adjust the weight of the box by putting in or taking out scoop-fuls of lead shot.

"Do not hurry your lift. Test the weight carefully. Re-adjust the weight as many times as you feel necessary. Do not strain.

"Remember that we are not interested in how much you are capable of lifting, but rather in the maximum amount that you would like to handle in your regular job."

Subjects were second-shift industrial workers from local industry. They were all in good health, as determined by a pre-experiment medical examination. Subjects performed push-up, pull-up, and deep-knee bend exercises for one week prior to their scheduled participation in the experiment. During the first four days of the experiment, subjects were instructed in the correct lifting procedures, given 18 practice trials at adjusting the weight of the lifted object, and gradually conditioned to the task by performing repeated lifting for varying periods of time.

Eighteen five-minute sessions, thirteen 12-minute sessions, three 15-minute sessions, and three 30-minute sessions of repeated lifting were performed by each subject before any measurements were recorded for analysis.

Each subject made a total of 18 judgments; six for the floor level to knuckle height lift, six for the knuckle height to shoulder height lift, and six for the shoulder height to arm reach lift. For one-half of the judgments, the initial total weight of the box (including varying amounts of shot in the false bottom) was 30 lb; for the other half, 100 lb was the initial weight. This procedure was intended to cancel out a constant error that might result from approaching the judged weight from only one direction. Initial total weight of the box, and the three lifting heights, were varied systematically. The test schedule is summarized in Table VII.

TABLE VII
Test Schedule

	Session Number	Initial Total Weight (lb)	Order of Lift				
			Weight of "Empty" Box (lb)	Floor to Knuckle Height	Knuckle Height to Shoulder Height	Shoulder Height to Arm Reach	
Training sessions	1	30	10	2	1	3	
	2	100	30	1	2	3	
	3	100	20	1	3	2	
	4	30	20	3	2	1	
	5	30	30	3	1	2	
	6	100	10	1	2	3	
Test sessions	7	30	10	2	1	3	
	8	100	20	1	3	2	
	9	30	20	3	2	1	
	10	100	30	3	1	2	
	11	30	30	2	3	1	
	12	100	10	1	2	3	

*Including lead shot in false bottom.

Subjects made only one judgment per lifting height in a single day. Another experiment, running simultaneously, required the subjects to perform three 60-minute sessions of repeated lifting after making judgments of maximum weight. Although part of another experiment, these long sessions of repeated lifting served to maintain conditioning of the subjects.

Results and Discussion.

The median weight for the six trials per lifting height was obtained for each subject. The means and standard deviations for these median weights are given in Table VIII, together with values for 90, 75, 25, and 10 per cent of population.

The size of our sample is admittedly

small, and values in Table VIII may change as more subjects are tested. Nevertheless, certain trends appear to be developing, and the following observations can be made:

1. With only one exception, standard deviations are considerably smaller than in the two Air Force studies, particularly with the lower lift. This can possibly be attributed to a reduction in errors achieved by additional experimental controls (for example, elimination of visual cues, approaching the judged weight from two directions, and a greater number of training and record trials).

2. There is a surprisingly small difference between the three lifting heights when compared with previous studies.

3. Results for the floor to knuckle height lift are somewhat less than for equivalent lifts in other studies. This could be a function of different instructions (for example, with the inclusion of a designated frequency of lift) or of the older, more experienced, and better conditioned subjects who have a better idea of the effects of long-term repeated lifting.

4. Results for the knuckle height to shoulder height lift are in general agreement with equivalent lifts of other studies.

5. Results for the shoulder height to arm reach lift are somewhat greater than for equivalent lifts in other studies. This could possibly result from beginning the lift at shoulder height, and not at the floor level used in the two Air Force studies.

TABLE VIII
Maximum Acceptable Weight of Lift for Males (Pounds)*

Height of Lift	SD	Per cent of Population				
		90	75	50	25	10
Floor level to knuckle height	11.0	52	59	66	73	80
Knuckle height to shoulder height	8.5	51	56	62	68	73
Shoulder height to arm reach	9.7	48	53	60	67	72

*From Liberty Mutual Insurance Company.

TABLE IX
Correlation Between Maximum Permissible Weight of Lift (Males) and Body Height, Body Weight, and Age

Height of Lift	Coefficient of Correlation (r)			Coefficient of Multiple Correlation (R)
	Height	Weight	Age	
Floor level to knuckle height	0.24	0.67*	0.14	0.70
Knuckle height to shoulder height	0.28	0.64*	0.10	0.68
Shoulder height to arm reach	0.11	0.71*	-0.09	0.72*

*Correlation coefficient (r) significantly different from zero at the 0.025 level.

All men should be trained in the correct procedures for lifting, and all new men should be allowed to condition to their new job gradually. Within these considerations, it can be concluded from the results of this experiment that 50 lb. is the maximum weight of a compact object that should be lifted by unselected, adult male workers. (This is essentially the recommendation of the Swiss Accident Insurance Institute). With greater degrees of personnel selection (see Table VIII) the maximum weight of lift may approach 75 to 80 lb. for lifts from floor level to knuckle height, and 65 to 70 lb. for lifts above knuckle height.

This paper was presented as part of the Ergonomics Session of the 1966 American Industrial Hygiene Conference. The discussant was Professor H. S. Belding, of the University of Pittsburgh. During his remarks, Professor Belding expressed the desirability of comparing results of the weight-lifting experiment with the physical characteristics of subjects who performed in the experiment. Consequently, correlation coefficients (Pearson r and multiple R) were calculated between individual results and available subject characteristics—body weight, body height, and age.

Table IX shows that, of the three subject characteristics considered, body weight is the only significant correlate of maximum acceptable weight of lift for the particular lifting tasks studied. It should be noted, however, that the low correlation with body height might partially be a function of classifying lifting height in terms of the subject's own anthropometric measurements. As the sample becomes larger, it will be possible to develop regression equations with greater

confidence than the current small sample now permits.

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Training—Communications in Safety

ARE YOU HARD OF LISTENING?

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Most of us are hard of listening when we interrupt the speaker to make our point, when we let our mind wander, when we offer solutions and make decisions rather than allow the speaker to reach his own alternatives, when we permit emotionally loaded words to blind our senses, and when we are more concerned with status than with the individual or his feelings.

"Listening is the most overused word in human relations. Everyone talks about it; few know what it really means. It is the essential step in helping, for to listen is to give understanding."¹ Spoken words don't always convey the full meaning to all who hear them. Listening involves a wordless understanding, what the French call *rapprochement*, which has greater depth than the mere exchange of words can express. Many of us haven't taken a look at the communications process and the basic factors which make listening effective.

Listening is active! It is the part of the interaction between people which integrates the spoken and the unspoken and results in an understanding of the other person. To give understanding requires people to be open with each other, to have an awareness of the situation and to be spontaneous. These are difficult skills to master, so many of us go through life "hard of listening."

¹ Levinson, Dr. Harry: *Emotional Health: In the Work World*.

Let's examine a few barriers to listening as they often occur, and discover what can be done to improve our skills in each area.

When we feel an urge to "cut the speaker short" so we can make our point, the result is often quite different from our intent. What this action reveals is that the speaker's ideas aren't as important as ours. It also reveals a lack of maturity because Mr. Listener isn't able to allow himself the uncertainty of letting the other fellow fully develop or finish his ideas. He demonstrates that he is uncomfortable when others are free to express ideas. Psychologists tell us that often when people feel threatened they try to re-

gain a state of balance by changing the situation to one they control and can feel comfortable in.

This "cutting off" action is quite common. Just think of your last conversation with your wife, with your boss, with your subordinates, or with a friend. Even more dramatic illustrations come from conversations about particular subjects. Recall the last conversation with your subordinates about a change you want to make. If you think you survive these conversations without being "cut off", then next time you have coffee with a friend, secretly keep tabs on how many times he interrupts you before you finish your idea.

Changing this behavior will improve our skill in listening, but we must remember that it takes an awareness of ourselves and an attitude that we want to be open with others and understand them.

When we let our mind wander and "tune out" a speaker we have created another common barrier to listening. Research by Dr. Ralph Nichols at the University of Minnesota revealed that we think about four times faster than the average speaker talks. The natural urge for listeners is to use this time for private thoughts, until these become more important than the conversation. The result is a wandering mind.

Experienced and skilled listeners have as their primary goal the task of understanding the other person. Even the silent communication of nervous body movements, the twitching, the fidgeting, and the foot swinging help this listener to understand. Communication comes on many channels, and when a listener is tuned into all the ways he can integrate a speaker's message, he'll not only capitalize on his faster thought speed, he'll become a better listener.

When we hear only what we want to hear and project our wishes into what the speaker says, we are frustrating all hopes for effective communication. In both cases the result is distortion of the message and misunder-

standing. Behavioral scientists call this limited listening "selective perception."

Research from Dr. Berelson and Dr. Steiner reports that most people listen to points which are in agreement with their point of view, in agreement with the group they belong to, and which reflect their values. Our pre-disposition can become a barometer on how well we are going to listen or attempt to understand the speaker. The urge to put our unique point of view first is always present because we all see the world from our own experiences. So realistically speaking, selective perception and projection will usually be present every time two people communicate. Effective listening and a reduction to this selective perception barrier can only come when we have an awareness of our feelings toward a speaker or his subject; when we are aware of our biases and can adjust for them.

One executive who completed a listening course scored very high in the post-test. When advised that he did well on every section except those portions of the tape where a woman talked, he quipped, "I tuned out my wife years ago." Think of the areas you have strong feelings about and take them into account next time you hear someone speak about them.

When we allow emotionally loaded words to blind our senses we create another common barrier to effective listening. Emotionally loaded words distort our feelings because they threaten us, and we react automatically by trying to defend ourselves. So, when a doctor is called a "quack", an Italian a "wop" or a Southerner a "redneck", the reaction is predictable. The blood pressure rises, the pulse increases, the face becomes flushed, and the listener is ready to defend himself. Speakers are often cautioned about using loaded words when they are told to know the audience or direct the message to the needs of the group. But little is ever mentioned about how a listener, the other person in the communication interchange, reacts to loaded words.

A workable solution is for the listener to, first, understand that words alone can't really threaten him and, second, to identify the specific terms which create this reaction in him. This awareness will help keep the emotions in control. Think of a conversation you have had with a rough-tough person with little vocabulary other than all the four letter

words in the language. If he was a pleasant chap you overlooked his coarse words and crude manners in an attempt to understand what he was saying (and generally these men are understood). This is basically the same position a listener should take with all speakers if he is to become effective with others.

When you as a listener break in to offer a solution to the speaker you defeat any attempt toward mutual trust and openness. Listening in an adult work situation is difficult at best; it is impossible if you refuse to be a sounding board so the speaker can examine his own thinking. Your role as a listener is to let the speaker talk about ideas which are difficult to express and often not fully thought out by the speaker. If you offer cliches, start talking about yourself, and offer advice, you are only succeeding in escaping from the task of listening. The final result is that the speaker will soon feel that you really don't care about him or what he is saying. You only succeed in creating resentment as you fail in your main task—to understand.

When we are more concerned with status than with the speaker, we fail in communications. Status can become a barrier when we judge someone as "less worthy" or prejudge the effect of his message by his place in the "pecking order". Status is real, and because it is we as listeners have to become aware of the effect it can have on us. Think of the recommendations which failed because the boss "just didn't have time to listen" or because "Jones is a good boy down in the shop, but . . .".

Both sides of communications, speaking and listening, are vital to the interchange between people. A listener who hides behind status really demonstrates his need to dominate others and hold to his own place in the pecking order. When we avoid showing an interest in others, we avoid the remotest of possibilities for an honest open interchange and effective communication.

We have all seen instances when status is dropped and understanding is immediately improved. A man on the line is stopped by the boss and, in place of the usual polite "time of day" exchange, the boss asks the man for his ideas on an operation. He listens and thanks the man. As the boss walks away the man remarks, "Who said he was a stuffed shirt?". A genuine interest in others

and respect for their feelings goes a long way in removing the barriers created by status.

Can we learn to listen? For the mature person the answer is, yes; for he has demonstrated that he is aware, spontaneous and willing to participate in an open exchange with others. For the average person the answer lies in his potential to master these skills, for many of the basic skills needed in effective listening are his to a greater or lesser degree. However, it is a myth to believe that everyone can learn to listen. Not everyone is capable of mastering the complex set of listening skills any more than everyone can learn to run the four minute mile.

It takes a mature person to show empathy, establish *rapprochement*, understand feelings, and recognize how the speaker's views may differ from yours. S.I. Hayakawa, expert semantist, has said, "most of us most of the time are chiefly concerned with getting our views across, and we tend to find other people's speeches a tedious interruption of the flow of our own ideas." We often go through life proving Hayakawa's observation correct and don't really reach for maturity in our relationships. A large part of our problem is that we all have a filter called selective perception. It is ours alone and it is based on our unique experiences and emotional attitudes which can distort whatever we hear.

The hope for the normal person learning to listen lies in his gaining an awareness of how he listens, what his biases are, and that

his job as a listener is to integrate the communications which are coming in at several levels, both verbal and non-verbal, and to understand the meaning which speaker intends.

Dr. Carl Rogers suggests an exercise that may help all of us become aware of our listening skills. When a group is talking and there is disagreement, have one person involved in the differing views accurately state the position of the other person or group before he proceeds with his own case. If the other person or group feels that he is not understanding their position correctly they stop him, and he restates their position again. The ground rules state that one can only proceed if he can state the other's position accurately and the other person agrees that he understands. This calls for skill in communications. It also relies heavily upon the relationships of the people and their openness and honesty in their interchange.

For those of you who care to probe deeper, the best seller by Dr. Eric Berne, *Games People Play* is perhaps one of the most penetrating studies into the very core of what happens when people communicate with one another.

I started by asking if you are hard of listening. In closing, I state that before any listening program can be effective there has to be a lot of meaningful thinking given to our relationships with others. For the sum and substance in the art of effective listening rests on our genuine interest in doing everything we can to understand others.

Safety Pays at Mobil Oil

MOBIL'S SAFETY PHILOSOPHY

By H. J. PECKHEISER

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Our principal product is highly volatile and flammable, and it's manufactured under conditions involving high temperatures and pressures. Yet the oil refining business compares favorably with industry generally in terms of frequency of disabling injuries and has almost as good a record as industry generally in terms of severity.

Our industry delivers this product at the rate of 200,000,000 gallons a day to retail outlets located in virtually every community and crossroads in the nation. Yet the equipment we have developed is so safe and our training of employees has been so effective that accidents in the delivery of gasoline are rare. You would have to go back more than 40 years to find a case of an explosion of a storage tank at a service station. Tank trucks have an accident rate well below the average for all trucks and, incidentally, below the rate for milk and ice cream trucks. Service stations are so safe that no other retail business receives a lower fire insurance rate.

Our primary concern at Mobil is for the health and welfare of our employees and any other people our operations affect. People first, then plants and other property.

Like many other industrial organizations, we emphasize that safety is an essential part of every manager's responsibility. The chairman of the board, the division manager, and the foreman in any facility share this responsibility—and so do all the other managers who form the long line of our corporate structure. Safety, then, is a management responsibility. Working with professional safety people and communicating, clearly and directly, with all other employees, each manager is directly responsible and accountable for the safety of the men and operations he supervises.

Safety is never a simple matter; in a company of the size and diversity of ours, it is tremendously complex. We cannot simply devise a master plan and then adhere to it. We have more than 80,000 employees in

more than 100 countries, and each of our installations has its own problems and specific areas of concentration. The diversity of jobs, working environments, and people in a large international oil company means that our safety people have an enormous and difficult job.

Regardless of the function and location of the installation, we stress two primary points: prevention and communication.

Most accidents and many injuries are preventable. We cannot foresee every eventuality, but we must *try* to do so. We can demonstrate that our philosophy of accident-prevention works. As proof, we find a far better safety record in those aspects of the oil business where a company such as Mobil has full responsibility—for equipment, for training, for control—compared with the safety experience in those parts of the business carried on by small, independent contractors.

At least one-third of all industrial accidents could be prevented by common sense, adequate precautionary measures, and clear communication.

That brings us to the subject of communication. All of the newest techniques of accident prevention, fire-fighting, storage practices, safety equipment—all of these things are useless unless those who come in contact with them know how to use them. Most of all they must *believe* that this knowledge is not only useful but necessary.

Persuading people to do something is, of course, the most difficult part of management. Persuasion takes many forms. One small example comes to my mind from my own experience. Every time I visit one of our refineries, they hand me a safety helmet to wear as long as I'm inside the plant gates. I can't help feeling a little odd and self-conscious, wearing a business suit and a safety helmet. But I always remind myself that this is one way we in management can demon-

strate that we're serious about safety. If I didn't wear the helmet, there's very little chance I would get hurt. But there's a very good chance the men who saw me without it would take this, consciously or not, as one more excuse not to wear their own helmets and not to observe all the other safety rules they've been taught.

A few years ago John W. Gardner wrote a book that had quite an impact on people's ideas. The title of the book was "Excellence."

"Our society," Mr. Gardner wrote, "cannot achieve greatness unless individuals at many levels of ability accept the need for high standards of performance and strive to achieve those standards within the limits possible for them. We want the highest conceivable excellence, of course, in the activi-

ties crucial to our effectiveness and creativity as a society; but that isn't enough. If the man in the street says, "Those fellows at the top have to be good, but I'm just a slob and can act like one"—then our days of greatness are behind us. We must foster a conception of excellence which may be applied to every degree of ability and to every socially acceptable activity. A missile may blow up on its launching pad because the designer was incompetent or because the mechanic who adjusted the last valve was incompetent. The same is true of everything else in our society. We need excellent physicists and excellent mechanics. We need excellent cabinet members and excellent first-grade teachers. The tone and fiber of our society depend upon a pervasive and almost universal striving for good performance."

PROFILE OF MOBIL OIL CORPORATION

By F. J. DOOLAN

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Keeping people and equipment safe at Mobil is a large and complex task. It involves protecting the health and welfare of some 81,000 people around the world. It also involves the safe operation of well over \$3 billion worth of capital equipment.

The large numbers may surprise those of you who know Mobil only through its service stations. I don't mean to minimize the importance of our worldwide network of retail outlets; they house more than 47,000 cash registers. But you will need to know more about the company before you can fully appreciate the importance of safety planning in its operations.

Since its founding 101 years ago, Mobil has grown to be the world's eighth largest industrial company in terms of sales, and fifth largest in terms of assets. Assets and annual revenues each exceed \$5½ billion.

One of the company's most valuable assets, but one that can't readily be translated into dollars and cents, is the quality of its people.

This is an international company in every

sense of the word: a group photograph of Mobil people would look like the Family of Man. Mobil companies operate in more than 100 countries and territories in the free world, and we hire and train local people for as many jobs as they can fill. Equally important, we are trying more and more to fill high-level posts with the best-qualified executives, whatever their birthplace. So, a Frenchman is our ranking man in Europe; the vice president heading our Exploration and Producing division on the U.S. West Coast is a British subject; Canadians run our important Libyan and Venezuelan operations; and an Englishman is president of Mobil Oil Hellas, in Greece.

Mobil people work in offices, refineries, chemical plants, truck terminals, warehouses and laboratories. They operate tank ships, drilling rigs, earth movers, automobiles and airplanes, computers, typewriters, electron accelerators, and radiotelephones.

They are a youngish group and, by and large, they are dissatisfied with the way things were done yesterday. Management

believes this is a good thing, because yesterday's methods are probably not up to tomorrow's tasks.

How do we know? The growth in demand for oil tells part of the tale.

Since 1950, free world consumption has been increasing at an average annual rate of 6.7 per cent. This year's expected demand (30.6 million barrels daily) is more than three times the 1950 figure. Between now and 1987, free world demand for oil is expected to reach more than 75 million barrels daily. To meet the growing demand, the oil industry must find some 385 billion barrels of oil in the next 20 years—more than twice the amount produced in the free world area in the last 100 years.

Of course, simply finding vast amounts of crude oil does not put a single drop of gasoline in your tank or fuel in your burner. Before oil in the ground is of use to anyone, it must be *produced*, that is, taken out of the ground; *transported*, usually by tanker or pipeline; *refined* into valuable products; and *marketed*. These are enormous tasks. No commodity in the world is moved in such tremendous volumes as oil. Companies that perform all these functions—finding, moving, refining, and marketing—are known as integrated companies. Mobil is such a company.

As we have said, the first task of an integrated oil company is to find and produce the oil. Mobil produces oil from 17 countries throughout the free world. Almost half of this production—some 628,000 barrels a day during the first six months of 1967—comes from the Middle East. About 30 per cent comes from North America.

Among our newest sources of oil, and potentially our largest outside the Middle East, are those in Libya and Rainbow Lake, in Canada. Another major exploration area is in the North Sea basin, which is in the midst of one of the world's largest industrial markets. Cook Inlet in Alaska is another new and promising source of crude oil, as is offshore Nigeria. Mobil is active in all three areas.

Today, Mobil is looking at other sources of petroleum that have not been economic in the past. In Rifle, Colo., the corporation is working with the Colorado School of Mines and other oil companies on the extraction of oil from oil shale. The research will show if oil can be recovered from this oil shale at a cost comparable to that of natural crude oil.

While these rather exotic sources of oil may be vital to us in a decade or two, conventional wells will meet most of our crude oil needs in the immediate future.

Once this oil has been taken out of the ground, it must be transported to refineries to be made into useful products. Mobil's transport operations are in themselves a huge enterprise. The Mobil fleet is among the largest commercial fleets in the world. The company owns 38 deep-sea tankers and holds long-term charters on 43 others for a total of 86 vessels with a capacity of well over 3 million deadweight tons. Four 200,000-deadweight-ton tankers are presently on order, and three of these mammoth ships are expected to join the fleet in 1969.

Pipelines also move tremendous volumes of oil and oil products with great efficiency. Mobil owns more than 15,500 miles of pipeline in the United States. The company owns crude pipelines in Venezuela and has part interest in other pipelines in the United States, Canada, Europe, South America, the Middle East, and Africa. We transport crude to 41 refineries throughout the world, which we own completely or in partnership. At these refineries, the crude oil is made into 3,000 separate products. These 41 refineries last year processed a record 1,540,000 barrels of crude oil a day.

Last year marked the start of a significant expansion of our refining capacity. In Western Europe, construction began on a new 80,000-barrel-a-day refinery near Amsterdam, in the Netherlands. The refinery is scheduled for completion next year. Plans have recently been announced for the construction of a 70,000-barrel-a-day refinery in southwestern Germany. Work will begin early next year and is scheduled for completion in 1970. In the next few years we plan also to expand existing plants or build new refineries in Austria, the United Kingdom, and Japan.

Last year marked the startup of Mobil's first wholly-owned refinery in Southeast Asia. The new plant, located in the Jurong area of Singapore, can process 22,500 barrels of crude oil a day. Also in the Far East, a company in which Mobil has a half interest began construction of a 60,000 barrel-a-day refinery near Tokyo.

Products from our refineries are shipped in a number of ways—tankers, pipelines, tank

truck, and rail—to more than 400 terminals and from these to over 47,000 retail outlets in more than 100 countries and territories.

I have suggested that Mobil is perhaps best known through its service stations. We have 28,000 retail outlets in this country, and about 22,000 overseas. However, the Mobil brand name also is known through well-established promotional efforts such as the Mobil Economy Run and the Mobil Travel Guide. In all its regional editions, the Mobil Travel Guide sold nearly a million copies in the U.S. last year, second only to the Bible.

Our "We Want You to Live" advertising campaign has also received much attention. The campaign has won praise across the country from newspaper editors, clergymen, state governors, and from thousands of motorists who have written to the company in appreciation of our efforts to make our highways safer.

Mobil also has substantial chemical operations. In terms of sales, Mobil Chemical is the second-largest U.S. chemical operation affiliated with an integrated oil company. On the same basis, it ranks among the first 15 U.S. chemical companies of all kinds. The company, which employs more than 11,000 people, operates or has interests in some 70 manufacturing plants on five continents. Chief products include petrochemicals, plastics, paints and chemical coatings, and agricultural and industrial chemicals.

It is a truism by now that no large com-

mercial enterprise can achieve sustained growth and development without a vigorous research program. Research has been a cornerstone of Mobil's growth since the day it was born. The company was, in fact, established to test a scientific hypothesis: that crude oil distilled under a vacuum would yield a greater proportion of kerosene. Kerosene was the most valuable oil product in 1866.

The goals of Mobil's research program include the discovery of new or improved ways of finding and recovering oil and of making new or improved fuels, lubricants, and chemicals. More than 2,000 Mobil people are engaged in research activities—about one out of every ten of them in fundamental research—in a program costing more than \$40 million a year.

Some of our researchers' more recent contributions include the development of a premium-grade synthetic lubricant for advanced jet aircraft engines; a new fuel for jet aircraft that fly at three times the speed of sound; the Borehole Televiwer, an instrument that can photograph the wall of a well even when the well is filled with oil or drilling mud; a unique purification process for terephthalic acid, a key ingredient for making fibers used in permanent press clothing and a host of other products; and the development of the Durabead family of zeolite cracking catalysts that increase yields of high-octane gasoline by as much as 25 per cent.

MOBIL'S SAFETY PROGRAM WORLDWIDE

By J. J. McKENNA

Manager of Safety and Security, Mobil Oil Corporation, New York, N. Y.

Although we are big in terms of both personnel and assets, and operate in more than 100 countries of the world, our safety goal is the same as that of other smaller companies—to protect people and property.

But, even though our goal is the same as that of smaller companies, our approaches must be more diverse; they must satisfy widely differing customs, habits, climates, and attitudes. It is our job in New York to devise plans which take all these factors into consideration.

A year or so ago, we decided that accident and fire prevention and the corporate security function had similar approaches and a similar purpose—protection of plants and people. We therefore combined them in one department. Previously, the accident and fire prevention function had been in our Corporate Employee Relations portfolio. The plant protection responsibility was in the Security Department. With the marriage of the functions, we became the Security and Safety Department, and the Manager of Accident

and Fire Prevention came over to work with us. Functionally working with him are four safety and plant protection advisors: one for our North American Division, one for Mobil Chemical Company, one for the International Division, and one for the worldwide Marine Transportation operations. These four advisors are located in New York and coordinate the activities of the various safety people in our field operations. Organizationally, we have a very uncomplicated system.

In safety, as in security, the most important preventive tool is good management techniques backed up by determined action. As you know, it is frequently hard to isolate a safety measure as such; a well-run refinery, minimizing hazards, is in itself a safety measure. Good management techniques are at the heart of Mobil's safety program; that is why each manager is held responsible for the safety of the men and materials he supervises. This means that each safety program—aside from the general theories and overall procedures emanating from headquarters—is designed to meet local needs. We believe in custom tailoring—an exact fit to meet exact and specific local conditions.

A safety regulation that is right and proper for the relatively sophisticated workers in the United States just isn't going to work in all other parts of the world.

For example, we have some operations in the Sudan. Over the years, we have recognized that the Sudanese are a strong-willed people. There are things they will do and things they will not do. One of the things many of them object to is the wearing of shoes. In our warehouses there, as in similar operations here in the States, the men handle heavy metal containers—drums of kerosene and lubricating oils. Here in the States, the wearing of safety shoes is obligatory but the Sudanese refuse to wear shoes of any kind. Does this create a safety problem? No, it doesn't. The Sudanese are so careful and so proud of their working habits that we have no problem at all with foot accidents. I might add that I'm sure we have fewer drums damaged at Khartoum in the Sudan than we do in Cicero, Illinois.

So, in the Sudan, as in other parts of the world, we must reckon with local customs to get the job done safely. On the other hand, we cannot afford to be too flexible. We can't always give in to local customs.

At one of our installations in Greece,

workers employed by an outside construction firm had the idea that drinking milk would make them immune to poisoning of any kind. They were totally convinced that by drinking a quart a day they could walk into a tank containing tetraethyl lead and no harm would come to them.

We had quite a time persuading them this was a fallacy. The company doctor talked with them; the installation manager and the safety man were not able to convince them that, although milk was healthful, it was no substitute for protective clothing and respiratory equipment. But local superstition was too strong, and the outside contractor permitted them to work under the conditions they wanted. It was only after 18 or 19 men came down with lead poisoning that the other workers decided that, in addition to milk, they needed the proper clothing and equipment.

In other parts of Europe, we are responsible for a man's safety from the time he leaves his house in the morning until the time he gets back from work at night. We have portal-to-portal responsibility. If he rides a bike to work, and hits a rut in the road and tumbles down, we are considered responsible for the accident. That's one reason we frequently have to go beyond on-the-job safety and teach our employees such things as correct driving habits—of automobiles, bicycles, or even horses and mules when these are the most-used modes of transportation.

One of the driving instructions we give to our people in the Libya desert is a simple one: "Never leave your car." Driver training in Libya contains many such instructions, including "Don't get off the main roads" and "Try not to travel during the daylight hours" and "Always bring along plenty of water." Even though we give such instructions, we know some of our people will become lost. Because of this, we have to teach the basic principles of survival and rescue:

1. Stop the vehicle in a spot where it can best be seen from long distances. Avoid aimless attempts to find your own way. Such efforts can result in your unknowingly going farther from your route and can greatly prolong and enlarge the search effort.

2. Remain with the vehicle. Searchers can find it much more easily than they can spot a person on foot. Also, by remaining with the vehicle you can keep all emergency sup-

plies at hand and the vehicle itself will provide shelter and many items useful for survival and signaling.

3. Preparations for signaling should be completed at once; but don't begin signaling attempts, such as burning tires and fuel, too soon. It may be many hours before preliminary searches and checks are completed and a widespread search is started.

4. Protect and conserve food and water in order to sustain life and health. Avoid unnecessary physical exertion and remain alert and watch for rescue attempts.

You can readily see that our driver-training in the Libyan desert is different from what we stress in Houston, Chicago, or New

York. You can also see why we cannot insist that a hard, unbending safety program—with a detailed list of inflexible do's and don'ts—be followed in all our installations throughout the world. So instead of pontificating with policies, manuals, and procedures, we at headquarters devote much of our time to analyzing trends and problems and trying to improve our overall safety record as much as possible. This is the way we try to stay on top of our safety situation. We use statistics, not as an end in themselves, but as a guide to our determining how and where we can improve management emphasis on, and employee consciousness of, safe procedures.

SAFETY IN MOBIL CHEMICAL

By C. S. DEDON

Manager, Employee Relations, Agricultural Chemicals Division, Mobil Chemical Co.,
Richmond, Va.

Mobil Chemical has grown large in just seven years. In 1960, Mobil's chemical interests consisted of a still unfinished petrochemicals complex and three paint plants. Today, the company operates or has interests in 70 plants on four continents. It has added plastics and agricultural and industrial chemicals to its product list, and has created a large research division almost from scratch.

The rapid growth has been satisfying in many respects, but it's caused some problems, too. As you can imagine, our safety people have had their share.

As far as safety programs went, each of the company's five divisions had worked independently. Some had safety supervisors; some did not. A few had solid programs; others had let their programs lag.

The obvious fact about safety at Mobil Chemical was that it needed emphasis. So, early in the game we brought key management people together for a two-day safety conference. At the meeting, key line and staff people heard top management and outside safety experts discuss the elements of a good safety program.

To start, each person in the audience received a manual outlining the company's safety policy and the objectives of our pro-

gram. They heard about fire fighting techniques and fire extinguishing systems. They heard about emergency planning, the hazards of static electricity, and the safe handling of light ends. They probably heard more than they cared to, and perhaps less than they needed to about the crucial role of safety planning in chemical operations.

But when they left the conference, they knew several things for sure: they knew that top management was keenly interested in safety. And they knew that safety was an element of their operations that demanded constant attention.

Three pressing problems remained. We had to find the career safety people who could do the job we needed done in the field. They, in turn, had to help us find out where we stood. Unless all the divisions measured safety performance with the same yardstick, we would be in the dark about the effectiveness of our programs. Finally, we needed to standardize equipment. This, we knew, would cut our maintenance costs and ease the problem of training safety people.

Since manufacturing operations are different in each division, the safety problems they face are different, too; but at least two elements apply throughout the company.

Open communications is one, and we rate it high on the list of achievements. Our company safety advisor in New York is in constant communication with safety people in the field. In fact, he moves pins on his wall map to keep track of their whereabouts.

In case of emergencies, communication in the field is quick and direct. Our Wood Finishes Department, part of the Chemical Coatings Division, recently had a truck carrying solvent go off the road in Tennessee and wind up in a lake. When the safety man at Wood Finishes headquarters, in High Point, N.C., heard about the accident, he immediately called the division safety advisor in Plainfield, N.J.—woke him up at home, in fact. The division safety man was on the scene the next day supervising salvage operations. By directing the cargo to be pumped out before the truck was moved, he probably prevented a spill that might have created a serious contamination and possible fire hazard on the lake.

The second element of our program that pertains throughout the company is a little harder to put your finger on. It is increased management support for the program. This is hard to define except to say that our safety people feel it. They are getting the kind of support they need to do their jobs.

Our Agricultural and Industrial Chemicals Division, headquartered in Richmond, Va., produces and markets fertilizers throughout the major farm sections of the country. A plant in Atlanta, Ga., manufactures multi-wall bags for agricultural and industrial materials. The division mines some four million tons of phosphate rock a year from reserves in Florida. Phosphate is one of the three major ingredients in mixed fertilizers, and it's also the source of many of our industrial chemicals.

The Industrial Chemicals Division converts phosphate rock into elemental phosphorous. This, in turn, is converted into intermediates, which are used by manufacturers of pharmaceuticals, soft drinks, cleaning and polishing products, and water treating materials. Other derivatives are used in the manufacture of powdered and liquid detergents. Our Industrial Chemicals Division has also developed a product that imparts flame retardant properties to urethane foam insulation.

The Industrial Chemicals Division and our Agricultural Chemicals Division have safety coordinators at major manufacturing loca-

tions. Each of these men has been through a concentrated safety and fire training course.

Hard hats, safety eye protection, and other personal protective equipment are widely used.

The Industrial Chemicals Division has recently begun a pilot job safety analysis program. This means a qualified safety man will study each job in the plant to look for all the possible ways a man can get hurt. Then the hazards are removed. Those we can't remove, we will protect against. In the process, we write operating instructions which are used in the training of new employees.

In our phosphate-mining operations in Florida we have some unique safety problems, and we have instituted some interesting safety practices. Phosphate mining and processing is not a particularly hazardous undertaking; nevertheless, a typical worker in the phosphate field is likely to have in his possession, or have access to, as many as 40 different pieces of safety equipment. These include such ordinary items as hard hats, safety glasses and leather gloves, as well as a host of extraordinary items such as snake bite kits, skin creams, and air-cooled hoods.

Our sandblasters wear the air-cooled hood which, in effect, is a private air conditioner. This device, which is operated by the same compressor the man uses to blast the sand, enables the worker to lower the temperature of the air around him by as much as 20 degrees. Ninety-five and 100-degree days are common in Florida in the summer time, and without the air-cooled hood, workers could suffer from heat prostration. Furthermore, when a worker is comfortable, he works safer and more effectively.

The machine shop operator not only has the hard hat and safety goggles, but he also wears dark glasses to protect his eyes from ultra violet rays and a pair of ear defenders to safeguard against high-frequency shrill that may affect his hearing.

We have what we think is about the safest ladder in the world, because it's virtually impossible for a man to fall from it—providing he's wearing his safety belt.

A rail is welded to the center of the rungs on the ladder; at every eight-inch interval all the way to the top there is a notch which catches and automatically locks the safety belt if he should slip. Some of our men think they're safer at the top of the water tower than they are on the ground.

A vital part of our operation is moving

product from our washer and flotation plants to storage some 20 miles away. Traffic can get congested on the nine railroad tracks that lead into the flotation plant, for example, and you never know when a man is going to get hurt in the hustle and bustle of moving cars around. To reduce the possibilities of injury, we have mechanized this operation to the point where one man functioning in a control tower can move all the cars by merely pushing a button. This way, nobody is on the tracks running the risk of being caught between cars. In the event it is necessary for a man to go down on the tracks, he uses crossovers which make it possible for a man to reach the ground level next to every car on every track without having to climb through or between the cars.

The Chemical Coatings Division has 14 plants in the United States and wholly or partially owned plants in six other nations making products for almost every type of paint-using industry. These range from primers for the auto industry to marine coatings to wood finishes for the furniture industry. Mobil Chemical is the largest supplier of wood finishes in the U.S.

All of the chemical coatings plants handle large volumes of highly flammable solvents such as toluol and xylol. Flash points of these materials may be as low as 15° F. The products cannot be handled in closed systems the way they are in refineries. Therefore, the plants use explosion-proof electrical equipment almost exclusively, as well as thorough grounding and bonding techniques.

In the Chemical Coatings Division, as well as the other divisions, safety is heavily emphasized to employees from their first day with the company. Each new employee attends a safety orientation program before he assumes any duties at the plant. These are intended almost solely to develop his safety consciousness. He learns that his safety record is equally as important as his production record. He is instructed that all accidents are preventable. He is told that safety at his particular station is his responsibility, and he is told that safety rules must be observed to the letter.

Once he reports to the plant, his supervisor instructs him in specific safety regulations involved in his work, the use of eye protection and breathing apparatus where necessary, and the safe handling of flammable liquids.

In addition, each supervisor has a safety manual designed to guide him in holding safety meetings each month. Each meeting is devoted to a single safety topic, but the agenda also includes a review of any accidents that may have occurred in the preceding month, a discussion of any new hazards uncovered since the last meeting, and a discussion of the work coming up, with an eye toward possible hazards. Such meetings are also held in the other divisions.

A system of semi-annual safety inspections of all facilities, has also been installed in the Chemical Coatings Division. The inspecting team covers all aspects of loss prevention throughout each location.

The Petrochemicals Division is the one most closely related in its operations to the oil business. The division's largest plant, at Beaumont, Tex., manufactures high-purity ethylene, propylene, and butadiene. These chemicals are used in the manufacture of plastics, anti-freeze, tires, detergents, and paints. An aromatics unit, part of the same complex, produces high-purity benzene and toluene used in the manufacture of dyes, fibers, plastics, solvents, synthetic rubber and other products.

A smaller plant, also in Beaumont, produces fiber-grade terephthalic acid, commonly called TPA, for use in polyester fibers. A nearby nitrogen plant produces feedstocks for the company's Agricultural Chemicals Division.

The TPA plant, only recently completed, presented an especially difficult safety problem. The plant uses a new Mobil-developed manufacturing process. But even before all the bugs were worked out, management decided to enlarge the plant. Naturally, this required close cooperation between Mobil people and the construction crews to assure safe operation.

Both Mobil and the contractor had safety men on each shift, and management was advised of safety problems as they came up. All plant guards had been trained in fire protection and were given refresher courses every 60 days. One of their jobs that required constant attention was to see that construction equipment did not block the access of safety vehicles. The safety people needed to keep tabs on plant operation as well as on construction. They had to know which lines were in use and they had to know what areas were safe for open flame.

Cooperation between plant and construction personnel was close and constant. As a result, there was not a single lost time accident at either the nitrogen or, TPA plants during the 2½ years they were under construction.

Safety is stressed at the division's other plants, too. A safety manual has been prepared for each plant. Each plant in the petrochemical complex has a safety advisor. And safety indoctrination is part of the training of each new employee. In fact, all new operators are hired as part of the plant protection force. Safety training and operator training go on simultaneously for a year before the new employee becomes a full-fledged operator.

The division also has an active safety suggestion system. Each employee suggestion is reviewed by at least three supervisors who cull the promising ones and turn them over to a management group that picks the winners. A good idea proposed recently was to have signs at plant exit gates to remind employees to fasten their seat belts. While it's not a startling innovation, I think it does show how a suggestion program stimulates people to think about the total safety picture.

The Plastics Division, with headquarters in Macedon, N.Y., operates eight plants which produce a variety of plastic films and plastic foam, chiefly for packaging. The division tried to operate for two years without a full-time safety advisor. As you might suspect, their record was not outstanding. They have one now, and things are much better.

New employees get up to four hours of safety training before they start their jobs. Supervisors all have been given first aid training and the same training is available to anyone else who wants it. Fire brigades have been formed at each location and they receive continuous training. Safety committees meet monthly to review operations. Each committee has four or five permanent members: the plant manager, safety advisor, plant engineer, the top production man, and often a nurse. Plant supervisory people serve as rotating members.

Inter-plant safety competitions are run regularly throughout the division. All injuries requiring medical attention are considered in the judging. Plaques are awarded each quarter and at the end of the year. An award also goes to the plant that showed most improvement.

The division also runs family safety contests with the object of encouraging safety off the job. The winning employees are taken to dinner with their families by the company. The division also promotes off-the-job safety by making home fire extinguishers and seat belts available to employees at company cost.

The division has established a safety poster contest, with the winning posters published in plant newsletters. Employees not only develop the ideas, they also produce the posters.

Next, and last, I want to discuss our Research Division. Research people, as you probably know, tend to become deeply absorbed in their work. Our experience has taught us that a Ph.D. working, say, on some new development in plasma physics, does not get terribly concerned about safety equipment. We realized that only a chemist could interest another chemist in safety; we therefore appointed a man with degrees in chemistry and industrial engineering as the research safety advisor.

Interest in safety has picked up considerably. The division's safety eyeglass program is now 100 per cent effective. Emergency squads have been formed at the research lab, staffed by technicians, all of whom have volunteered for the job, and all of whom have had special training at the Ansul school in Marinette, Wis.

The labs themselves have been built with safety in mind, especially our lab at Metuchen, N.J., which does a great deal of work with materials under pressure.

Mobil Chemical reports its monthly accident record to the Manufacturing Chemists Association, and we participate in their annual award program. In addition, we maintain a dialogue with many important groups and associations in the safety field. These include the National Safety Council, the American Society of Safety Engineers, the Safety Executives of New York, and the Fire Committee of the Society of Plastics Industries.

We also participate in the Wise Owl program of the National Society for the Prevention of Blindness. As you know, this opens membership in the group to any employee who has saved his sight through the use of safety eye protection.

One thing we all have learned is that no long-term program can succeed unless its course is carefully charted. To say simply

that our goal is to make Mobil Chemical a safer place to work would be, in practical terms, to say that we have no goal at all. It would lend no direction to efforts, and offer no scale with which to measure them.

For this reason each of our divisions is required each year to translate that fond desire into practical, reachable, meaningful objectives; in other words, into numbers. How many films shown, how many safety meetings held, how many training sessions, how often to review equipment, how many jobs to be analyzed, how many contests. If, at the

beginning of the year, a division reports that it intends to have every employee see at least ten safety films, it is not hard to see at the end of the year if the goal was met.

We are pleased with progress, but we have a long way to go. But that will always be true. One of the frustrations of a career in the safety business is that you measure success in terms of what doesn't happen. One of the rewards is the constant challenge to find better ways to do the job. That is the challenge we have picked up at Mobil Chemical.

FIRE PREVENTION AT MOBIL

By **LEONARD O. FRANKLIN**

Regional Operations Advisor, Exploration and Producing Division,
Mobil Oil Corporation, Houston, Tex.

In the oil business, we deal every day with substances that are highly flammable, highly volatile and, if not properly handled, extremely dangerous. Oil and its principal by-products are tough materials to handle properly.

You may be interested to know that in America there are fewer fires in service stations than there are in churches and schools. Mobil's contribution to this exceptional record, I believe, reflects our emphasis on fire prevention and our strong employee education program and our rigid enforcement of regulations.

In all of our operations—refineries, exploration and producing areas on and offshore, tankers and pipelines, service stations—fire is an ever-present hazard. Our philosophy is simple. Get the best equipment possible. Inspect it, maintain it, and operate it properly. Educate all workers about the importance of fire safety and the proper safety procedures. (I might add that we frequently use outside fire departments whenever we can, and train their men along with our own whenever special situations make this kind of training necessary.)

We also conduct continuing safety-preparedness planning surveys. These are sometimes directed by our own safety people, sometimes by outside experts. These very detailed surveys enable us to determine methods of developing better safety designs,

practices, and communication in existing refineries. They also help us to provide new and better designs for refineries being constructed or modernized.

Refineries handle and store vast quantities of flammable materials. Because of this, they are particularly susceptible to fires. As some of you may know, a series of refinery fires occurred in August, 1967. In the largest of these, a fire and explosion at Lake Charles, La., seven people were killed and 13 injured. We still don't know exactly how much damage was caused.

We at Mobil haven't had a serious refinery fire for about ten years, but we see no reason to rest on our record. In addition to providing the necessary equipment and instructions to our employees, we try to provide an atmosphere which cuts down the possibility of human error. Of course, it's impossible to get rid of the human-error factor entirely, but we feel a strong responsibility to do a number of things: to select and train qualified safety personnel; to upgrade existing skill levels; sometimes to use automation or other electronic controls to preclude the possibility of human error and, perhaps most important, to arrange procedural checks and regular supervisory reviews.

Specifically, what do we do to emphasize fire safety in our refineries? Here are a few examples.

We allow no smoking whatsoever in any

areas where gasoline, liquid-petroleum gas, or other flammable materials are stored.

We make available the very latest in fire-protection equipment and teach all our people how, when, and where to use this equipment. Our basic components in fire control and extinguishing are dry powder and mechanical foam. Water-fog and hose streams are used for secondary cooling and certain kinds of fire control; we might use a water-fog screen to protect men while operating valves in a fire or danger area. Each of our refineries has at least one combination foam-dry chemical truck. Both hoses can be used simultaneously.

In addition, each operating and storage unit is equipped with a built-in-water spray system, centrally controlled. Refinery workers can activate valves which almost immediately spray an entire operating unit, helping to prevent an explosion and hampering the spread of fire. Of course, spray hoses can also be directed by hand.

In case of a tank fire, one complete foam tower unit is carried on the fire truck; another is located in the fire shed. Additional dry foam powder in 50-pound buckets is stored in a central warehouse.

Of course, proper maintenance is necessary. Periodic testing and inspection is made of all hoses, spray systems, fire-truck equipment, and other fire-fighting devices.

Before storage tanks are entered for cleaning, or before any welding is done on them, they are tested for the presence of combustible gas. Protective aluminum suits enable men to withstand extreme temperatures. Demand air containers are also available.

Offshore drilling is becoming more and more important in oil exploration in this country and overseas. On offshore drilling rigs and producing platforms, fire can be very dangerous at all times, particularly because evacuation can be very difficult.

On this kind of operation, we hold fire drills at least once a month. No prior warning is given. Some oil-soaked rags are burnt, and the alarm is sounded. The extinguishers use dry chemicals, foam, or sea water. Lifeboats are in place at all times. In evacuation drills, the men swing on ropes from the platform to a tug. This in itself can be hazardous, but it's the best way to get the men off the rig quickly in case of emergency. I might add that an emergency might mean high winds or high water, as well as fire. The

evacuation procedure remains the same.

Of course, wherever gasoline is stored, there is some danger of ignition as a result of static electricity. An approved method of bonding and grounding must be used wherever flammable liquids are loaded or unloaded.

In-service stations, too, we are always on guard against the possibility of a fire. We do not allow smoking near the pump island, for obvious reasons. We provide and maintain fire extinguishers for each company-owned station.

There is probably no fire as terrifying as a fire at sea. And there's no fire at sea as fearful as a tanker fire, especially when the cargo is a light, highly combustible product such as gasoline or jet fuel. Mariners cannot run from the scene. There's no way to get outside assistance. Their own skill and courage and the firefighting equipment on board are all they have.

For this reason, every man on board every Mobil tanker, from the cook to the captain, is a skilled firefighter. His life may depend on his knowledge. Every tanker is a kind of floating fire house. You can barely walk ten feet on a modern tanker without seeing some piece of equipment, or a sign commanding the observance of a fire regulation.

One obvious hazard aboard a tanker is the careless smoker. There are none of these among sailors who have been around for a while. New men quickly learn the do's and don'ts under the patient guidance of the old salts. But reminders abound. A sign at a door to the after house is there to make sure that no one ventures out on the cargo or weather deck with a lit cigarette. Other no smoking signs are posted conspicuously around the deck. While a tanker is at sea, it is safe to smoke outside on the poop deck but a sailor has no trouble telling when he is out of bounds with his cigarette.

Outside areas must sometimes be illuminated. Vapor-proof protectors and metal cages are around the light bulbs. These are used throughout the ship.

We want to keep cigarettes away from the cargo, and we also want to keep the cargo away from the cigarettes, or from anything else that might ignite it. This means controlling the vapors. This is done by means of a pressure operated venting system. The ullage hole, a small opening in the tank top, pro-

vides access to the tank for gauging volume and for taking samples. The brass ullage screen acts as a flame barrier and is kept in place during loading and unloading procedures.

Should the worst happen, a battery of extinguishing equipment can be brought into play almost immediately. Hand extinguishers for smaller fires are located throughout the ship. The typical modern tanker carries some 45 foam and dry chemical hand extinguishers.

A tanker also has several automatic systems for handling larger fires. At the flick of a switch, the bosun can smother critical areas of the ship in a blast of carbon dioxide. The CO₂ is stored in 100-pound bottles in the after part of the ship. They're inspected regularly. Cargo tanks can also be smothered in steam at the turn of a valve.

Good equipment is worthless unless there's an alert and well trained crew around to use it. The general alarm button signals a fire drill at least once a week on Mobil tankers; more often if the crew is new. At the signal, the crew musters on the double at the boats and at fire stations. To keep drills from becoming routine, the location of the simulated fire is changed from drill to drill, and also the nature of the fire. This gets all the equipment in use and keeps the officers and crew on their toes.

As an adjunct to fire and boat drills, there are exercises in the use of a line-throwing gun, fresh air masks, resuscitators, and other safety equipment procedures.

Loading and discharging cargo is perhaps the most critical period in the operation of a tanker. Tanks are open, product is flowing and crew members and shore personnel are constantly coming and going. "Danger—handling petroleum—no fires—no smoking" is the first greeting anyone gets when coming aboard. A red signal flag is hoisted to show the ship is carrying flammable cargo. Doors to the living areas are closed and kept closed. Fire extinguishers are placed at the cargo manifolds and shore lines are bled into drain pans while flanges are removed. Foam extinguishers are placed at recirculating lines, and scupper plugs are inserted to contain any spills on board.

Mobil conducts training and refresher courses in firefighting at several ports around the world for both its U.S. and international crews. Officers and crew on standby or awaiting assignment to a ship attend the schools whenever possible. The training is supplemented with training films shown at sea and with regular publications which discuss safety matters and call attention to any new hazards. On a Mobil tanker, seamanship and safety mean pretty much the same thing.

MOBIL FLEET SAFETY PROGRAMS

By DONALD E. JOHNSON

Safety Supervisor, Southwest Marketing Division, Mobil Oil Corp., Dallas, Tex.

We at Mobil emphasize driving safety. And, of course, since we have established ourselves as preachers to the vast motoring public, we certainly have to practice, in our own operations, what we preach.

We have quite a few motor vehicles in Mobil's fleet, ranging from passenger cars to huge tank wagons. Because of the huge volumes we move and the large numbers of vehicles we move them in, safe driving is a vitally important consideration.

There is at least one full-time driving instructor in each of our eight U.S. marketing

divisions. It's his job to train new men and to re-train the veterans—even experienced drivers need a booster shot of instruction once in a while, to keep up with new findings and techniques. Every Mobil driver attends at least one formal training session every year, as well as informal sessions scattered throughout the year whenever we feel they might be necessary or useful.

Our bible is the *Motor Fleet Manual*. It contains just about everything a driver has to know, from federal highway laws to Mobil's own regulations on such matters as pre-

ventive maintenance, driver-performance standards, even painting and lettering specifications.

I'm not going to bore you by going through the contents of this manual, chapter by chapter and page by page. I want to emphasize, though, that we continually change it, and we have a permanent coordinating committee responsible for making sure that it's clear, accurate, and up to date.

Each new Mobil driver, regardless of his previous experience, goes through a formal two-week training program. At least five full days are spent going along with a veteran company driver as he makes his usual rounds. At the same time, the mechanics of driving and details of all equipment are explained thoroughly. In our classroom sessions, we make extensive use of the Harold Smith driver-training system. Instructors, veteran drivers themselves, explain the console of the cab, local driving regulations, and safe methods of loading and unloading the products the vehicle will convey.

Motor fleet safety entails more than just safe driving. Safety in loading and unloading, and in maintaining maximum visibility so that our vehicles can be seen easily by other vehicles on the road, are just as important. Keeping the truck clean—in most cases, washing it at least once a day—is emphasized. Loading at bulk terminals requires safe handling of all products. Before the driver

can begin loading his vehicle, he *must* attach the grounding cable. When he does so, the light over the pumps goes on. Not until then can he proceed with the loading.

In California we use an unusual safety device to prevent the escape of vapors into the air. The driver attaches a metal hose which collects all gasoline vapors. This accomplishes two things: First, it reduces the danger of fire or explosion on the spot; second, it does not allow vapors to contribute to the state's air-pollution problem. The captured vapors are brought through a series of pipes to a condenser, then reformulated into premium gasoline and sent back to storage tanks.

In delivering gasoline to a service station, pipes are constructed so that, once the attachment is made, there is an automatic grounding contact.

As I mentioned previously, our drivers make the rounds at first with an experienced man. Later, they are graded on their performance by everybody involved in the training process. That means an evaluation by the terminal superintendent, the fleet instructor, the employee relations advisor, and the field operating supervisor.

Accidents, of course, do happen, in spite of every precaution. When they do, we try to make sure a similar accident will not happen again. We hold informal discussions on the nature of the accident, its causes, and its effects.

WE WANT YOU TO LIVE

By NICHOLAS L. BRISTOW

Community Relations Representative, Mobil Oil Corporation, New York, N. Y.

Driving safety has received a lot of emphasis during the past few months and you have only to take a glance at the grim statistics to know that the emphasis is well deserved.

Last year more than 50,000 of us crashed to death on the roads. More than 1,700,000 were injured—more than the total number of students attending all public and parochial schools in New York City. More than the entire population of Manhattan or the Bronx. I'm sure you'll agree that these are staggering figures.

We at Mobil want to do something about it. We don't know how much we can help—but we know we have to try. We want to tell you some obvious and some not so obvious things we can all do to stay in one piece. We want to be professional nuisances, to nag you and plead with you to treat your car as if it were loaded. If one person is helped, it's good enough for us.

A closer examination of the accident statistics shows that young people 15 to 25 years old were involved in 31 per cent of all accidents, although they make up only 20

Pages

129 - to 144

MISSING

Medical Views of 3 A's in Industry

ATTITUDES

By VLADMIR G. URSE, M.D.

Supt., Mental Health Clinic, Cook County Hospital, Chicago, Ill.

Generally speaking, attitude refers to the manner with which one faces and reacts to his environment. It has its roots in early life, and if the individual grows up in an atmosphere of love and understanding he develops a feeling of security and trust. If turmoil and dissension are the early influences and there are no strong figures to nourish love and understanding, then insecurity and lack of trust are the end products. Such a person is frequently hostile, suspicious, and pessimistic even when others attempt to relate to him.

We are becoming more and more interested in the interaction of people in an effort to create an atmosphere of wholesomeness and understanding. This is especially important since the structure of society has changed remarkably in the last 50 to 100 years. I believe this is particularly true in this country, which is after all in its infancy as far as an identity in the world structure of mankind is concerned. The leap and bounds by which it has progressed is almost impossible to believe. One hundred years ago—a short time in the history of the world—wagons and wagon trains were crossing the land on which this city now stands. Rivers were an important artery of travel—now they are merely polluted streams, carrying away the dirt and debris of a civilized society.

The last 50 years have shown an even more remarkable and dramatic change. Prior to this, and even as recently as 30 years ago, ours was essentially an agricultural economy and society. The farms of that time were essentially a family enterprise, each farm or cluster of farms worked by family and/or relatives, or friends. Interaction was intimate and the successes and failures were shared by all. Communication between them was complete since they essentially had only each other to depend on.

Paralleling this, industry was of a similar structure. Businesses and industrial plants were small, employing a relatively small number of employees, most of whom came from the same neighborhood or community

and, in some instances, from the same family or family group. Interaction was much more intimate and communication direct and complete because of this intimacy.

Today, we live in a world of mechanized large farms, giant industrial combines, super-merchandising chains and cities. Less than one-half of the population of this country is rural, and in a short time practically 80 to 90 per cent of the population will be urban. As a result, personal interaction has become less intimate, less personal and some of the personal identity has been lost in the shuffle.

At this point you are prompted to ask what has this to do with attitude? Obviously, the forces of the environment play a role in influencing one's attitude. I believe we are seeing more and more situational factors involved in the attitude, behavior, and emotional being of people. These factors may stem from the home, the community or work. The influence of environmental factors is demonstrated in the treatment of emotional disorders, in that in the therapeutic unit we attempt to establish an environment which is conducive to helping the sick or disorganized personality reintegrate.

The average person spends about one-third of his time in employment following his early developmental and educational years. In his employment community he must establish relationships with those about him who are an intimate part of his life. In this environment certain demands are made upon him, and he may not have the freedom of choice which exist in his home or community. Many of his attitudes must be influenced by the impact those about him have on him, and it is control of some of his attitudes which leads to a more wholesome, reasonable relationship with those about him.

Employment should not only mean a paycheck. Unfortunately, this seems to be a commonly accepted role in too large a segment of our society. Work should fulfill the

feeling of being needed and give the individual a personal identity.

The individual assumes an adult identity when he has been able to transfer some of his childhood dependencies to his work. In the early years of life the child is dependent on those about him—parents, teacher, scout leaders, etc. As he achieves an adult identity his dependency must be transferred in part to his work. He depends upon his employer, his superiors, and coworkers and they, in turn, depend on him to be productive. With a realistic evaluation of these responsibilities the adult individual is able to maintain a healthy balance and thereby avoid many emotional symptoms. He has a *healthy attitude*.

How do attitudes affect the interaction of people? They have a profound influence on interaction and can frequently spell the difference between failure and success. Unfortunately, in this highly complex and industrialized society pressures are great and a place for failure seems to be lost. Should there not be a place for freedom or privilege to fail? After all, it is possible that the person who never fails is conceivably a person who never does anything more than is ever expected of him or does exactly as he is told, never using his creative or imaginative powers to improve himself or the job he is doing. How many failures were there before success finally was achieved in the many things we take for granted? If the person who failed had not had the privilege of failing there would have been no success, because he would have become a "do-nothing." It behooves us to recognize that people about us can fail, and that we cannot forever hold this against them.

Esteem relates itself to value, and self-esteem is essentially the value or opinion one has of one's self. When one has a normal amount of self-esteem, one is generally cheerful, happy, outgoing, and able to relate well and tolerantly to those about him. His values concerning himself are good, and he possesses an air of self confidence with which he is able to relate to those about him. He can take risks and afford an occasional failure without his whole personality being threatened.

The person who has low self-esteem frequently shows this by an extreme hypersensitivity and over-reactions to what are very ordinary interactions between people. A tone

of voice, the absence of a smile with the daily greeting, or the simple, ordinary correction of an error can be the basis for a severe threat to such a person and result in a flood of tears, irritability, or anger. When one sees this response in an individual who usually does not respond this way, one may suspect that the person is depressed—a condition which is almost always accompanied by lowered self-esteem.

Management or supervising personnel cannot hope to cope with such an individual by being critical, demanding, or beating him further down the ladder of esteem, since the person himself feels that he cannot go much lower. Cool hostility, sarcasm, and arguing are not the solution to the problem. Rather, an understanding of the attitude, and acceptance and approval, are the better tactics to employ.

The *anxious attitude* is another that we frequently observe in those about us. Here, too, there are certain reactions that frequently indicate the basic problem. The extremely moist hand, the anxious expression on the face, tremors of the hands, frequent complaints to the medical department, increase in accidents may all be manifestations of anxiety. Anxiety may stem from the occupational environment and be carried into the home, or it may arise in the home and be carried to work. Diplomatic seeking-out must be the approach to such a problem, and a diplomatic referral for treatment made.

The *paranoid attitude* is more subtle. There are people who tend to remain distant and aloof from those about them, never establishing close relationships unless it be with persons of their own makeup. There are constant complainers, fault finders, who feel they are always being taken advantage of and are being put upon. Because of their attitude they are often trouble makers, and if they should be in a supervisory capacity they may influence a whole group with their feelings and ideas. Such persons are most difficult to reach and manage. They frequently leave of their own accord (thus solving the problem for those who have to deal with them), only to carry their hostility and anger to another job. They are essentially unhappy people going on in their own unhappy way, never quite realizing that they themselves are at fault, but always tending to blame someone else.

Each of us possesses an individuality of

his own by which others know us and which can broadly be defined as the "self." In this individuality are certain components which relate to certain needs all of us have. Perhaps one of the most important components is the need for respect. In dealing with people, be they clients, patients; customers, or employees, one must always bear this in mind. One cannot constantly belittle another and expect a harmonious relationship to exist. All of us have the need to be respected and cannot tolerate a constant barrage of belittlement without reacting in some way. Too often, this reaction may be anger or hostility or occasionally a loss of self-esteem. It behooves us, then, to treat the other person with the respect that is due him as an individual, even though he may have shortcomings.

There is no place for the remark, "You can be replaced by a machine" unless one is sure that the proper interpersonal relationship exists and it will be accepted as a joke. Man will never be replaced by a machine; there will always be people. Perhaps in this hustle bustle hurry-up world we are apt to overlook the dignity of man.

Some of the most important elements in creating healthy attitudes in industry or in any employment situation, or for that matter, in social or familiar situations are: interest, communication, and respect. We are all familiar with the disinterest too many of us show, especially when we are confronted with someone else's troubles. Are others really interested in listening to troubles? I believe not. Perhaps this is why psychiatrist's offices are so crowded—the patient has a paid listener. In this relationship he can ventilate, and I can assure you that ventilation of his problems and troubles can frequently bring relief.

Communication is an overworked term. Too frequently we believe that the use of words is communication, but I believe that to have meaningful communication, it must be *interested* communication. It is the interest that gives a deeper meaning to the words and conveys sincerity and respect. Without this there is no meaningful communication. It must also be understandable communication, and if it is interested communication it will be understandable communication.

All about us are printed posters, mimeographed sheets, memos, and paper of all sorts with communications printed on them.

This type of communication will really reach only a small percentage of the persons it is intended for. With the "paper barrage", as I like to refer to it, a certain percentage will immediately dispose of it without reading it. A certain percentage will read it and understand it. A certain percentage will not understand it and, as a result, pay little attention to it. Yet the communication was intended for all. I believe that except for the simplest type of communication, anything of importance which is intended for all to grasp should be verbal communication of the type I have referred to before. Let it be truly meaningful communication.

Obviously, there are many persons in industry who present some of the syndromes mentioned. The question arises as to what is to be done with them or for them. This may require the greatest diplomacy, since the recommendation that the person see a psychiatrist may not be readily accepted. In spite of the fact that there has been much publicity concerning emotional illness, there remains resistance on the part of individuals to accept treatment for emotional illness.

Interested and judicious inquiry into the factors surrounding the patient's condition is necessary, and then the diplomatic suggestion that the patient seek professional help for his condition follows. In a serious discussion the use of such terms as "head shrinker", "loony bin", "nut house", etc. have no place.

Industry must respect the relationship of the psychiatrist and his patient, even though the referral may be from the patient's place of employment. The psychiatrist must maintain a neutral role in his relationship as regards the patient and his employer. The question of whether psychiatric services on a full time basis in corporate structure will ever materialize is a question which cannot be answered at this time. Too often a company psychiatrist could be viewed by the patient as company or organization man. Consultant services by outside practitioners seems to be more acceptable and effective as of this time.

What about employability and employment of the person who has had an emotional problem or illness? Patients who have had serious illnesses can go into a remission and reintegrate well enough to return to the community and employment. One of the

great problems is finding a suitable place for them so that they may become self supporting and contribute something to society, instead of remaining dependent upon society. This requires an enlightened industrial society which recognizes the fact that such persons can contribute something to the total organization. Industry must enter into the program of educating its community to the acceptance of such persons, much as community psychiatry is attempting to establish the acceptance of such persons into the community.

Management may be willing to create opportunity for work, but all too often the persons involved with such patients lack understanding or do not possess the ability to interact with them for a healthy relationship. Much productive work can be done by these persons in an atmosphere of understanding, tolerance, and support. It is to be hoped that in the future enlightenment and increased knowledge will lead to an understanding resulting in healthier relationships for all concerned.

In conclusion, there are a few points which might prove of some help in creating healthier attitudes in this highly industrialized, compact society of ours:

1. Recognition of some of the more prominent manifestations of emotional problems, such as lowered self esteem, anxiety, and feelings of inadequacy, with an attempt to work out programs which may help in reestablishing equilibrium, and referral of such problems for professional help when it is indicated.

2. Enlightenment of management and employees with respect to the acceptance of emotional illness as an illness and recognition of the fact that such illness does not necessarily mean lack of consideration for a place in the working community.

3. Improved communications which will be interested, meaningful communications leading to greater trust and faith, rather than to less trust.

Finally, if we do unto others as we would have them do unto us, much grief, misunderstanding, and conflict will be avoided.

ALCOHOLISM

By ROBERT R. J. HILKER, M.D.

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Alcoholism is a very prevalent and misunderstood disease.

You are all familiar with the symbols of other important public health problems: the sword of the Cancer Society, the cross of the Tuberculosis Association, and the heart and torch of the Heart Association. Unfortunately, the symbol of alcoholism is, to most of us, the skid row drunk. Our concepts of alcoholism are all too often influenced by this erroneous view and our actions in prevention, treatment, and rehabilitation are geared to this completely false concept.

It is true that the exact number of alcoholics cannot be determined. It is equally true that excessive drinking is known to be fairly prevalent in the United States, and that a relatively large percentage of heavy drinkers are alcoholics or are on the road to becoming alcoholics. Most authorities agree there are probably 6½ million true alcoholics in

our population, an estimate which is up 1½ million in the last decade. If problem drinkers are included, this number may well be in excess of 11 million people. In Illinois alone, there are an estimated 303,100 alcoholics, of whom 292,000 are in Chicago. The effect of alcohol does not stop with the alcoholic but spreads to adversely effect the life of possibly 30 million close relatives.

The toll taken by alcoholism is difficult to measure. A recent statistical bulletin of the Metropolitan Life Insurance Company shows that alcoholism is a rapidly growing medical-social problem. Nearly 11,000 deaths were directly attributed to alcoholism in 1964. The reported death rate from alcoholic disorders has risen 60 per cent between 1950 and 1964. It is probable that these statistics do not really present an accurate picture of the problem. Several studies show that serious understatement exists in reporting deaths

due to alcoholism. This is presumably due to the social stigma involved and other causes of death are at times certified, where this is at all possible; in spite of this, it is quite clear that alcoholics are subject to a higher death rate by $2\frac{1}{2}$ to three times the average.

The excess death rates are mainly due to diseases of the digestive system, suicide, motor vehicle accidents, other accidents, and homicides. But long before health is destroyed, the alcoholic may become unable to hold a regular job. Drunkenness and loss of income lead to breaking up of the family, dependency, and child neglect. Losses to industry from absenteeism, accidents and other problems associated with heavy drinking are now estimated at \$2 billion per year. In addition, \$1 billion or more is spent yearly for the care and treatment of alcoholics and for financial support to their families.

This multi-billion dollar economic cost stands out in sharp contrast to the very small sums, estimated at \$12 million yearly, spent by state and federal agencies seeking answers to this problem. Proponents of expanded government activity in this field point out that the \$3.8 million spent by the Federal government in 1964 was only a little more than one-thousandth of the \$3.5 billion received by the Federal treasury in that year from taxes on alcoholic beverages. In contrast, it is interesting to note that the Canadian province of Ontario recently obtained authorization to spend \$20 million per year.

This neglect of alcoholism as a public health problem appears to be nearing an end. True, there is no large voluntary organization similar to the Cancer Society primarily interested in this disease. There is a growing public awareness of the problem. At the Federal government level there is much more interest. Contrasted to the 87th and 88th Congress, in which only one member showed any interest in specific alcohol legislation, there were 46 members in the 89th Congress who sponsored such legislation. Many more members have given their support to this legislation. The Highway Safety Act of 1966 includes a section studying the relationship of alcohol to traffic accidents and a study of existing programs. At the direction of the President, an 18 member Advisory Committee on Alcoholism will work with the Secretary of Health, Education and Welfare. Additionally, the National Center for the Prevention and Control of Alcoholism

has recently been established within the National Institute of Mental Health. The Vocational Rehabilitation Administration has expanded its work in this field.

In spite of these stated programs there is still an essential factor missing—money! In 1966 the total expenditure for identifiable alcoholism projects in the Federal government was only \$7 million. Yet this country is known to have the most severe alcoholism problem in the world, and it seems to be growing at a rapid rate. Existing agencies have done a splendid job in spite of minute budgets. Real progress will be made only if there is a substantial effort by industry, as well as an increase in local and Federal spending to combat the problem.

There are specific areas in industry in which alcoholic employees cause serious problems. Because alcoholism is often a hidden disease, it is doubtful that even the best informed industry knows the real magnitude of the problem of alcoholism in its ranks. We do know that the alcoholic employee is an absence problem. Studies have shown that he will average from 22-30 days absence per year for alcoholism alone, and that he will have a greater number of absences for other illnesses. In one industrywide study the alcoholic employee has $2\frac{1}{2}$ times the absence that non-drinkers do. Accident rates are higher—this includes both on the job and off the job accidents. Studies indicate that alcoholic employees have more than twice as many on the job accidents, and up to ten times the off the job accidents of non-drinkers. This is costly to each industry and has been estimated to reduce our national gross product by $2\frac{1}{2}$ per cent.

Traffic accidents deserve special attention. They have now reached epidemic proportions and, as such, are of grave concern to industry. Much has been said about making the vehicle safe. No one denies the importance of this. Yet the shocking facts are that alcohol is a great contributor to traffic accidents. Recently published figures indicate that well over half of the fatally injured drivers have been drinking; among drivers responsible for fatal accidents, two-thirds have been drinking; and in one-car fatal accidents, seven of ten had been drinking.

The alcoholic employee is not an effective employee. The age range of employees with drinking problems is between 30 and 55; during these years they would normally

achieve their maximum value as productive workers. During these years potential management employees are lost for promotion because of alcoholism. If the employee must be replaced, retraining will cost from \$2,000 to \$10,000 per employee.

Morale of other employees, as well as supervisors, and management, is seriously affected by the presence of alcoholics. Public relations, and customer relations are seriously damaged.

These problems aren't new, and various approaches have been tried through the years by different societies to check the tendency to drink alcohol beverages to excess. The drunkard has been reviled, punished, excommunicated, ostracized, ridiculed, and often just plain tolerated depending on the laws, mores, and social class of the drinker or the circumstances of his drinking. Exertion of social controls over the consumption of alcoholic beverages to reduce the ills resulting from excessive drinking has been confined largely to nations of the West. A review of these attempts classifies them as follows: 1) Prohibition—making it illegal to manufacture, distribute, or consume alcoholic beverages; 2) indoctrinating people in the evil consequences of excessive drinking; 3) control—regulating the manufacture, distribution and sale of alcoholic beverages; and 4) substituting "counter-attractions," such as recreational facilities in isolated communities where drinking seemed to be the only release from boredom. Laudible as are the aims of these efforts, they have not been successful.

Failure is caused not only by the wrong approach, but also because there are some serious obstacles to treatment:

1. Many alcoholics are hidden and protected. The wife is powerless to control the problem and reluctant to disclose it lest she suffer a complete loss of income.

2. Most first line supervisors tend to protect the alcoholic employee until the problem becomes obvious and acute.

3. The alcoholic himself denies his disease and has insufficient motivation to seek help.

4. It is difficult to force the affected person to accept treatment. This is gradually being overcome, and 36 states now have some provision for involuntary commitment for the very serious alcoholic.

Little is done about the person who is still "functioning". In 10 states, courts may com-

mit an offender in lieu of a criminal sentence. The voluntarily committed alcoholic is generally viewed as a more favorable prospect for recovery than one who is forced to undergo treatment, but there is some opinion to the effect that compulsory treatment may have a special benefit for certain alcoholics, particularly those who refuse to admit they have a drinking problem and find it a relief to have treatment forced upon them.

5. There is a lack of consensus as to the cause of the disease. The medical profession now recognizes there are different types of alcoholism—some drink because of emotional maladjustments, some drink to avoid everyday personal problems. Others appear to drink because they have a physical addiction to alcohol. Some physicians maintain that excessive drinking is entirely an emotional problem, but others maintain that it is either a physiologic disorder or even a deficiency disease. With the causes of alcoholism so obscure and apparently varied, treatment has developed in an empiric and haphazard way.

6. Another reason for failure is professional antipathy to treating alcoholics. Few doctors, nurses, social workers, etc., choose to work with alcoholics, nor do their training institutions generally provide preparation in this field of work. This resistance arises in large part from the difficulties presented by the alcoholic himself. It is characteristic of this disorder that the sufferer will not admit he has a drinking problem, and they are known for lying and "playing games" with those who try to help them. Many physicians, including psychiatrists, avoid taking alcoholics as patients.

7. Lack of hospital facilities. The hospitals who specialize in the treatment of alcoholism are often suboptimal. Of 37 general hospitals surveyed in a large midwestern city, only four would take alcoholic patients with no other admitting illness. The explanation given was that it would put too large a burden on the nursing staff, whereas it is really a failure to view alcoholism as a disease.

8. Punitive treatment of alcoholism by law enforcement agencies. There is now a rising sentiment against throwing an alcoholic into a jail cell. Although experts in the field of alcoholism may disagree on causes, definitions, treatment, and many other aspects of the disease, hardly a single authority in any discipline concerned with the ques-

tion believes that jailing an alcoholic is the proper way to handle the problem. In two recent test cases it was ruled that jailing an alcoholic is not proper and is, indeed, a violation of his civil rights. The alcoholic is considered a public health problem and not a criminal.

In spite of the obstacles to treatment, much of great value has been done and is being done. Alcoholic treatment centers are rapidly being established by governmental agencies as well as by private funds. Of special note is the contribution Alcoholics Anonymous has made to the treatment of this disease. Founded in 1935 by two alcoholics—a physician and a stock broker—it has grown to an estimated 400,000 members. There is little doubt that more contemporary alcoholics have found sobriety through the fellowship of Alcoholics Anonymous than through all other agencies combined. Although the secret of their success is difficult to analyze, it certainly combines religious zeal with the advantage of group psychotherapy and group support. By their conspicuous success, they have also contributed greatly to a change in public attitude toward the compulsive drinker.

Up to now, this may have sounded like a pessimistic view of the problem. However, industry can and must play a key role in the control of this disease. Early recognition of the problem drinker is essential, just as early diagnosis is important in any other disease. First line supervisors can be trained easily to become our best case finders. It is well known that families, clergy, physicians, and even courts and law enforcement agencies find it difficult, if not impossible, to force the alcoholic to accept treatment. It is also well known that the alcoholic will go to almost any end to save his job. Therefore, industry, with the threat of the loss of the paycheck, can do more than anyone to make the alcoholic accept rehabilitation by applying constructive coercion. Industry is in the key position to keep the alcoholic employee working, and working effectively.

It may sound as if such a program in industry must be expensive and extensive. Neither is the case. What are the basic ingredients of an effective program?

1. Recognition of alcoholism as a disease. The notion that alcoholics are really sick people is not new, but it is only in recent years that it has generally been taken as a

starting point in programs to control alcoholism. An Edinburgh physician, Dr. Thomas Trotter, wrote in 1804 that "I consider drunkenness, strictly speaking, to be a disease produced by a remote cause, giving birth to actions in a living body that disorder the functions of health". He also said that heavy drinkers suffer "bodily infirmity" and that "the habit of drunkenness is a disease of the mind". He deplored the "injudicious and ill-timed chastisements of officious friends that ruin unfortunate inebriates who might have been saved by a different method".

Dr. J. Edward Turner, in Bath, Maine, proposed the rehabilitation of alcoholics in 1846. The Washingtonian movement proposed the same thing in 1870. Full professional acceptance of the medical nature of alcoholism was signified in 1956 when the American Medical Association approved a statement placing "alcoholic symptomatology" within the scope of medical practice. They also said general hospitals should have adequate facilities for treating alcoholics. The following year the American Hospital Association adopted the same position.

2. The second essential of a program is a written statement of policy. This may be a single sheet with a forthright statement, or may take the form of a more formalized booklet explaining alcoholism in detail.

3. The whole hearted understanding and support of management is basic to the success of any program.

4. Union officials should be consulted about the program, and their support obtained.

5. Education of management—especially first line supervision—in the early recognition of the problem and the technique of confronting the employee and referring him for help is the real cornerstone of an industrial program.

6. The program should be brought to the attention of all employees and, hopefully, to their families.

The type of program one wishes to have will be dictated largely by the size of the company and the facilities available. Any organized program in industry is called an "in-plant" program—this simply means that the essentials just outlined have been met and the industry is ready to deal with alcoholism in a realistic manner. Most large industries have a medical department and the alcohol-

ics program is part of their responsibility. This is the type of program we have at Illinois Bell Telephone Company.

The alcoholics counselor may be a physician, social worker, psychologist, or AA member working as part of the medical department team. This counselor works directly with the individual alcoholic employee. In other industries, the responsibility is assigned to another department such as personnel or labor relations, but the duties remain the same. Allis Chalmers is one of the pioneers in the use of this type of program and has been very successful.

A third type is an inplant program of detection and referral utilizing either outside individuals, groups, treatment centers, or community services for directing therapy. Regardless of the type of program selected, it need not be unusually expensive. Its success will really depend on meeting the essen-

tials of a good program as well as the zeal and enthusiasm of the person responsible for directing the program.

We have succeeded in rehabilitating 65 per cent of alcoholics who have been exposed to our program. We have had a sharp reduction in both off and on the job accidents in our rehabilitated employees. Their sickness disability record has been markedly improved. Efficiency on the job has been improved and in several instances has been so consistent that the employee has been promoted.

Our program at Illinois Bell Telephone Company has been in operation for about 11 years. It has gradually grown until now it is really more than a full time job for one counselor. We feel that the degree of success has been such that we can enthusiastically recommend it to management and to other industries.

ABSENTEEISM

By GERALD W. CRAWLEY, M.D.

Staff Medical Director, Western Electric Company, Chicago, Illinois

There is no secret to the reason why it is so hard to get a handle on the problem of "absenteeism" in industry.

The word itself denotes a negative person—a statistical omission. Thus, every effort we make to measure the impact of "the little man who wasn't there" leads us to the nagging suspicion that we don't yet know how to measure a void.

One figure we do have to prove that an employee is conspicuous by his absence is the bill for his direct costs—sickness benefits paid out by industry last year came to \$2.5 billion. Lost production and delayed work bring this bill to more than \$10 billion per year.

And yet, of course, we're trying to measure what a man might have done had he been there. We never do know exactly what the cost really is.

Similarly, we've never been able to measure with precision the factors which control absenteeism. We do know in a broad sense that, to have a man on the job, you must

have a man who wants to be there and who is physically able to be there.

In considering the factors which make a man *want* to be there, and the factors which make it physically possible, we will be able to isolate some factors over which industry and medicine can exercise some controls. These variable factors may not respond with the kind of certainty that we expect in a scientific age, but they do indicate that a great deal can and must be done for both the health of our workers and the health of our economy.

I want to emphasize at the start that these variable factors cannot be controlled by medical consultants alone. Indeed, by far the greatest burden rests on line management. Not only is a man's boss in the best position to evaluate and act on absenteeism, but more importantly he is the prime motivator. He does much to establish the atmosphere which makes a man *want* to come to work, he communicates the attitude of the company toward absences, and sets a level of

"absentee expectation" among the group he supervises.

Make no mistake about it, the control of absenteeism is a social as well as a medical problem. We can see this by simply looking at many of the well known patterns of absenteeism.

Age, sex and type of job are three constant factors which indicate this social aspect. All organizations must be familiar with them—the age curve, with its characteristic high incidence of absences among young workers during their first few years of employment, the sharp decline during the middle years, and a gradual increase in absences as the employee reaches long service. These frequent absences in the early years (when employees are by and large at their healthiest) is matched by the high absence frequency of women (who are also assumed to be healthier than their statistical counterpart, men). And, of course, both of these patterns of age and sex are characterized by short term absences. The other obvious social factor is type of job—again the well known pattern of shop workers being absent more often than office workers (despite no recognizable inherent physical reason).

All of which is to say that the environment of "absentee expectations" which the supervisor maintains is the prime factor in controlling absenteeism. But it is not to say that medical consultants do not play an important cooperative role. In fact, the industrial medical department is frequently and properly the catalytic agent behind management's efforts to create this environment.

The medical consultants should do more than help identify the norms for ability to work—healthful physical environment, proper clinical on-the-job treatment, and safety practices. They must become concerned with the environmental health of the "total man." This involves the mental as well as physical hygiene of the worker at home as well as on the job.

The need for this is dramatically borne out by the well known axiom that *off-the-job* accidents happen 10 times as often as *on-the-job* accidents. Actually, at Western Electric we find the ratio relating to absences caused by accidents at 11½ to 1.

But the need for total environmental concern goes beyond accident prevention to periodic head-to-toe health examinations and

counseling, convalescent progress at home and on the job, and day-to-day assistance on such twentieth century illnesses as (1) the presumed psychological pressures of automation, (2) the two per cent to four per cent of the total industrial work force suffering from alcoholism, and (3) the vastly increasing respiratory diseases of urban areas.

General Medical Director of Western Electric, Dr. Edward J. Schowalter, states that "our responsibility is not only to conserve the life and health of workers, but to have a positive impact on their families and on the community."

If this sounds like industrial doctors are taking on the medical role of the family physician, it is incorrect. Fifty years ago a family doctor could know the patient's total background—working and living environment. Now, family doctors find it harder to become familiar with the increasingly complex conditions of the work environment. There are, therefore, more environments today, and they're sharply separated. Together, the family and the occupational physician can truly practice environmental health, while separately they cannot do as much.

I have tried to set the stage for a discussion of the factors which control absenteeism by sketching a range of responsibilities which management, medical consultants and family physicians must share. Cooperatively they can, I believe, have a profound influence on absenteeism.

They can, for example, drastically alter the frequency and length of "illness" absences. Management has demonstrated this time and again by swapping supervisors between two similar departments. The absence record of the department tends to follow the supervisor.

The same is true for frequency of on-the-job accidents. We are all familiar with this phenomenon—management lets the emphasis on safety practices slip, and the accident rate goes up. Management then puts great emphasis on safety, and the rate goes down.

Another achievable goal is the shortening of convalescent periods by close private and company physician cooperation. We find that the patient's rehabilitation is enhanced by working, even if he must limit his activities at first. We strive to be aware of a man's abilities during convalescence, rather than over-reacting to his disabilities. At Western

Electric we find the following three steps particularly fruitful:

1. Acquaint private physicians with nature of work, requirements of Benefit Plan, and function of company medical staff. This has been accomplished by various means, ranging from simple phone calls to plant visits to open houses for community doctors. We find a direct correlation between the amount of familiarity a patient's doctor has with the company and the length of illness absences.

2. Visitation of sick employees to discuss convalescent progress. This visitation may be done by supervision or nurses. In the past we have utilized visiting nurses, but we are having our nurses primarily visit by telephone now. It is still company policy to have supervision visit the employee to show continued interest in the employee while he is disabled.

3. Once a patient is ambulatory, he is asked to visit the company dispensary. The ability of the employee to return to his regular job or to "light duty" can then be discussed between company and private physicians.

Obviously, this kind of close attention to employee's health, and to the work and home environments that contribute to it, can best be accomplished by an on-premise medical force. A company as large as Western Electric finds the effort not only a humanitarian necessity, but one which pays off in on-the-job performance.

The scale of Western's commitment to employee health can be seen in these figures.

—37 full-time and 99 part-time physicians; health and safety programs at 57 company locations; programs ranging from biomechanics to computerized epidemiological studies, and fundamental research in such varied fields as heart disease and laser hazards.

I appreciate that smaller companies cannot spread these costs across a large employee body. Many companies have found that private clinics can take on this vital medical-management partnership. Others depend on insurance benefit plans—a sure way to prolong absences. Many reports have indicated there is a tendency for length of absences to increase as benefits increase.

Sound management plan is essential to control absenteeism. It creates the psychological and physical environment conducive to good attendance. The cooperation of family and occupational physicians can do much to improve this attendance. This cooperation can restore the ill and injured to work as soon as possible and practice on a broad scale all that we mean by "preventive medicine." Management and medicine can make a contribution to the operating efficiency of the organization. But most important of all, a vigorous medical-management plan is a foundation upon which to build a healthy society on and off the job. As the pressures of our technological age increase, as our urban environment becomes more complex, it is imperative that we bring business and medicine together to seek mutual solutions to health and safety hazards.

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Page 55

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National Safety Congress
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NATIONAL SAFETY COUNCIL

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Papers Delivered in the

HOME SESSIONS

Five Years of Future Dates for the National Safety Congress	4
The Consumer's Legal Protection From Hazardous Products	Thomas F. Lambert Jr. 5
Safety in the Home	Marguerite Robinson 10

JOINT CIVIC LEADERSHIP SESSION

Outdoor Power Equipment Safety	Harold K. Howe 15
Outdoor Power Equipment Safety	Frank Burgmeier 16
Home Firearm Safety Depends on You	Warren L. Cheek 18

OFF-THE-JOB SAFETY

JOINT SESSION WITH INDUSTRIAL CONFERENCE

Opening Remarks	Robert F. Beeson 20
Developing an Off-the-Job Activity	Robert B. Regan 20
Safety Glass Demonstration	Thomas C. Klapperich 22
The Psychological Point of View	Howard Klopp 25
The Community Viewpoint	Janice R. Westaby 27
Industry Response	William J. Kerns 29
Members of the Home Conference 1967-68	35
Other Volumes in 1967 National Safety Congress Transactions	Back Cover

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CONTENTS

Responsibility—Safety's Most Effective Standard.....	Frank N. Ikard	5
DuPont Chambers Works—Off-the-Job Safety Programs.....	D. T. Smith	8
A Device to Neutralize Static Charges in Loading of Petroleum Fuels.....	R. B. Jacobs, W. L. Bulkley	9
Subsurface Foam Application.....	H. S. Mahley	11
Portable Combustible Gas Indicators.....	J. E. Zatek	15
JOINT SESSION WITH CHEMICAL SECTION		
Static Problems in Chemical Operations.....	E. L. Litchfield	19
United States of America Standards Institute Safety Standards	Henry G. Lamb	22
Systems Analysis—A Powerful Tool for Accident Prevention	Ernest Levens	25
Safety Motivation	Robert P. Hering	33
Resolved: That Injury Frequency Is an Accurate Measure of Safety Performance—A Debate.....	Harry D. Britt G. H. Perry Van Zandt B. G. Blanchard	36 37 38
Officers of the Petroleum Section 1967-68.....		43
Five Years of Future Dates for the National Safety Congress.....		45
Other Volumes in 1967 National Safety Congress Transactions.....		Back Cover

RESPONSIBILITY—SAFETY'S MOST EFFECTIVE STANDARD

By FRANK N. IKARD

President, American Petroleum Institute

It has been said that safety is at a crossroad, and that decisions taken now by industry and government will determine its whole course for the next few decades. This may well be the case. I am also certain that over the next ten or fifteen years your responsibilities will be considerably broadened. More of your activities may fall into the areas of public and government relations. Some may involve economic and social research. Future years should offer ample challenge, for safety is an integral part of the swift economic, social, and political change sweeping our country.

Recent proposals, by people both in and out of government seem to suggest that a manufacturer—aside from making a safe product—has an obligation to protect the consumer from himself. If these concepts are extended further in the future, a manufacturer will be held responsible for a product's performance long after it has passed from his control.

The petroleum industry certainly has its own case histories of how a complex, high-speed, highly industrialized society has brought about the expansion of safety concepts. For example, most people think of air pollution in terms of discomfort, crop damage, defacement of buildings, and possible effects on health. But at a recent air pollution abatement conference in New York City, automotive exhaust was tied to aircraft safety.

Furthermore, the new regulations covering automotive exhaust emissions, part of the Clean Air Act, are also spelled out in the National Traffic Safety Act. Our problems are becoming more interrelated with each passing year.

There is no question, of course, but that we live in a safety-conscious age. We are shocked when we turn back the pages of petroleum's history. Our present safety consciousness, however, has caused us to stretch concepts of safety to include the unknown and the unproved.

Our record is excellent, but a record, of course, simply deals with the past. Tomorrow's

safety people may be asked to tell what *will* happen, not what *did* happen.

Expanding concepts of safety are far from the only element of change that will affect your activities. Equally impressive is the expanding role of government in safety matters.

The safety movement has grown in a familiar framework of private and government cooperation. So far as the petroleum industry is concerned, most of the safety standards have been devised by people closest to the subject—the people in the industry itself.

The evolution of these standards has long been marked by extraordinary cooperation among interested associations and professional groups. In the American Petroleum Institute, for example, a central committee on Safety and Fire protection was organized as early as 1920. The committee operates on an interdivisional basis, cutting across all industry activities. It works closely with such organizations as the U.S.A. Standards Institute, the National Fire Protection Association, and, of course, the National Safety Council.

The system of cooperation among associations to develop rigorous safety codes and procedures has worked well. Further support for it was found in the feeling that no government agency alone could hope to acquire the intimate knowledge and expertise required to develop the safety procedures for a particular industry. Government has been a participant in the process through its review of standards and its monitoring of results.

Yet even though this system has worked, there is a growing feeling on the part of some in government that no industry can really be counted on to protect its customers and the public without government pressure. Underlying this feeling is a deep suspicion that consumer protection is a concept diametrically opposed to the profit motive.

The critics say, in effect, that if a company is wholehearted about profit, it is necessarily half-hearted about safety. But of course this view is fallacious, particularly when it applies to an industry dealing with hazardous materials. A company producing a

potentially dangerous product simply must place safety at the center of its philosophy or it would shortly be out of business. The most profitable companies are nearly always the manufacturers of the most dependable products.

As for working conditions within the plant gates of a company making such a product, it is obvious that an unsafe plant is not economical. Sooner or later an unsafe plant will breed accidents, and accidents cost money. Every law of reason, logic, and humanity shows us that only a safe plant will help a company reach its profit goals.

Yet the push for further government participation and control of safety is insistent. Currently a bill to control natural gas pipelines has been taken up by the Senate Commerce Committee. One feature of the bill may be of particular interest here. As proposed, federal safety regulations would apply to not only the natural gas interstate pipeline system, but also the gas gathering lines. There are some 62,000 miles of gathering lines, and of this total only 1.8 per cent are located within subdivided or urban areas. For the most part, the lines are in oil and gas fields, far from residential areas. While there were several accidents during the five year period from 1962 to 1966, not a single one occurred on lines located within the subdivided or urban areas. Yet federal control, under the proposed pipeline safety bill, would extend to an area with a remarkable safety record.

Still another element of change that may radically alter your responsibilities in future years is that of size. Nearly everything we deal with is growing bigger. The nation's metropolitan areas are growing larger, and concentrations of people invariably mean a complication of problems. Our facilities and equipment are growing larger. Our own industry sees the almost continuous development of larger tankers, bigger refineries, longer refinery runs, more massive offshore rigs, bigger everything. So far as our processes are concerned, the trend to larger size is accompanied by greater reliance on automatic controls. And, of course, this is happening at an accelerated pace.

An executive of a leading petroleum equipment supply firm recently estimated that half the tools and techniques now in use in the petroleum industry will be changed within a decade. He also noted that in some

supply companies, 75 per cent of sales can be attributed to products introduced in the past three years.

Our industry is not only changing tools, procedures, and techniques very rapidly, but we are among the leaders in utilizing automation. We were pioneers in the use of automatic controls, and today we are the second largest user of computers. Petroleum industry safety directors are already dealing with the advantages and problems of an automated age.

For one thing, this will mean more responsibility for safety people; certainly not less. More and better instrumentation will be required for closer supervision of all operations. Computers and better instrumentation will certainly help in projecting safety margins, and in monitoring and evaluating data, but the human factor will be more important than ever. All the instruments, computers and machines will mean more reliance upon the trained intelligence and perception of the men at the controls.

A picture of the typical company organization chart for several decades from now will probably show less people at the bottom of the pyramid. A large percentage of personnel will consist of managers and policy-makers. The chief objective of a safety director may be to eliminate his job as it is structured now. He would be needed, it seems to me, as a policy-maker and full participant in all company planning.

The next few decades ought to hold out a full measure of challenge and opportunity to those concerned with safety. To deal with these many changes successfully, we will have to rely on the timeless element of responsibility. For in the long run, responsibility is the real key to safety, as it has always been.

Here again, safety people have an obligation to take on a broader role. They should do more than just infuse an organization of people with a sense of responsibility in safety matters; they should work toward advancing responsibility itself.

This would represent a new approach, for most of our safety practices have grown from first hand experience. Pioneer oilmen developed safe techniques on a learn-as-you-go basis, because they were dealing with the unknown and the untried.

Even some of their tools and operations were developed on a hit or miss basis. For

example, the petroleum history books tell us about a compound that was developed by a chemist about 100 years ago.

No one was really sure what the compound could be used for. Many people burned it in lamps, because it looked like lard oil. Some people drank it, because it tasted a bit like whiskey. For a while the new compound was put up in jars and widely sold as a remedy for headaches. Evidently it had its followers; it was administered to Secretary of State James Blaine on his deathbed.

This sort of thing went on for a full twenty years—people using the product in various ways, and manufacturers selling it for variety of purposes. Then, one day, a consignment of the compound was jolted from the back of a cart and a sizeable explosion followed. So, after picking up the pieces, people finally discovered one of the more useful properties of this compound—nitro-glycerine.

For generations, first-hand experience has been our great teacher in developing safety practices. But in the future, safety people will have to reach out much more for opportunities to extend safety concepts. Of course, this is already happening.

In contrast to other days, when most of our thinking was directed toward the safety of the employees who worked in the plant, we are now extending this to the use of our products under any conceivable conditions.

If we can continue to do this kind of a job—anticipating the needs and then taking prompt action to correct them—we need have little fear that the responsibility for safety will be taken out of the hands of those who understand it best.

A sense of responsibility, of course, must extend from top to bottom of an organization if it is to be effective. The best safety program on paper is headed for failure unless it is understood and supported by the whole organization.

I am sure this must be a familiar thought to you, safety experts. But I believe the safety record in our industry gives the idea

special substance. In 1966, petroleum's industry frequency rate dropped five per cent, giving the industry a rate lower than many others. But it is important to remember that such figures are for the industry as a whole—production, transportation, manufacturing and marketing. It is significant that injury frequency rates are much lower than the total industry average where company management is concerned with the safety program. This is proof, I believe, that the petroleum industry operations are safest when top management insists on a high grade safety program to the degree that the concept of safety infuses the organization from top to bottom.

When it comes to the question of government interest in safety matters, here again the key question comes down to the element of responsibility.

Government, of course, has a large and necessary role in safety in our society. It is a role we readily acknowledge. But government should recognize the limits of what rules and regulations can really accomplish. It should recognize the dangers of over-regulation, which can defeat safety aims and retard responsibility. Certainly, government should acknowledge what self-regulation has accomplished in the past, and what it can do in the future.

In the long run, responsibility can be developed only when it is allowed to be practiced. The man behind the steering wheel of a car may be personally safer with a seat belt, but this safety device does not automatically make a safer driver.

So it is with our industry, our individual companies and the people in them. The wisest government policy is one that encourages the growth of responsibility, not stifles it.

In sum, safety people have a real stake in policies of both industry and government that would advance or retard responsibility. By taking an active interest in affairs that can foster responsibility, in the plant, in the community, or in government, I think you will be serving well both the public and the petroleum industry.

DUPONT CHAMBERS WORKS— OFF-THE-JOB-SAFETY PROGRAMS

By D. T. SMITH

Supt., Protection Div., E. I. du Pont de Nemours & Co., Inc., Deepwater, N. J.

The attitude of the duPont Company toward the safety of the individual off-the-job is the same as when he is at work; namely, that all injuries can be prevented. We feel that it is the responsibility of each employee to prevent injury to himself or to others. Efforts to achieve this goal in off-the-job safety are made by line organization while at work, as well as by fostering a great deal of employee participation in various off-the-job safety programs which also take place on the plant. This active participation in the conception, planning, and conduct of various off-the-job safety programs develops a feeling of commitment in the employee. This in turn favorably influences his attitude, and that of those around him, toward acceptance of the common safety goal.

The series of 50 slides illustrate some specific off-the-job activities.

1. *Organization.* A safety task force is appointed each year, made up equally of supervisory and non-supervisory personnel. One of the committees is devoted to off-the-job safety. Their job is to create activities to educate and encourage employees and their families to live safely. Their efforts reach employees through line organization in safety meetings, or by direct contact with employees and their families.

2. *"Falls" Program.* Employees posed pictures at home illustrating the various types of falls which can and have hurt Chambers Works people. These pictures were then published in the plant newspaper coincident with plant safety meetings held on the subject.

3. *"Hunting" and "Spring Home Hazards"* were developed and presented in the same way.

4. *Employee Demonstrations.* Selected, demonstration type, off-the-job safety programs were developed and presented by employees throughout the works.

5. *Automobile Safety.* This is the number one off-the-job safety problem. Driver education was done through a flannelboard presentation of the "Smith Driving System". Seat belt promotion and sale of seat belts through

payroll deduction was carried out. A "C.A.R.E." Program, standing for Courtesy, Attitude, Reaction, Equipment, featuring a C.A.R.E. package of driver hints plus first aid equipment, was well received. A display of wrecked cars, showing mannequins with and without seat belts, was effective.

6. *Boating Safety.* Employee members of the U. S. Coast Guard Auxiliary and N. J. Marine Patrol staged a display of safe handling and demonstrations of safe equipment on the plant.

7. *"Tots 'N Teens" Safety Poster Contest.* Children of employees, or those sponsored by employees, were encouraged to submit safety posters on plant furnished material. The local newspapers played this up big. Judging was by school groups, prizes were awarded by the works manager at a big shindig with refreshments at a local country club. The response was terrific.

8. *"Tel-O-Quiz".* A home safety slogan for the week, together with a brief safety message on the subject, was sent to all employees' homes. Names were drawn at random and employee's homes were called. A right answer won a small radio. This contest ran for eight weeks.

9. *"Cedar Post" Sign Boards.* Employees were invited to submit safety slogans, catchy phrases, and picture ideas for large sign boards posted at each of the plant exits. Recognition was given on the boards to the author. This program has been going strong for two years now.

10. *Mobile Safety Control Center.* "Safety Control" was the theme one year for the Chambers Works. Accordingly, an available 10 ft. x 50 ft. office-type trailer was fitted out with safety displays built by the employees. Many were animated, many were do-it-yourself, all were interesting. The trailer was moved to a new spot on the plant every week. Displays were changed quarterly throughout the year.

11. *"Safety Sand" For Slippery Surfaces.* This was one of the most popular items for off-the-job safety. Dried sand was packaged

in colorful, familiar, green and white "Safety Sand" half-gallon milk cartons. About 15,000 cartons were given away this winter.

12. *Holiday Weekend Live Displays.* In an effort to caution people to drive safely over holiday week-ends, the committee came up with special live displays featuring plant people with safety messages and hand-outs for the kids. This special program was sta-

tioned at each plant exit on the day before each holiday weekend. It may have been a coincidence, but only one person of the 7,200 people on the plant had a time-losing automobile injury in 1965 and 1966.

This completes the program. If you have gotten just one idea that might help the cause of your Off-The-Job Safety program, it has been time well spent.

A DEVICE TO NEUTRALIZE STATIC CHARGES IN THE LOADING OF PETROLEUM FUELS

By R. B. JACOBS and W. L. BULKLEY

Research and Development Department, American Oil Company, Whiting, Indiana

Most transports and aircraft are loaded without hazard or incident. These loadings are safe because the vapor space in the tank of the vehicle is usually over-rich with gasoline-type fuels, or it is too lean to burn with distillate-type fuels. Opportunities for accidents occur only when low RVP fuels such as JP-4 are loaded, or when distillate fuels become dangerously contaminated during their loading into compartments which previously contained gasoline (switch loading). Accidents do not occur every time a flammable mixture is present, because a source of ignition is also required. Static charges generated in the fuel during the loading sometimes provide this source.

The problem is complex. Loadings have been made safer by inerting, educting, using anti-static additives, pumping slowly, locating the filter and meter a considerable distance upstream of the loading nozzle, and others. While all of these stratagems promote safety, some are time-consuming and others are expensive or inconvenient. As a result they are not always practiced, and accidents do sometimes occur.

To alleviate such hazards, a new device has been developed for reducing the electric charge carried by the oil. Even though a flammable mixture is present and the oil upstream of the device is heavily charged, the chances for a static ignition accident can be substantially minimized.

Description and Operation

Electric charges (either + or -) are

usually developed when a petroleum liquid flows rapidly through a pipe. Charges opposite to those carried by the oil flow to ground. When positively charged oil flows into a closed container, such as a tank truck, both the oil and the vehicle become positively charged. If the vehicle is grounded, the charges that have made their way to the exterior of the vehicle will flow to ground. But the important point to note is that charges still exist throughout the oil inside the grounded vehicle; i.e., grounding has not made the vehicle safe. Ignition can occur when a spark of sufficient energy jumps from the highly charged oil surface to some nearby grounded metallic object such as a fill pipe.

Our measurements have shown that a charged oil surface no larger than one foot in diameter can furnish sufficient energy for an incendiary discharge, and that as much as 20,000 volts are developed on the surface of an oil carrying 30 microcoulombs of charge per cubic meter. Yet, this is not a high charge density; charge densities as high as 300 microcoulombs per cubic meter are frequently encountered in flowing oil. Voltages necessary for sparking in some typical configurations range upward from 12,000 volts.

On a stiffener of the type frequently used in aluminum transport trucks, sparking can occur from two points—at 14 and 27 kilovolts, respectively. Ample charge and voltage for sparking are therefore common within fuel compartments even with moderately charged oils. However, our tests indicate if

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CONTENTS

Calculated Safety	<i>Linda L. Wright</i>	4
Insulating Hardware — A Challenging Opportunity	<i>Arthur L. Lewis</i>	7
Safety — Management Right or Management Privilege	<i>Wade W. Larkin</i>	10
Common Accidents and Methods of Prevention	<i>Donald L. Stevens</i>	15
Safe Handling of Pipe and Fittings	<i>Kenneth R. Boyd</i>	18
Safe Trenching Practices	<i>William A. Herrscher</i>	20
The Gas Industry's Off-the-Job Safety Activities	<i>Alex Pierson</i>	25
Five Years of Future Dates for the National Safety Congress		29
Officers of the Public Utilities Section 1967-68		30
Other Volumes in 1967 National Safety Congress Transactions		Back Cover

CALCULATED SAFETY

By LINDA L. WRIGHT

Information Representative, United Fuel Gas Co., Charleston, W. Va.

Someone once said that the ideal ages *must* be four and twenty. At four you have all the questions, at twenty you have all the answers. We at the gas company don't have all the questions or all the answers. But we do have a pretty good reply for a new employee who asks: Why does the gas company have a safety program?

The answer to this question is very simple: First, the company has a sincere interest in the well-being and welfare of its employees; an injury to one is an injury to the other. Second, we feel we can contribute to public safety by training our drivers to be safe. If you were to ask any other businesses why they have safety programs, I'm sure you'd get the same answers.

When it comes to promoting safety, most companies go all out. They use billboards, letters, magazines, and any other way they can think of to drill safety into the minds of their employees. You may think that a program like this is a waste of time because nobody is going to have an accident or cause one on purpose. You'll find, though, that organized safety programs are effective and do help reduce accidents by making people safety conscious.

Of course, it's easier to convince a person to be safe on the job because to be unsafe may cost him a promotion or even his job. But off the job it's a different story. We are all guilty of taking chances at home that we wouldn't think of taking at work simply because the boss isn't looking over our shoulder or evaluating our performance. But we should know that the stakes are just as high and maybe even higher.

All sorts of accidents happen in homes and on farms. Many of them are caused because somebody forgot to be safe. For example, a train had run over a cow, and the farmer was suing the railroad for damages. During the court proceedings, the lawyer for the railroad had the train engineer on the stand and was asking him a lot of meaningless and long questions. The engineer was getting pretty fed up with the whole thing when the lawyer asked: "Was the cow on the tracks?" Well, that did it. The engineer had had it. "No of course not," he shouted.

"She was in a field half a mile away. But when it saw her, the engine left the rails, jumped the fence, and chased her across the field and up a tree. There it strangled her to death."

Either the farmer or the engineer might have prevented that accident. The farmer could have made sure the gate was closed. The engineer could have slowed the train, presuming of course, that he had time. Both men were probably taking chances.

Now there's the heart of the matter: Why do people take chances? Why do they have accidents? A lot of scientists are trying to find answers to these questions, but I'll bet I can give you five reasons that will pretty well explain why accidents happen.

In my book, the first cause of accidents is that people do not read directions. There's an old saying that goes, "When all else fails, follow directions." That may be OK when you're talking about putting a toy together. But when your safety and personal health are involved, you'd better read the directions first.

(Visual-hair spray). This can of hair spray is a good example of what I'm talking about. On the back it says: "Caution: Flammable. Keep away from fire or flame. Do not spray in eyes. Do not puncture or burn this container. Keep in cool place." Now that's a pretty stern warning, but evidently some people don't read it or if they do they don't seem to follow the directions. One woman found out the hard way. She was using hair spray in a bathroom. When she lit a cigarette, the spray ignited and burned her so severely that she died two days later.

Many other products in aerosol cans are flammable, so please read the directions carefully and use accordingly. Incidentally, no matter what the product is, don't puncture an aerosol can or throw it into a fire. The can is under pressure and heat will make it explode. The can, or pieces of it, packs a mighty wallop when it's unleashed by an explosion.

(Visual-bleach bottle). Reading directions on this bottle of bleach can save you some real heartaches too. The directions say not to mix the contents with other household clean-

ers such as ammonia. Bleach combined with acid cleaners creates a cloud of deadly chlorine gas. One woman either didn't believe that or she didn't read the directions. She mixed bleach and ammonia and got a big whiff of the fumes. She was lucky and only had to spend a few weeks in a hospital. But in a similar case, another woman wasn't so lucky.

Don't take a chance by mixing bleach with other cleaners. It should never be mixed with lye, rust remover, oven cleaner, or even vinegar. It's better to be safe than sorry if there's any doubt in your mind about mixing cleaners.

I guess by now you've all been wondering what this blinking gadget is. Well, this is a safety computer, and it is used to compute answers to safety problems.

After some rugged training, I learned how to use the computer, and in a few minutes I'll show you how it works. I think most of you know that a computer can't think for itself. You have to put information into it before it can calculate anything. Most computers have to be fed information punched on a small card. This computer uses cards, but of a special variety. The printing is magnetized and the machine's brain reads the magnetic code and then does the computations. Incidentally, here's what the computer's brain looks like (*visual-transistor*) . . . it's called a cathodic electroservimetric binary inductogenic magnegrid diode. Here are the cards illustrating my first two examples of "didn't read directions" accidents. I'll put these in the computer and later add cards for other causes of accidents. When they're all in, we'll ask the computer to tell us how to prevent accidents. Just so you don't forget the various causes of accidents we're analyzing, I'll list them here (*pulls card out*) as we go along. "Didn't read directions" was the first cause. Now let's go on.

The second reason people have accidents is because they think they're rushed for time. The classic example here is the man who rushes out the door, steps on a roller skate, (*visual-roller skate*) and goes sprawling to the ground. In all probability, somebody didn't take time to pick up the skate and put it where it belonged. Falls account for more home injuries each year than any other hazard. I haven't seen any breakdown of the statistics, but I'll bet most of these falls are caused because somebody thinks he didn't have time to remedy a situation like picking

up toys. (*Puts roller skate card in computer*).

"I didn't have time" is a lame excuse for sure, but I guess we're all guilty of it to some degree, either at home or on the job, but more often, in an automobile.

For example, one fellow I know almost got killed because, as he put it, "I didn't have time to replace the tire." He knew there were some defects in one of his tires and he even had a new one in his trunk to replace it. But he kept putting off the task until one day on an expressway the tire blew out. He ended up in a hospital looking like a giant roll of adhesive tape and his car went to that Great Junk Yard in the Sky. All because he didn't take 15 minutes to get the tire changed.

(*Visual-glass jar*). Here's another example of an "I didn't have time" accident. Let's pretend that this is gasoline and that it was put in this glass jar by a fellow who was in too big a hurry to put it in the proper container—an approved metal can. Just think how easy this glass jar would be to break and catch on fire? It has happened several times—please don't let it happen in your home. Take those few extra minutes to put a combustible liquid in the proper container and store it away from heat. Believe me, you'll be glad you did. (*Puts gasoline card into computer*).

Reason three for accidents: people don't know a product is dangerous because there's nothing about it that indicates danger. I have two good examples and both are advertised in shop-by-mail sections of newspapers and magazines. Here's one: an aerosol fire extinguisher. It makes a good paper weight but that's about all. It wouldn't even put out a small fire because there isn't enough extinguishing agent in it. Some of these extinguishers contain toxic chemicals that are dangerous to breathe, some have even exploded in the user's face. To my knowledge, none of the aerosol extinguishers are approved by Underwriter's Laboratories. If you want a good fire extinguisher (*Visual-fire extinguisher*) invest a few dollars in an approved two-and-a-half pound dry chemical type like this. (*Puts fire extinguisher card into computer*).

Here's an interesting little novelty (*Visual-flashlight*). Would you ever expect that this flashlight could burn down your house? It can. This particular flashlight is imported and has no brand name or testing laboratory

label. To recharge the battery the instructions say plug the unit into an electrical outlet and leave it overnight. Some people in Washington state followed those directions and they found that the unit overheats and catches on fire. To leave it plugged in overnight could be disastrous. If you have a rechargeable flashlight, check to see if it has a brand name and testing label. If it hasn't, get rid of it. (*Puts flashlight card into computer*).

The fourth cause of accidents is usually described after the accident, when somebody says, "I didn't think so-and-so." And you can add your own ending to that—I didn't think the gun was loaded, I didn't think it was really dangerous, I didn't think it would explode, etc. People who usually end up saying "I didn't think," realize that something is dangerous if the danger is pointed out to them in advance. But for some reason, they don't think in advance for themselves and consequently get injured. Here's a prime example of this (*Visual-carbon tet*). Imagine that this is carbon tetrachloride. Most people know carbon tet is an extremely hazardous liquid, yet they go on using it to clean upholstery, ranges, and any other thing that is greasy or oily around the house. The fumes attack the vital organs, especially the kidneys. In New York City, a mother used half a cup to clean a chair. That afternoon her seven-year-old daughter came home from school with a slight cold and sat in the chair to watch television. Later the child became so violently ill that she was taken to a hospital where doctors found her kidneys had stopped functioning and she was near death. It took ten doctors, an artificial kidney, and six weeks in the hospital to keep the child alive. But a young man in New Jersey wasn't so lucky. He died as a result of using carbon tet to clean his shoes in a closet.

You may think that opening a couple of windows will eliminate the hazardous fumes, but accident reports show that won't do the trick. Outside the house, some authorities don't consider carbon tet to be a great hazard as long as the wind blows the vapors away. But there are a lot of "ifs" in using carbon tet, so why take any chances at all when there are less toxic cleaners on the market? (*Puts carbon tet card into computer*).

(*Visual-Aspirin*). This item usually brings cries of, "I didn't think the baby could get to it or could get it open." This is

flavored aspirin for children. Aspirin bottles warn you to keep the aspirin out of children's reach. Despite the warnings, aspirin poisoning is the number one drug killer of children. And don't underestimate youngster's efforts to get to it, especially if it's flavored aspirin. If kids think there are some orange-flavored candy pills around they're going to go after them. That's why you should never tell a child that he is eating candy when he's taking flavored pills. By all means, keep aspirin and other drugs safely out of children's reach or under lock and key. (*Puts aspirin card in computer*).

The fifth reason for accidents I just can't explain. That's when somebody has read the directions, has plenty of time, knows the product, thinks about it and still takes a chance. Maybe it's a gambling instinct that makes a person do foolish things; maybe it's a desire to show others that he's daring; maybe he's just trying to get injured. I sure wish I knew the answers.

The only thing I know that I can show you to illustrate this reason is this dunce's hat. Anybody who knows the safety rules and then disregards them should wear one of these. (*Puts dunce's hat in computer*).

Now all the information is in the computer. On this card is a question: "What can we do to prevent accidents?" I'll put the question in and let the computer give us an answer. (Turns on computer, looks bewildered—reaches in and gets tilt card).

Good heavens, it looks like the computer had more than it could handle. What it should have said was: read directions, take time to do a job properly, know the product you're buying, think a little bit about what you're going to do, and by all means, don't take reckless chances. That's wise advice from a machine—but you're probably wondering how you can be safe.

There are a lot of things you can do to be safe at home. (*Visual*). Take this apron for example. If you are going to be working with combustible liquids, you should wear one of these so your clothing won't absorb any of the liquid and make you a potential torch. (*Visual*). Rubber gloves like these can protect your hands against caustic chemicals and any rough material you may be working with. (*Visual*). If you are going to be around any loud noises you will need a set of silencers like these. Many people underestimate the danger of loud and continuous noise. (*Visual*). Goggles are also important

safety items. With them on, you might feel like a monster from outer space, but one thing you won't feel is the pain of something hitting you in the eye. (*Visual*). For head protection you can use a safety helmet like this. Most industries require employees to wear one of these if they are going to be any place where something could drop on them. (*Visual*). Last but not least are these boots. Getting something dropped on your foot is

sure no picnic. Hard-toe boots like these may look pretty clumsy, but they will protect your feet from most things you will be dropping.

I guess I look pretty silly with all this on. But my point is this. You don't have to go to extremes, as I have done, to be safe. Simple rules of patience, courtesy, and common sense are *your* best guides to a safe secure life.

INSULATING HARDWARE—A CHALLENGING OPPORTUNITY

By ARTHUR L. LEWIS

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Public Service Electric and Gas Co.,
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A Lineman-Grade 1, age 25, with approximately five years of service, was fatally injured by electric shock resulting from a primary wire making contact with a pole pin bracket. The investigative report read in part as follows.

"Conclusion: Victim's upper arm came in contact with an energized through-bolt of the bracket. Circuit completed through foot with the secondary rack.

Recommendations: 1. That all Line Department personnel be reminded to be on guard at all times for possible hardware electric shock hazards created by insulator factors or accidental contact between conductors and metal pole-top parts.

2. That all linemen be reminded always to assume a working position where their spurs are in wood and their feet and legs cleared of uncovered metal equipment and conductors. When this is impracticable, a lineman's platform shall be used.

3. That the Transmission and Distribution Engineer's Office investigate methods of reducing these hazards."

The function of the electric utility is the generation and distribution of electric power. To distribute this power, metallic conductors are required. If these were the only metal on our distribution lines, our linemen would be very fortunate. The work of a lineman, though, may be hazardous since much of the other equipment on our poles is metal. In

fact, even the creosoted pine pole is a fairly good conductor of electricity. Most of the accidents we experience are not just due to contact with a conductor, but due to a simultaneous contact with a ground path for the current. It has been our aim, therefore, for the past few years to reduce the hazard by replacing metal items with nonmetallic items.

The story of the increasing role of nonmetallic materials in the distribution plant of Public Service Electric and Gas Company starts with a snow storm in March, 1958. The damage in some of our areas was so devastating and lengths of outages were so long that our company decided a change in construction design to improve the strength and storm resistance of our distribution plant was necessary. The resultant change was the adoption of spacer-cable and lashed-cable as the standard for three-phase distribution, and the adoption of a high-strength conductor on a ridge pin for single-phase distribution. After a sample area installation, management approved the high-strength construction not only because of reliability but also because of the improved appearance. Experience in storms since 1958 has verified the improved reliability of the new construction.

With the decision in 1962 to establish 7.6/13.2 kv distribution as a standard voltage, similar primary construction consisting

of high-strength insulated wire for single-phase and spacer-cable for three-phase was adopted. With such an insulated plant and realizing service interruption or duplicate facilities for maintenance of lines was impractical, it was apparent the new construction would have to be worked on with rubber gloves rather than hot-line tools. After many laboratory and field experiments involving both management and union, it was proven to everyone's satisfaction that the construction could be safely worked from either an insulating lineman's work platform, or an insulating aerial lift truck. Detailed work practices and minimum construction standards were developed for the Company.

Nonmetallic Hardware.

In examining the pole top for changes, it seemed necessary to have greater clearances between the working position of the lineman and ground, and greater clearances between conductors at points where the man would have to work. Up to this time, the tangent brackets and ridge pins had been made of steel. We decided to look into the possibility of using some other basic construction material. Glass fiber reinforced plastic materials were being used for car and truck bodies, boat hulls, fishing poles, golf clubs, radio antennas and many other products. This material has high strength, light weight, and high dielectric strength among many characteristics. One large supplier of line tools and equipment had been using "Epoxiglas" for several years to replace wood in hot-line maintenance tools. In collaboration with these people, we developed the initial line of nonmetallic hardware using tubular components similar to hot line tools.

Since that first attempt, there have been many rapid changes in design. There have been no fixed guide lines, and there has had to be a great deal of trial and error work. Other reputable manufacturers have joined in producing similar line hardware for us, and slowly we have developed certain criteria to evaluate the new products. Our first thought was to use a nonmetallic material to substitute for the steel in order to remove the metal ground from the vicinity of the lineman. While it does do this, the increased electrical impulse levels also obtained have been of great value, especially with items such as corner brackets, which were a weak spot electrically in our spacer-cable plant.

Now, what do we have in the way of

nonmetallic hardware, tools, etc.? We now have ridge pins, corner brackets, and adjustable brackets for single-phase construction. We have two-phase brackets, and by combining these with the single-phase bracket, we can handle three-phase open wire. We have light-duty and heavy-duty tangent brackets, corner brackets and a pole-top extension for spacer cable. Nonmetallic preformed ties used to hold wires in place were initially developed for both the spacers and regular insulators. Thirteen different ties were required, so we have been developing with another manufacturer a single universal tie to replace the thirteen styles.

The guy wire has always been a dangerous piece of hardware, providing a current path in many accidents. We have been using a 78 inch fiberglass strain insulator at the pole end in all guying of 13 kv construction. We have also been experimenting with fiberglass rod as a guy and have quite a few trial installations. So far, after over two years in service, they show no deterioration and have been well received by the linemen.

One of the smallest pieces of nonmetallic hardware is our underarm bracket or "L" hanger. This item is one of our most recently adopted and is now in full production. It will be less expensive than its present plastic dipped metal counterpart and will also be used in underground work to take the place of the small metal hanger and porcelain saddle used for secondary cables.

About the largest piece of grounded metal on a pole is a transformer tank. We have several nonmetallic tanks in trial use, and the designs so far show great promise. We also have portions of several 26 kv lines built with nonmetallic hardware. Using this hardware has allowed us to build open-wire lines through residential areas without unfavorable reaction and also along narrow rights-of-way.

Each of the manufacturers has attacked in different ways the problems in attaining necessary strengths. They also have different ideas about what coating will provide the longest life and best tracking resistance.

Our original manufacturer of line hardware uses for structural members a tube of filament wound glass fiber in an epoxy resin around a foam core. A second supplier uses a solid fiberglass core surrounded with filament wound glass fiber in an epoxy resin. A third supplier uses matched metal dies to

compress and cure chopped glass fiber in polyester resin around a selected wood core. Each manufacturer uses a different finish coat, and the insulator threads are made of several different materials.

The specifications we have given for many of our items are listed in the attached table. Time will help tell how adequate these specifications are and how the various finishes will stand up in actual practice. Initial tests of the first nonmetallic hardware were made on a 13 kv test line in one of our switching station yards. A 26 kv test line was also built and is still in use as an accelerated life test for equipment. Recently, our testing laboratory completed an excellent fog chamber, where we have been making accelerated life tests of the ties, ridge pin brackets, spacers, and other associated equipment.

While one manufacturer has excellent testing facilities, most of the other manufacturers have had to go to independent laboratories, or we have made their tests. As the other firms have been getting into more utility work, they have been adding to their own testing equipment.

A Plastics Products Task Force of the Edison Electric Institute was formed in early 1965 and has held several meetings. I hope this group will assist in the standardization of specifications as they would be doing an excellent service to the industry and the manufacturers.

Safety Record.

At the time of our decision to go to 13 kv distribution as a company-wide standard, we had only a small amount of 13 kv open wire operating in one development. This was bare wire and was handled at that time with hot-line tools. The installation of the new 13 kv construction has been such as to avoid expansion of the existing 4 kv substation facilities. This has meant that 13 kv construction has been installed in the most rapidly growing areas and that a major portion of our work is now in 13 kv areas.

At the end of 1966, we had 386 miles of equivalent three-phase 13 kv open wire construction while the equivalent 4 kv construction has dropped to 3,902 miles. Almost all of the 13 kv open wire is in single-phase construction so actual miles of pole-line exposure are quite high. The 13 kv aerial cable (spacer) is now up to 645 miles while the 4 kv cable has now dropped to 2,186 miles.

The safety record has been excellent even

with approximately 15 per cent of our facilities in 13 kv construction and a great deal of our work in these areas. We have not had a disabling injury or contact accident on this new construction through the first half of 1967. In the same period, we have experienced on 4 kv construction 18 flash injuries, and six contacts—of these two were fatal while the other 22 were lost-time accidents.

In July of this year, we had a disabling flash accident—our first on 13 kv and it occurred under very unusual circumstances. Two-phase wires of a 13 kv spacer cable had burned down during a lightning storm and were hanging clear of the ground. Due to a nearby automobile accident, a lineman was stationed near the wires to keep spectators clear of the area. The two wires came together causing a flash that set the lineman's trousers on fire.

The new construction standards, along with new work practices, safety rules, and tools have been responsible for our record. We cannot say which has been the most important factor. To go back, though, to the accident described at the beginning—if the new construction in use today had been on that pole, that man would probably be alive today.

Conclusion.

We have been encouraging other utilities to use nonmetallic hardware and tools. We know that some items at the present time will be more expensive than their metal or wood counterparts. The question, though, is not just initial expense, but what will be the mass produced cost, what will be its life, is the appearance better and, most important, is it safer?

The value of a life saved is a hard thing on which to put a price. We feel we are preventing many injuries and possibly saving lives—the added expense, at this time, of the nonmetallic hardware and insulated tools is worthwhile. Our goal, which is still high in the sky, is to develop a pole top on which the only metal is the conductor. The plastics industry has the knowledge and experience to aid the electric industry in working toward this goal. We need to develop stronger materials and more track-resistant finishes. We need items from bolts to poles as good or better than their metal and wood counterparts. It has been and is "A challenging opportunity" for Public Service, and I hope it will be for some of you.

SAFETY — MANAGEMENT RIGHT OR MANAGEMENT PRIVILEGE

By WADE W. LARKIN

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Since the beginning of the Industrial Revolution, and even before in the small craft units performing such manufacturing tasks as there were then, the right to establish safe working conditions and develop a safe working climate has been vested in the management of the enterprise. The burden of proceeding toward safety logically gravitated toward the leadership of the organization, and the right to do something safety-wise became managements. This right existed virtually without challenge for almost 200 years.

For every right, or privilege one has, there is an accompanying obligation. In this instance, of course, it was management's obligation to maintain working conditions and the working climate in such a state that safety was an obvious result. Evidently management didn't maintain its obligation properly, because it is fast losing its right, or even privilege, to direct its own safety program.

You know, and I know, that this loss of management rights did not occur overnight. We are also both quite aware that the sociology of our times is changing, and this change in social responsibility is having its effect on the dilution of management rights. If we are wholly objective with ourselves, however, we know that in the Labor-Management-Government triangle, action flows in areas where the greatest vacuum exists. Evidently we, as management, had left a pretty large vacuum in the safety area, because labor and government action is surely flowing into the safety arena at the present time, and at an amazing rate. If management hasn't already lost the ball game it, in my opinion, is in the last of the ninth with two out.

I am not going to burden you with a lot of documentation as to how we got ourselves into this jackpot, because I am sure we can all recall instances in our own companies where a little awareness, a little foresight, or a little empathy would have avoided an industrial accident that shook the company from top to bottom. When management is shaken, and let's face it, management doesn't

shake too easily, you can be sure that others are shaken even more so, and the vacuum we have created by not living up to our obligation begins to fill with "protective balms" from labor and governmental sources.

There are those who feel that maybe a two-party or a three-party responsibility for safety might be a good thing. They feel that a certain abdication of management rights here might be worthwhile. Management could get off the safety hook, where they now are all alone. If all of the parties to this trilogy of safety responsibility could be wholly altruistic and non-adversary in their approach to safety, it might be all right, but believe me they cannot be.

Whenever government, particularly the Department of Labor, is brought into a dispute between management and labor, we all know whose side the government is going to take. Labor is using the safety route to gain many of their objectives that they could not get at the bargaining table. Some of the softest featherbedding in the railroad industry has been accomplished under the guise of safety, and this practice is rapidly spreading to many other industries. Please do not feel that I am castigating the union leadership for doing this—the very nature of unionism virtually requires the union to seize on every available opportunity to further their objectives. If I were a union leader, I would do the same thing. The union leader who does not recognize this is soon out of office. I do not criticize this practice *per se*; all I am saying is that management must be aware that it is a fact of life.

As an example unions object to their members having to wear insulated hard hats, even though this is a matter of state law, but conversely, fight for code regulations that require two men on a pole under certain working conditions. No one can deny the need for insulated headgear when working near or on energized equipment, but there are many cases where two men on a pole actually doubles the hazard as far as an accidental electrical contact is concerned. Yet because this presumably provides more work for the membership, under the guise of safety, the

union actively pursues the establishment of codes and regulations requiring two men on a pole, knowing full well that all attempts to obtain this at the bargaining table have failed.

Another example is where the unions attempt to prevent any work being done on electrical systems where the exposure voltage is over 5,000 volts except with hot sticks. The union knows full well that there are many instances where work with Class III rubber gloves is fully safe up to 8,650 volts maximum exposure voltage, and they know that their sister locals all over the country have agreed by contract to glove 8,650 volts; but because hot sticks provide more work for the membership, they try every means to obtain a 5,000 volt hot stick clause.

As soon as they are successful here (and in some states, in some utilities, they have been), they immediately attempt to obtain a pay increase for a hot stick lineman on the pretext that he has more skills than one who uses rubber gloves—and so it goes. I am not criticizing this procedure, I am merely stating a fact of life.

When management loses its unilateral right to be responsible for the safety program, all sorts of things can and do happen to management because of it.

Labor and government together are marshalling their forces to consolidate their gains as fast as they can. Nationally, they are promoting a variety of techniques to do this. The IBEW, the International Brotherhood of Electrical Workers, are preaching joint labor-management safety committees. The IBEW has been instrumental in establishing over 800 safety committees. I do not want to intimate that this is all bad. We at NSP have them, and they are basically good. There are many labor-management safety relationships that are truly non-adversary. Many responsible locals have told their membership that the union has agreed to a certain safety program, and you, Mr. Union Member, are going to follow it.

A story making the rounds in our shop has to do with the labor-management relationship in the safety area. Presumably, it was to represent the unanimity of purpose in this area. A first-line supervisor had met with an unfortunate industrial accident and the poor guy was in the hospital recovering. The union representing the men working for him thought it would be a nice gesture to send him a "get-well" wish. Under the Landrum-

Griffith Act it is necessary that everything be handled in a democratic manner. The note as finally delivered said, "Local Union 928 wishes you a speedy recovery by a vote of 18 to 17".

Alan Burch, Safety Director of the International Union of Operating Engineers, at the last National Safety Congress said that the National Labor Relations Board, has answered the question, "Should safety be negotiated in union contracts?" He's right. The NLRB has ruled that safety is a mandatory subject for collective bargaining. This decision was cradled right in my own industry. The Gulf Power Company of Pensacola, Florida alleged that a Florida statute required all electric utility companies, as a matter of regulation, to exercise a high degree of care in their public utility operations. They alleged that if they were to comply with this regulation, they must have a unilateral right to establish safety rules and regulations. The NLRB not only said, "No", they said, "Hell, No!" No regulatory commission, they said, could pre-empt the field of regulation to a point where they excluded the concept of collective bargaining.

Canada, of course, historically has been far ahead of us in what they prefer to call social reform. John Dowling, Safety and Health Division, United Steelworkers of America working in Canada, says that their safety programs in Canada have some real teeth in them. Under circumstances where an employer fails to comply with some provision of the Industrial Safety Act, the employer, upon conviction, can be fined up to \$1,000 for each day the infraction exists, or can be imprisoned for not more than 12 months for each day of infraction. Mr. Dowling also recommends that all safety codes be in such language that all working people can fully understand them. Surely we can't argue over the value of clear language, but we all recognize that many safety provisions cannot be all black or all white. It may be presumed that Canadian management has to give their employees very precise working conditions, or they could well end up fined or in jail. Is the U.S. only a few steps behind in this type of safety regulation?

My purpose in discussing these things, of course, is to prove my point that management rights are fast being diluted, and that management rights in the safety area today are greatly reduced over even a decade ago. If management is to continue even to have

the privilege of participating in the safety program, it is going to have to wrest back from labor and from government, the leadership required to direct the safety program in the direction it should go.

When management had the ball all to itself, why did it drop it? Was it because it didn't recognize the nature, the causes, and results of accidents? No; I don't think we can say management's failure was in recognition. Surely when we look at the management-developed accident classifications and accident statistics, we can't say that lack of recognition of the nature, the causes, and the results was management's failure.

Was it because management didn't understand the principles of accident prevention? Some managements understand accident prevention better than others, but all managements know that they have to establish and eliminate both potential and actual accident causes. They learned very quickly that they had to detect unsafe conditions promptly through inspection. They also learned that all supervision had to detect unsafe work practices promptly. They saw intuitively, that they had to identify the sources of the unsafe condition or practice, and further saw that they had to look for the personal factor causes of accidents. Some managements did better than others, but failure to understand the principles of accident prevention did not bring management's downfall in the safety arena.

Was management's failure due to "lack of program" in the safety area? No, I don't think that management lacked program. Some programs are probably better than others, but programs we've got. Whether it's a job safety analysis, the tailboard conference, the regular safety contact, the safety training for new men, the discussion method, the planned safety inspection, or the investigation of accidents—all are programs which are based on the premise of fewer future accidents, and lack of program cannot be assessed as a management failure.

How about job safety training? Here I think we can give some managements a poor grade; not many failures perhaps, but surely very mediocre performance by some managements. As the individual worker, or the whole crew becomes more experienced in their job, there is a natural tendency to skip the oft-repeated safety training steps. The initial safety orientation for the new situation, the initial job instruction, the pre-job

safety instructions, the planned safety contacts, and the correctional safety contacts are all training routines that must be followed on a *continuing* basis if safety training is to maintain its effectiveness. Did management fail its safety training course? No; I don't think average management failed here, but it surely could have gotten a better course grade.

I've talked a lot about where management made the grade, and at the same time I have continually alluded to the fact that management failed. Where *did* management fail? In my opinion, in two areas: first, in failing to motivate employees to work safely and, second, in handling the safety problem employee.

An immediate reaction to these two past statements would be, "Well, if management's failure lies here, so will anybody else's." I'm not quite ready to say everyone else would fail here. Motivation is essentially synonymous with selling. Failure to motivate is really failure to sell. The welfare of most enterprise controlled by the same management we have been talking about this evening lies in the ability of the organization to sell its merchandise. If the safety function had the same impact on the business as the selling function, I think we would see some marked improvement in our ability to motivate employees to work safely.

If this were the case, management would immediately begin to recognize what the motivation problem is. Management would quickly face up to the fact that: (1) men are not always willing to do what they know they should for the sake of their own safety; (2) almost all workmen will now and then risk an unsafe practice; and (3) men will sometimes deliberately elect to work unsafely because *other* motivations often conflict with, and win out over the motivation to work safely, and some men just like to work unsafely for the "hell of it".

In a selling situation, if a marketing organization sees that other merchandise is bought even though it is of inferior quality, and if it sees that other merchandise is bought just because the buyer wants something different, or if it sees other merchandise bought because someone or something else does a better selling or motivating job, corrective action is immediately taken! Personal contacts are made, the best sales people are brought into the act, special presentations are prepared and made, and much ef-

fort is expended to correct the defecting situation. Not so when safety motivation lags; if no immediate accident occurs, it is usually dismissed with a shrug of the shoulder—no significant impact, no significant action.

Throughout this discussion I've been quite critical of management in the safety area. It would be wholly unfair if there weren't some positive actions recommended for management's consideration.

One of management's principal failures in safety programs was to motivate men to work safely. Management should develop, and use, a strategy for motivating men to work safely. Of course, there is no pat answer to safety motivation, but there are five principles worthy of consideration by all managements. If there were a word "cides" it would be a pat memory formula for remembering these five motivating principles. The "C" would stand for *cooperation*, the "I" for *incentives*, "D" for *deterrents*, "E" for *example*, and "S" for *skill*.

The first of these, *cooperation*, means developing a sound basis for cooperation in following the established safety practices. Most employees really want to cooperate with the supervisor. If the working climate is such that the men are basically antagonistic toward their supervisor, this supervisor will have great difficulty in obtaining compliance with anything he is trying to promote and, of course, safety is included. Developing cooperation is a must in motivating men to work safely, but you must have adequate supervision to produce a cooperative climate.

The second principle is *incentive*. Management must provide incentives to work safely. Some people say safety is its own reward. We counter this argument by saying, "you can't argue with success". Incentives do work. What are some?

- (1) Compliment safe work.
- (2) Publicly cite the company's appreciation for a workman's individual safe work performance. This word gets around—Joe is thought well of by the boss—and the safety climate is reinforced by more willing cooperation.
- (3) Emphasize the personal gains of working safely. These are obvious gains and should be reiterated frequently.
- (4) Talk about how the job gains when using safe methods; reminding the crew that the safe way takes less

time and less individual exertion is quite persuasive.

- (5) Always explain the "why" of a safety practice. Telling them "why" is like reasoning, and cooperation usually follows the reasoning process.
- (6) Make safety something that all men will participate in. Ask their opinions, solicit discussions and ideas. Identifications will occur with the safety effort, and men will follow what they consider a product of their own thinking.
- (7) Have management commend men deserving of special recognition for some significant safety effort. When management identifies with the safety program by thoughts, words and deeds, we know that there will be a strong incentive going for it.

The next principle in our memory word is *deterrents*. A deterrent, of course, is something that prevents some action for fear of the consequences. There are two ways to use deterrents. We can remove any deterrents that might keep us from working safely; or we can highlight and reinforce those things that keep us on the right path and deterred from working unsafely. In many instances, men fail to realize the potential injury severity. Don't cry "wolf", but do point out how severe certain types of accidents can be. Always correct observed unsafe work practices. Deterrents are a large subject, but I'm sure we all agree that fear of the consequences can be a very forceful motivating tool.

The next principle word is *example*. If we set the right example, we develop the right kind of attitudes. Let's define attitude for our safety purposes. An attitude, as we define it here, is a readiness to react favorably or unfavorably, or not at all, toward some safety criteria. We must recognize that these attitudes exist in the safety area, and that established attitudes are extremely difficult to change.

Our attitudes are directly determined by personal experience. If a man is antagonistic toward his supervisor, he probably will have a similar attitude toward working safely. All people tend to share the frustrations and gratifications of the people with whom we work and necessarily identify with very closely. If a friend is dealt with severely, as we see it, we tend to develop the same strong antagonistic feelings toward the supervisor as if the action had taken place to-

ward ourselves. The example set toward one person may well affect the attitude of the entire group.

There is a third attitude, and this is the borrowed attitude. The newcomer to the group wants, and needs, acceptance. To do this, the newcomer must necessarily share the group's attitude toward safety, because without this he will never become part of the team.

Continuing our thoughts on *example*, if we have a supervisor working around with a cloth cap, or a felt hat, when everyone else is required to wear hard hats, we have a bad example. A bad example has more impact than the good example. We must be fully aware of the demoralizing effect that occurs when setting the wrong example in matters of safety.

We are now at the last letter of our memory word, the "S" that stands for *skill*. We are referring, of course, to the skills of the first-line supervisor. No matter how sincerely we work at our first four principles of motivation, there are always one or two workers who won't be persuaded. This is something that cannot be ignored. The chronic safety offender must be given special attention by the supervisor. The skillful supervisor recognizes this, and he knows he must employ his best supervisory skills at all times with his problem child, because without his special handling, other motivation principles become fruitless.

Cooperation, incentives, deterrents, examples, and skills; if these are all practiced with reasonable diligence, experience shows us that people can and will be successfully motivated to work safely.

One parting shot at management. I have said that management failed to motivate properly, and that management failed to face up to the safety problem employee.

Basically, there are two kinds of safety problem employees. There are those that are chronically or organically impaired because of some mental or physical condition over which they have little or no control; and there are those that are accident-prone because they have no sense of responsibility or sense of self-discipline to work safely.

The organically impaired employee can usually be easily spotted by the aware supervisor. These fall into six basic slots—extreme fatigue, alcoholic effect, acute illness, mental depressions, emotional agitations, and incapacitation because of recent injury. The so-

lution of these problems usually is not too difficult if it is recognized and faced-up to. Normally, consultation with higher supervision will result in having the man work under closer supervision, or having the man re-assigned to more compatible work. It might be appropriate to arrange for a prompt medical checkup, or the man might be persuaded to leave the plant and not return until his condition has moderated. These solutions become quite evident.

The accident-prone employee who apparently has no physical or mental impairment requires a different kind of treatment, and is usually the one ignored by the supervisor. This situation requires a high degree of skill, and really needs program help from higher supervision. Poor supervisory performance here stems from three sources: (1) supervisors have not been adequately trained to handle these situations in a manner that will not get their authority overruled, or so there will be no arbitration case, or so there will be no other form of collective retaliation; (2) there is no standardized procedure to handle these irresponsible employees; and (3) violations and poor safety procedures practiced by our problem employee are not made a matter of record.

All of these training inadequacies, when corrected, of course, lead to discipline; but the discipline we are talking about is *corrective* discipline. We correct by reinstruction. We correct by reminding. We correct by persuading, and we correct by warning. If these have not been sufficient, we hold a correction interview, and if all else fails, we correct by penalty. All of these steps are followed in accordance with appropriate communication between man and supervisor, and the documentation is available, so if we must go to the last step, the penalty will stick.

Safety is more complex today than it ever was, but the principles that govern the motivation of people to work safely are still basic, and really have existed through the years without much, if any change.

Management may be losing its right to direct its safety program in a unilateral way, but if it will only recognize that if it can again seize the leadership needed to provide safe working conditions, it can restore itself to its former position. With leadership restored in the safety area, it will find that dilution of its rights in other areas can be sig-

nificantly slowed. Management should look on safety as an added tool which, if effectively used, can build success and stability

into its management system. Management should look on this as a *privilege*, not a right.

COMMON ACCIDENTS AND METHODS OF PREVENTION

By DONALD L. STEVENS

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Before we start I feel it is necessary to define a couple of these words so we will know just what we are talking about. First of all, the word "common"; we'll say that this refers to something shared alike by all of our water utilities. Next, we'll define "accident". To me, an accident is an unplanned event; not only is it unplanned but it is undesirable, so we'll say that an accident is any undesirable unplanned event. Don't confuse this word "accident" with the word "injury", because an injury may or may not result from an undesirable unplanned event.

"Methods" means *ways*. That leaves us with "prevention". We'll say that prevention means eliminate, do away with, or, if you wish, *stop*.

One of the most common accidents associated with water utilities is the one you seldom hear about. These are the near misses, the close calls, the ones that usually are not reported. They are not newsworthy so they do not make the paper, radio or "TV". These are the ones that your employees try to hide. They are afraid to report them because they are usually the result of their own negligence.

Another common accident is the one resulting from the calculated risk. A chance is taken and an accident results, sometimes an injury too, but this is accepted as "just one of those things." Is it really, or have we failed to fully evaluate the consequences of this particular calculated risk?

There just ain't nothin' common about us Water People or our accidents or our injuries or our dying. If there is anything common about us Water People it is an apparent disregard for the safety, well being, and future of ourselves, our employees, and our families. We in the water industry have

compiled one of the most disgusting accident records in the history of public utilities. Each and every one of us who has anything to do with the operation of a water utility has fallen down on the job. We have failed and will continue to fail until we accept the full responsibility of being leaders in our industry.

We accept the importance of proper treatment of water. We fully realize the dangers of impure water supplies. We know that some of the most destructive events recorded in the history of mankind have resulted from water born disease. We know and accept this but we have not, as of now, accepted as our responsibility the safety of our fellow workers, the safety of our friends, the safety of our employees.

How many times have you permitted an unsafe act, an unsafe procedure or an unsafe condition to exist without calling it to the attention of the individual, the foreman, or the supervisor?

How many times have you, by your silence, by your indifference, by your looking the other way accepted, condoned, even encouraged an unsafe act, procedure, or condition? Silence is not golden where safety is concerned.

Just where is safety concerned? Sometimes you wonder; and this is a shameful thing to have to say. Safety must be accepted as "a part of" and not as "an addition to." Safety is not a thing of or by itself. Safety is an integral part of life. Without safety, life would cease.

You and I have partially accepted safety or we would not be here. Most people partially accept safety.

The question, therefore, is not one of ac-

cepting or not accepting safety as a part of our existence, but rather is one of how much safety we are willing to accept. As free men we have this choice.

Most people want just enough of this safety thing to assure themselves of a pleasurable existence. Sometimes the amount deemed necessary is miscalculated and acci-

dental injury or death results.

This then is our challenge:

1. Look closer at near misses.
2. Fully evaluate calculated risks.
3. Speak up for safety.
4. Set a good example.

You are a leader—accept this responsibility fully.

SAFE HANDLING OF PIPE AND FITTINGS

By KENNETH R. BOYD

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Your water utility can eliminate accidents when handling pipe and fittings. Many water utilities in various parts of the country have established and maintain frequency rates which range from 0 in systems with 10 or 15 employees to frequency rates well below 10 where employments exceed 1,000. One company with more than 150 employees has had no lost time accidents for over 10 years. These records include exposure to injury in vehicles, shops, offices, laboratories, warehouses, water treatment and pumping stations, system operations, maintenance and repair, and new construction. They include the dog that bites the meter reader, and the bee that stings the pipe patrolman. Pipe and fittings must be handled safely or their frequency rates would suffer.

Other utilities desiring to equal or surpass these rates ask, "How do you handle pipe and fittings safely?" Several answers are available. Upon examination, the answers are basically the same—education. Manuals, on-the-job training, class rooms, or any combination of these methods is effective in educating the workman. They help in educating the supervisory employee.

Management, however, requires education of a different nature. It must learn its role. Alertness to need, investigation of problems, determination to acquire products, vehicles, tools, and equipment designed to function adequately is management's task. Proper use and maintenance of these items is the duty of the employee. Suggestions to the employees in the use of materials and methods of installation, coupled with suggestions to the management for improvement in products,

methods, and equipment, are the supervisor's sphere. In a well organized company, liaison on safety education flows up and down the chain of command and all employees are educated in the steps necessary to prevent accidents in all phases of the work, including pipe and fitting handling.

Education leading to safe handling of pipe and fittings requires a knowledge of many materials and work methods. One of the difficulties encountered in preparing manuals is the desire to cover every detail encountered in many current methods by which various materials are installed. Obsolescence begins as soon as new products, improved equipment, or different techniques come into being. Classroom or jobsite training is usually limited to materials, methods, and equipment currently in use. Here, too, costly and time consuming retraining may be needed to meet advances in the industry.

By using a functional approach to education in safe handling of pipe and fittings, we can remain timely without continual updating. It is easy to understand, and is readily applicable to wide varieties of products, tools and equipment.

Such an approach may seem to change the subject from "Safe Handling of Pipe and Fittings" to "General Safety Practice in the Field and in the Shop". To a large degree this is true. Safety in the handling of pipe and fittings is attained by the same general practices by which safety is obtained in every field in which a human being uses tools and equipment.

Several generalizations are just as ap-

propriate for pipe handling as they are to many other projects:

1. Know what you're doing at all times; guard against carelessness in repetitious jobs.
2. Use the proper materials, tools and equipment.
3. Make safe and ample work room.
4. Look and think ahead.
5. Work with the speed which gives good results. Do not mistake "haste" for "speed."
6. Examine partial results from time to time; test, if necessary, to assure good results.
7. Avoid shortcuts that are not fully thought out.
8. Clean up the tools, equipment, and work areas before, during, and after the job.
9. Upon completion, consider whether the next similar job can be done in a safer or more skillful way.

Applying these rules to specific jobs in handling pipe and fittings will result in fine workmanship, long lasting installations, and the reduction or absence of industrial accidents.

In order to understand why certain functions are common to wide areas of pipe and fitting work, let us examine the distribution system of a water utility. It may include pipe and fittings ranging from $\frac{1}{8}$ inch in size to 60 inches in diameter. The material used for pipe, and sometimes fittings, includes: copper, brass, wrought iron, steel, asbestos cement, plastic, lead, concrete, and, on rare occasions, wood. The pipe and fittings may be joined together by brazing, soldering and silver soldering, pipe threads, welding, rubber gasket compression sleeves, flared joints and following nuts, adhesives, gasketed or metal to metal flanges retained by nuts and bolts, or bell and spigot joints, filled with molten lead, sulphur compound, or dampened cement hammered to compaction.

The piping will usually be installed in trenches and excavations. Ground cover will vary from a few inches to several feet, especially in cases where protection against freezing or interference of other utilities is indicated. Some aboveground installations may be encountered adjacent to treatment or pumping plants, or where rough terrain requires bridging. Installation may require special hot or cold coatings or wrappings, re-

taining devices to prevent undue motion, special concrete forms for support or for vaults and many other specialized treatments for individual problems.

Generally, a water distribution system is considered to be divided into two major categories: services and mains. Pumping and treatment plants, together with reservoirs and tanks, are necessary to the system but are classed more properly under the category of "Water Supply". In any event, applying a functional approach, the safety practices applied to handling service or main pipes will apply to pumps, tanks, etc.

Water services are the combination of valves, fittings and piping required to convey water from the main pipe to the individual consumer. While services may be as large as 16 inches in size, the great majority are $\frac{3}{4}$ inch or 1 inch when used for residences and usually 2 inches or less for commercial purposes.

From the early 1800's until about 1920, lead piping with brass or bronze fittings was usual for $\frac{1}{2}$ inch, $\frac{3}{4}$ inch, and 1 inch service work. After being cut with a hacksaw, in earlier years, the lead pipe was "wiped" to the fittings or other pipe by handworking molten solder. As time went by, the lead was formed with a ball-peen hammer to form a flat end which could be drawn into place by a threaded retaining nut which held the joint firmly against a threaded fitting. Leather gaskets prevented leakage. The tools required were a hacksaw, file, hammer, pot for melting solder, pouring ladle, center punch for maintaining full diameter at the working ends of the lead pipe, and pipe- or monkey-wrenches for tightening fittings. Openings into the water main required drilling and tapping tools.

During this time $1\frac{1}{2}$ inch or 2 inch pipes were made of wrought iron or steel, and were connected to the water main by multiple small lead connections. Galvanized steel pipe gradually came into use for $\frac{1}{2}$ inch, $\frac{3}{4}$ inch, or 1 inch services as it was improved in soil resistance, and the trade discovered that steel pipe could be driven underground, thus eliminating costly excavation, backfill, and paving. From about 1920 until World War II, the usual material for $\frac{3}{4}$ inch or 1 inch service pipes, as well as $1\frac{1}{2}$ inch or 2 inch pipes, was galvanized steel, connected to the water main by a short piece of lead to overcome settlement problems, or ground movements, and using threaded wrought iron pipe

fittings where needed. The tools required included hacksaws, wheeled pipe cutters, pipe threading devices, pipe vises, and pipe wrenches.

In the late 1930's and more strongly after 1945, flexible tubing made of copper became the most commonly used material for $\frac{3}{4}$ inch and 1 inch services. Methods for installation are quite similar to lead, but the flare is made in a cone shape held firmly against the cone shaped valve or fitting end by a retaining nut. Leakage is prevented by the smooth metal-to-metal seating. The tools required include hacksaws, wheeled tubing cutters, flaring tools similar to large center punches, hammers, and pipe wrenches. Some installations are made by jointing fittings or lengths of tubing by using common solder or silver solder. This method requires a heating device, usually a propane torch. Blowtorches and butane torches are occasionally used. Sandpaper and soldering flux are required.

The latest material to attain widespread use in $\frac{3}{4}$ inch and 1 inch sizes is a plastic tubing, usually polyethylene. It appears to have reasonable longevity, it maintains long-term carrying capacity, and is less costly than other piping materials. This service pipe may be joined by heating the ends somewhat above the boiling point of water and then using conventional copper service fittings and flaring methods, or it may be joined by plastic fittings and special plastic adhesive, or by using plastic or bronze fittings to which the plastic tubing is retained by small stainless steel bands; much as one would install a radiator hose in his automobile. Tools required include hacksaws, wheeled tubing cutters, propane or butane torches, heating units and containers for a glycol bath to heat the tubing, flaring tools, pipe, and monkey wrenches.

The connection of a service pipe to the water main may require drilling through cast iron, ductile iron, asbestos cement pipe, concrete pipe with or without a steel insert, or through steel or even wood. Most materials may be pierced by a steel drill and can be successfully threaded with a steel tap. For steel mains, welding may be required to attach the first fitting to the main. Where main pipe diameters do not permit direct drilling and tapping, a "saddle" held to the main by use of a "U" bolt is generally used. The water main is pierced through the saddle opening or through the valve it holds.

Before leaving the area of service piping,

attention should be directed to hydraulic jacking devices which may be used to ram steel tubing underground to avoid trenching. This work is accomplished by use of water jetting, or by drilling, or by force derived from impact or leverage. The pipe is forced forward in sand, clay, and similar soils. Occasionally the driven pipe is removed and copper or plastic is fed through the tunnel. In some cases, installation is through the originally driven pipe.

Let us now direct our attention to water mains which, more by reason of their size than of their composition, require different tools and equipment and therefore raise other facets of protection against injury.

Materials encountered in normal water main work are: cast iron or ductile iron (which is similar to cast iron in longevity but approaches steel in tensile strength), asbestos transite, steel tubing, or fabricated pipe made from steel plate or strips, concrete, and a combination of concrete with a steel liner. Wood stave piping is sometimes used where frost is deep.

The method of joining may be by compacting damp cement or molten lead, or by pouring hot sulphur compounds, into a bell and spigot joint. It may be joined by threading or welding in steel pipe, or by compression joints in which a rubber ring is held forcibly in place by a jacket or coupling. Several varieties of flanges and bolting using gaskets, rubber rings, or metal-to-metal seating are all in use. Bell and spigot jointing in which a rubber gasket is retained in grooves and a compression ring sleeve covering two plain pipe ends is sometimes used. Brazing of cast iron or steel may be done on rare occasions, usually in repair jobs. Cotton may be used with woodpipe joints and seams to ensure water-tightness by swelling.

Large services ranging from over 2 inches to 16 inches and larger are identical to water mains in materials and methods. On the other hand, water mains 2 inches and smaller are identical to water services.

The fittings encountered on distribution mains are much more usually made of cast iron than any other material, since these fittings work well on cast iron, ductile iron, or asbestos cement piping.

The tools usually used for installation and repair of water mains include: hand-operated wheel cutters, hydraulically powered wheel cutters, portable drag saws, and more recently, abrasive wheel cutters similar in

nature to portable chain saws, mechanical and hydraulic "jacking" devices, chain tongs, peaveys, threading machines, pipe tongs for lifting, hand- or lever-operated chain falls, rope slings, chisels, hammers of various weights and shapes, manual or power driven compacting tools, and a wide variety of hand wrenches, files, axes, and saws. Pots for melting lead, sulphur or coating compounds heated by acetylene or butane, pouring ladles and "runners" to contain the molten materials until cool are in general use. Butane, acetylene, and oxy-acetylene burners and torches, as well as hell-arc and conventional arc welding devices may be required.

The weights encountered in cast or ductile iron fittings, valves, and most types of water main piping require mechanical lifting aids. Medium sized (6 inch or 8 inch) fittings and valves will weigh up to 300 pounds. Eighteen-foot lengths of similar size pipe may weigh 1,000 pounds. The odd shapes as well as the unbalanced weights encountered in narrow work areas require a wide variety of hand-operated, vehicle powered, or motorized lifting and pulling devices. Winches, cable hoists, cranes, sideboom tractors, hydraulic hoists, backhoe bucket attachments, hooks attached to tractor loaders, drag lines and combinations of these devices may be used in various situations. Chain, wire, cable, rope, canvas or rubberized slings, metal pipe tongs, and similar equipment and devices may be required in addition to the hand tools previously mentioned.

Now that we have some knowledge of the materials and tools which may be used on the distribution system pipe and fittings, let us put this knowledge to work on a functional basis. It should be apparent that first installation and later repairs or alterations will require similar or compatible materials and thereby similar tools and work methods. Reference to vehicular activities other than loading and unloading, or to excavation and backfill will be avoided. These subjects, while closely allied to the safe handling of pipe and fittings, are separate subjects.

The functions to consider in obtaining safety are not connected with specific or even general methods of installing or repairing water mains but rather with:

1. Hand tools.
2. Mechanical equipment.
3. Heating devices.
4. Competent workmanship.

Developing safe practices in the handling of

pipe and fittings becomes, in reality, the extension of universally accepted safety procedures. Many existing governmental "Safety Rules" or "Orders", trade manuals, manufacturers' guides, and general safety manuals are available. The preparation of manuals for classes, or on-the-job training in specific or general methods of pipe handling would appear to be unnecessary.

Application of well established principles connected with hand tools will lead to the general safety of the workman, supervisor, or even the management employee at home as well as in all activities on the job. Inspection, cleanliness, and good repair are imperative. Proper use and leverage forestall strains, cuts, abrasions, and contusions. The same safe practices apply wherever steel chisels and similar tools are to be used. They must be well sharpened and dressed to eliminate "mushrooming" at the upper end. Care in the use of hammers avoids injury. Eye protection and, if necessary, other body protection must be provided and used. While one or more devices may seem to be specialized for use in distribution system work, examination will disclose that the basic features, parts, and operations are common to the general field of hand tools and may be operated as other hand tools are safely used.

Mechanical or powered equipment for pipe and fitting handling during installation and repair is used in the same manner as it is used in the other work applications for which it is designed. Pipe and fittings are no different from other materials that must be loaded, unloaded, and placed in confined spaces. Knowledge of hoisting signals, rigging, care and inspection of ropes, cables, mechanical parts or other features of the equipment must be a part of the education possessed by the employee.

Safety in operating heating devices as well as the maintenance of these tools is not peculiar to pipe handling. Here, again, we must be sure that the employees operating such devices have a complete understanding of the proper uses, have attained skill in such uses, and realize the dangers involved in improper use of the appliances. They may then be confidently expected to use them in a safe manner.

Competent workmanship requires both formal education and comprehensive training in trade skills to the degree necessary to perform the most difficult or unusual task in a given field. It calls for flexibility as well as

ingenuity to achieve a safe and adequate result with available materials and equipment. Competent workmanship must be demanded from the employee. There is no room for the man who is ignorant of, or overlooks safe practices. Such a man injures himself, his family and his fellow workers. Management has the duty to enlist competent workmanship. Whether it is obtained from the pre-trained ranks of labor unions, or by apprenticeship within the organization becomes the management's choice.

Once acquired, the trained employee must be furnished with adequate safety devices, materials and equipment. He must be encouraged and guided by experienced supervision. The skilled workman and his supervisor should feel that they have the privilege and the duty to suggest to management a better product or method. This feeling is developed when the management listens and adopts or modifies the request or, in rejecting the suggestion adds the reason for rejection.

In conclusion, it should now be evident that safe handling of pipe and fittings is obtainable. To achieve this result management, supervision, and workmen must apply their knowledge and abilities to the task while recognizing that it is but a segment of the total utility field. They must, therefore, acquire and properly use the products, tools, and equipment necessary for an adequate result. All must be constantly alert to a better tool or method. All must review the existing conditions with a view to improvement. Each must keep abreast of changing times so that they may acquire or give additional training connected with new products, equipment, and methods. If men or organizations can reduce or eliminate accidents in any one part of the work they can do the same in handling pipe and fittings. No special cures are needed. All that is required is a skilled workman, a competent supervisor, and an alert management who mutually agree to use good tools, equipment, materials, and a fair amount of thinking.

SAFE TRENCHING PRACTICES

By WILLIAM A. HERRSCHER

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A figure has been used that during the fiscal year 1964-1965, fourteen times as many workers died from caving ditches, trenches, and excavations, as died from any other type of construction work.

Out of every one-hundred disabling injuries from cave-ins, eight workmen died; or to put it another way, out of every thirteen workers who received a disabling injury from cave-ins, one died.

All experienced construction men know that proper trench shoring cannot be reduced to a standard formula. What is adequate protection in one location, may be completely inadequate protection only a short distance away. Nevertheless, experience has indicated that observance of a few fundamentals will go a long way toward preventing most accidents.

Before we present these fundamentals, perhaps we should consider what some of the dangers are, and what can be done to

minimize them. In general, the dangers consist of the following:

1. Failure of trench walls.
2. Falling objects.
3. Men working too close together.
4. Men falling or tripping.
5. Other structures.

By far, the most prevalent danger is that of failure of the side walls of the excavation. Although everyone even remotely connected with trench work is aware of the dangers encountered with sliding or caving of the walls, this is still the commonest and potentially the most serious.

Why do these accidents happen?

The usual reason is that the workmen or the supervisor decided to take a chance. He thought:

"I've worked in this type of ground before without bracing."

"I'll spend more time bracing this than doing the work."

"I don't have enough trench jacks or timbers here."

"Bracing this trench would make the cost of this job too high, the boss will lose money."

Or any one of hundreds of other excuses may have been used.

Recently in my division, a crew of men was installing an eight inch water main alongside an unpaved street. The earth was a fairly uniform sand loam with a trace of brown clay. No other excavations of record had been made anywhere in the area. The pipe that was being installed was 18-foot lengths of cast-iron water main with rubber joints. The operation was to use a small excavating machine of the back-hoe type that had a 30-inch wide bucket. The trench was to be approximately six feet deep to give the pipe about five feet of cover. The excavation was made approximately 20 feet ahead of the bell end of the last pipe laid. The trench bottom was rough shaped by the digging machine so that all a man had to do was finish shaping the bed for the pipe. Since the earth was a sandy loam, no additional bedding was used. When the next pipe was lowered into the trench the workman had to insert the spigot end of the pipe into the bell end of the pipe previously laid, after he had cleaned the bell recess of the pipe by hand. The whole operation for the man in the trench didn't require more than two or three minutes.

Eleven hundred feet of a thirteen hundred foot job had been laid when the accident happened.

A rotted tree stump that had been buried by some other operation lay concealed in the wall of the trench, and just as the workman bent over to wipe out the pipe bell, the tree stump fell out bringing the entire wall with it.

The result was a fatality arising from complications developed from four fractured ribs.

All the usual excuses could be used here: "After 1,100 feet, who would think the trench would fail now?"

"Why spend five to ten minutes to brace a trench that's only open five minutes to do the work? A man is only in the trench about three minutes."

There was bracing available to at least support the area where the man had to bend over, but since it wasn't being used, it was left several hundred feet away. There is no

question that there were enough men on the job to install trench jacks after the trench had been roughed out. But it happened.

One approach to preventing accidents to workmen from trench failures is to insist that every trench that men are going to work in must either be braced or the sides sloped to the natural angle of repose of the material being excavated.

At first this sounds like a rigorous rule; but let's examine for a bit. The first question usually asked is, "Why should we brace a shallow trench that's only three or four feet deep?"

The amount of bracing installed is directly proportional to the depth of the trench. The amount of bracing in a shallow trench is minimal and conceivably can be only a couple of boards put in it with a spreader between them. Making the rule apply to all trenches eliminates the need for any interpretation.

Another question asked is, "How do you determine the angle of repose?"

Make a pile of the spoil out of the trench—the slope of the pile is the angle of repose.

Another question is, "Some trenches are too small to brace, like those for some small building footings."

If a trench is too small or narrow to brace, it's too small or narrow for a man to work in.

Still another question is, "Some trenches are too wide to brace, like those for large pipe."

Trenches that are too wide to span with braces have to be treated like excavations and braced similarly. In a trench for large pipe—6, 7, 8-foot diameter—the pipe itself can be used as support for the walls and, at the end of the pipe, considered as protection for the workmen.

Another reason for the walls of a trench caving or failing is because the excavated material was placed too close to the edge of the trench. Most sources indicate that fill and all loose material must be kept back at least two feet from the edge of the cut. The State of Michigan *Safety Rules and Regulations for the Construction Industry* indicate that nothing should be stored or placed nearer than four feet from the edge of the trench. However, if the two foot minimum is observed, in most cases in a braced trench the angle of repose of the excavated material will cause the surcharge load to be placed outside the area of possible failure by sliding.

A third reason for failure of trench walls is inadequate bracing because of a lack of knowledge, or failure to apply knowledge of bracing principles.

Usually, we find that a large project has had much consideration given to the nature of the soil, and the method of construction can and should be planned before starting work. The workmen then have a chance to determine how to install the bracing. Most accidents happen where a job is considered too small or too routine for any advance planning. A crew of men are sent out to do a job and they run into things they are not equipped to handle, by either ability or tools or both.

This falls into the management area—be sure the people assigned to work on a job are equipped to handle it. Advance planning, training programs and/or experienced people will in most cases take care of this problem.

A fourth reason for failure of a trench has been found to be attempting to use defective materials. Again, this is a problem that can be overcome by having experienced personnel who can and will recognize defective material and who know enough to say, "I'm not going to use that."

A big problem to be watched for is where conditions change during the course of an operation. Heavy rainfall, alternate freezing and thawing, seepage, overflow of sewers, melting of snow, etc., all produce hazards which must be considered. Heavy rainfall may wash excavated material back into the trench, greatly increase the rate of seepage, and cause damage to the trench walls. A job started in frozen ground may, when started, be safe; but thawing may cause the entire bank to fail.

A job may have been planned to be done with little or no equipment, but after once started, a large heavy piece of equipment working on the edge of a trench that was safe with smaller equipment may be enough to cause the failure.

The second hazard mentioned, that of objects falling on people working in the trench is another that requires constant attention. The most common source of trouble from this area arises from tools or material being dropped into or thrown from the trench. A hammer, saw, wrench, or other tool is needed by one of the workmen and someone attempts to drop it to him. Any number of things can happen:

(1) The tool is too heavy to catch, (2) he loses sight of it and catches it on his hand, (3) the aim is bad and someone else catches it on his hand, (4) the tool is deflected part way down, (5) when looking up to watch the tool, the workman has sand fall in his eye, etc.

The only safe way to control this is to never allow anything to be dropped to someone else.

When the man is through with the tool, rather than leave it in the hole where he might trip over it or lose it, the workman will decide to throw it back up. Again any number of things can happen:

(1) the man above misses it and it falls back, (2) the man above tries to reach for it and loses his balance, (3) the man above catches a sharp object—point first.

These can happen and have all happened before.

The way to prevent these things from happening is to insist that whenever tools are to be raised or lowered, they should be raised or lowered with a rope, or pail or box on the end of a rope. How often have you seen someone try to lower something in a pail that's too large to fit into the pail? When it gets part way down, the pail tips and drops everything out!

How often have you seen someone walking along the edge of a trench scuff sand into it?

How often have you seen tools left on the edge of a trench to be kicked in?

How often have you seen someone working in a trench without a safety helmet?

How often have you seen someone try to cross a trench by walking across a brace?

All these things only serve to keep the job interesting for the man below. He never knows who or what is going to drop in next.

Accidents from these things can be kept at a minimum by strict observance of a rule to keep everyone away from the edge of the trench except those men needed there; also a rule that whenever an object cannot be handed to a man in such a way that he can handle it, that it must be lowered by means of a rope.

This subject also covers working under overhanging materials. Be sure that whenever anyone is working under any overhanging material it is firmly and solidly in place.

The only other trench fatality beside the one already mentioned in my division came several years ago, when a man went under a

large piece of overhanging pavement. The men that worked around him and tried to get him out will never forget it.

Another danger connected with trench safety is that of men working too close together. Back in the days before excavating equipment was so widely used, forty or fifty men with picks and shovels were lined up and told to dig a trench. Here, the spacing between them for obvious reasons was important. However, fewer men now work in a trench, and this point is not thought of as often. Therefore it becomes more important, as workmen are more apt to forget to leave their fellow workman adequate work room.

Another hazard is men falling, or tripping. The normal bracing in a trench appears to be so good for climbing in and out that ladders are often omitted. Here again the dangers are obvious.

A man can slip off a cross brace. A man can try to climb on a loose brace or one that won't support him. Material can be knocked into the trench. A ladder should always be used to enter and leave an excavation, and the ladder should be used properly. Care should be taken to be sure that it is firmly positioned at the bottom and top. The top three rungs should be used only for support and should always extend above the top edge of the trench. Keep the rungs free of tools, oil, grease, etc. that might cause a man to trip.

In most urban areas, it is virtually impossible to make any excavation without encountering another structure. In my division, we have a standard procedure. Whenever we are going to do any digging whatsoever, we consult every other utility to determine if there are any ducts, wires, or pipes that may be involved. This has done much to cut down on damaging other installations and also to protect workmen from accidents.

Every underground worker has no end of stories about the damages he has seen or heard of being done to or by underground installations. These range from pushing a bar or probe into a high voltage electric wire, being blown out of a hole by water force, installing a water tap on a gas main, or seeing the many colored maze of wires when a multi-paired telephone wire is cut. Only too often, even experienced workmen will go ahead with an excavation without first investigating to see if there are any other utilities nearby. This is another area where constant

reminding is necessary: "Check before you dig."

Too many workmen think they can tell if a trench had been dug in the area before, and even who dug it. They acquire the ability to identify a trench by the faint raise or depression, the patch in the street, or the discoloration in the earth. This kind of ability indicates an experienced workman, but the use to which he puts his experience is the key.

Just because you're three feet away from a gas main trench doesn't mean there isn't one right where you're digging.

If electric wires are overhead, it doesn't mean there isn't one underneath.

The continually increasing development of different types of digging machines has done much to speed up excavating work and earth handling. However, whenever a digging machine is used, be it a back hoe, a trencher, a pull shovel, a clam bucket, a scoop or any other type, it is often difficult for the operator to see clearly at the point of actual digging. Many serious accidents have been caused by signals being given to an operator by anyone who is standing around. Maybe two or three will all team up and all give signals. On every job one competent man should be selected to give whatever signals are needed to the operator. This man should watch the boom to see that overhead wires are safely avoided. Also, he should watch the actual point of digging. Perhaps the operator can see, but the signalman's viewpoint is different. He may be able to see what the operator cannot.

The signal man and the machine operator should be used to working together so that their signals can be easily understood. No one should be allowed in the trench while a machine is working or when material is being raised or lowered. If someone is required to guide the material he should stand clear and use a pole and/or rope to do the guiding.

Remember, the machine operator has his hands full. He cannot watch what he is doing and also watch and listen to others who may be wandering around his machine.

Another factor that must be remembered is the new man. We must remember the major responsibility for the training and safety of the new man rests with the supervisor; but his fellow employees also share this responsibility. In order for a crew to

avoid injuries, they must learn to work together.

The supervisor can teach the care and handling of the tools, and can show how the department operates. We must remember that each crew may have somewhat different procedures, and that a new or transferred employee may not fit in immediately. It is everyone's job to help the new man become part of the team.

To summarize, a safe trenching procedure would be the following:

Have a competent person inspect the area before any work is done. If there are any overhead wires they should be noted and due consideration given when selecting digging or hoisting equipment. Records of all utilities should be checked and the locations of their installations determined. If any structures are noted to be in or immediately adjacent to the proposed trench, advance provisions should be made for removing, relocating, or protecting them. If there are any buildings nearby, they should be inspected for structural defects or conditions that may affect the work. A crack in a wall or a footing should be noted and plans made accordingly. If the work is to be done in a street or public walkway, means should be devised to protect from pedestrian and/or vehicular traffic.

Before any excavation is started, a determination must be made of whether it will have sloped sides, braced sides, or a combination of both. If the sides are to be braced, the method of bracing must be decided on and all the material required must be on the site or accounted for before any excavation is done.

If the excavation is to have sloped sides, an estimate of the distance the spoil pile will reach must be made as early as possible to be sure there will be adequate room for it and that the digging equipment will be able to place it there.

A competent person should be selected on every excavating job who will be responsible for frequent inspections of the shoring, and he should be informed he has this responsibility. Also, each workman should be instructed to report any sign of weakness to this man immediately.

Where diagonal bracing is installed, it is extremely important that adequate bearing is provided at the lower end to resist the thrust of the bank above.

If trench jacks or prefabricated shores are

going to be used, they should be inspected beforehand to be sure they are in good working condition and the workmen cautioned, continually, to properly center them so they will not kick out when a load is applied. When jacks are used, blocks should be installed under each end to minimize the hazard due to failure or slipping of the jacks.

While the excavating is being done, the bracing should be kept as close to the lower end of the digging boom as possible. This is important, not only from the standpoint of safety to the men but also to the protection of the trench. If the bank should fail several feet behind the machine, it will be necessary to back the machine either over the trench or around the trench to clean the material out, or to clean it out by hand methods.

One common error made, especially in wet areas, is to fail to toe the sheeting into the bottom of the trench to avoid upheaval or flow of the bottom, caused by the surcharge load of the spoil or in extreme cases the banks themselves. In these cases, the hydrostatic pressure on the sheeting must be considered when designing for the lateral loads to be carried. It must be remembered that, with a soil possessing sufficient cohesion to act as a solid, the side pressures reach a maximum at a point slightly about the center of the cut. With non-cohesive soils and saturated soils, the side pressures increase in proportion to the depth of the cut.

Recently, with the increasing costs of timber and labor and the awareness of safety of workmen, trench shields or boxes are being more widely used. The size and the type of the shield is usually governed by the trench width and depth. It should be wide enough to allow men and material and equipment to be moved in and out easily. They are usually constructed of steel plates welded to a heavy structural steel or pipe framework.

It must be remembered that with bracing of timber or trench jacks, single cross-members can be removed occasionally to allow material or equipment to be raised or lowered. In a prefabricated box with welded cross members, this is impossible.

When a job is completed, it is usually considered desirable to salvage the shoring or bracing for re-use. The removal of sheeting may leave a void that is difficult to fill. It is often necessary, where earth movement to fill voids left by the sheeting removal may

cause damage to another structure, to leave the sheeting in place.

However, where it is possible to remove sheeting, shoring, or cross bracing, it should be removed cautiously, keeping the backfill as close as possible. Systematic dismantling from the bottom upward, either by having the braces pulled out from above with lifting equipment or by introducing screw jacks that will take up the strain of wedged timber cross braces so they can be removed easily; then the strain on the screw jacks may be released slowly with the condition of the

side walls taken into account.

Safety in trenching, as with safety in any other operation, is accomplished by the constant repetition of a few basic points:

1. Brace or slope all trenches.
2. Maintain good housekeeping. Keep the work area free of idle tools, material or equipment.
3. Only allow the people around the work area that are needed there.
4. Make sure the workmen understand their job.

THE GAS INDUSTRY'S OFF-THE-JOB SAFETY ACTIVITIES

By ALEX PIERSON

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The accident prevention committee of the American Gas Association represents production, transmission, and distribution companies from the Atlantic to the Pacific and from Canada to Mexico. The committee accomplishes its work through 14 active subcommittees. One subcommittee is charged with off-the-job safety. The scope of this subcommittee is to promote off-the-job safety activities among companies in the gas industry and to gather, prepare and disseminate material on off-the-job safety from other industries, organizations, and conferences. The entire accident prevention committee meets twice a year to approve and further the work of the subcommittees.

What is off-the-job safety all about? Basically, it should be an extension of a company's on-the-job safety program. It is not a separate program—we refer to them as activities rather than as a program. Off-the-job safety involves employees, and this term is used by employers to designate that part of their safety program directed to the employee when he is not at work.

For years, a few of the gas companies were concerned about the large number of away-from-work accidents resulting in employee disabling injuries. One company experienced 24 off-the-job, lost-time injuries

for every disabling injury, on the job. The average of several companies was a six-to-one ratio.

This tells us that when an employee checks out at the end of his shift, he leaves behind his carefully constructed and constantly maintained network of safety. He becomes a member of the general public along the highways and at home during hours of recreation. It was imperative that we should concern ourselves with this problem. This off-the-job environment should be a primary concern for all safety and management people.

Our immediate aim was not to cause undue anxiety, but rather to suggest means of removing causes for alarm. Caution is not enough because many of the dangers in away-from-work environments are not commonly known. Few know, for example, that all four legs of a step ladder should be level before using it.

We wanted to emphasize the seriousness of certain risks to life and property frequently occurring in or about the home. We also wanted to give simple methods of care and caution against such hazards.

To learn more about the industry experience, we began our study by surveying 166 selected companies. The committee wanted

to know the injury experience and off-the-job safety activities in which these companies were involved. Thirty per cent of the companies replied to our survey questionnaire. Only 14 reported available statistics on injury experience. Incidentally, a number of company representatives asked for information and assistance since they were seriously considering formal off-the-job safety activities. Others reported that although they didn't keep score on disabling injuries, they were promoting off-the-job safety.

The data supplied to the American Gas Association, along with many requests for additional information, disturbed the committee members. It was apparent there was need to assist member companies, and that an additional subcommittee on off-the-job safety would be a step in the right direction.

Of particular concern was the large number of disabling injuries reported. The 14 companies previously referred to employed approximately 30,000 people, or 14 per cent of the industry's employees. A total of 1,794 disabling injuries (including three fatalities) resulted in more than 17,000 man-days away from productivity during 1964.

With cooperation from the National Safety Council, a booklet, *Off-the-Job Safety Program For the Gas Industry* was developed. The story of employee accidents occurring away from the plant was made available to the industry. The booklet featured a successful company program and many strong motives for promoting off-the-job safety. It outlined a program to assist in starting off-the-job safety activities, including an injury report form, and also listed several sources of useful handout material on a variety of safety subjects.

To make this initial impact on the industry more effective, and to create an atmosphere of acceptance, an off-the-job safety program folder was also developed. This folder used the theme of "Safety everywhere all the time", and a copy was mailed to each company.

Evaluation of this particular subcommittee project revealed:

1. More and more companies were considering formal off-the-job safety programs;
2. That not much promotional material was being purchased;
3. That an increasing number of companies were talking about off-the-job safety and that our project was a real start toward getting them involved.

Unfortunately, all these committee efforts were only able to motivate a few companies. Other firms were beginning to show interest, but little was being done by the industry as a whole.

Consequently, the committee intensified its promotional endeavors and disseminated information on ideas, activities, and materials to encourage more companies to actively support off-the-job safety.

The booklet, *Off-the-Job Safety Program For the Gas Industry*, was revised. Two major and significant changes were made. Our revisions focused on management's attention. The record achieved in the industry's reduction of on-duty injury proved we had this "know-how" and this should be applied to off-the-job safety, as well. The title of the booklet was changed to *Join the Gas Industry War Against Off-Duty Injury*.

Since the committee was determined in its efforts to wake up the industry to this waste of manpower and money, it was decided that our approach should be the same one that proved successful in curbing on-the-job injuries. We needed to know not only the number of disabling injuries from many more companies, but also the specific area in which accidents occurred. Guided by the National Safety Council's suggested method for reporting off-the-job injuries, we decided to use the same format for two reasons: First, to determine in which of three environments gas people are mostly involved; that is, home, transportation, or public. This would make available a comparison with other industries as reported to the National Safety Council. Secondly, to concentrate on that environment which would give us the greatest reduction of accidents.

In addition, a form was developed to report company experience to the Statistical Bureau of the American Gas Association. Our objective here, of course, was to encourage companies to record experience and report it to the association.

This mailing was followed by communications to safety correspondents in the industry, informing them of survey composites. We passed along additional information based on the industry's experience to supplement knowledge among gas companies now having off-the-job safety activities. Last, but far from least, information was intended to help other companies plan and institute such activities.

Statistics collected from member compa-

nies on off-the-job injuries were published in the American Gas Association monthly magazine. Articles were written on the subject and also were published in the monthly. We wanted top management to know that our industry was no different in off-the-job accidents than other industries.

From these statistics we now believe what other industries have known for years: that our greatest loss of manpower from accidents results from experience away from the job!

From last year's findings, we know that of the total number of *all* accidents experienced by 21 per cent of the industry's employees, 84 per cent of these accidents occurred away from the plant!

Although we are not overly enthused with the response received by this promotional drive, we were nevertheless pleased to learn that our efforts were not completely in vain. We did receive inquiries for additional assistance! The number of companies reporting off-the-job accident experience now numbers 38. Certainly this is an improvement from the seven companies who submitted their experience in 1962, and the 14 companies reporting for 1964.

The information obtained from these 38 companies for 1966 off-the-job injury experience justified our concern and intensified the emphasis in getting the industry involved. Based on this data, the 1966 experience shows that:

You can expect one disabling injury resulting from off-duty accidents for every 30 employees on your payroll.

You can expect each of these injured employees to lose approximately 10 working days.

You can expect, on the average, 5.4 disabling injuries off-the-job for every one on-the-job.

You can expect at the higher extreme 19 disabling off-the-job injuries for every one on-the-job and, on the lower extreme, 1.3 disabling injuries off-the-job for every one at work.

You can further expect that for every 10 off-duty accidents six of them will occur in the home. The other four will be split between public and traffic exposures.

You can expect it will cost your company manpower and money. The cost per accident depends on your company's employee absence policy. For a simplified plan in estimating such cost, I refer you to the National Safety Council *Data Sheet 601*. This sheet

was published in a September, 1967, issue of the *National Safety News*. I suggest you read this data sheet prepared by the National Safety Council staff. Besides reporting the cost of accidents, it deals with off-the-job programs, specific ideas, record-keeping, and statistical formulas.

We asked our safety correspondents again and again to indicate to us ways in which the accident prevention committee could assist them in off-the-job safety. We learned that we could help by developing educational material, training aids, program activities, providing annual experience reports and guides for selling an aggressive off-the-job safety program to management. Help is also needed in pressing major executives so that they will wear down the layers of management insulation between the chief executive and the workers.

On this last point we encountered a little problem: that last suggestion, "Hitting the top executive", is a tough assignment—I haven't found any committee member that is willing to tackle this one. However, we did develop something that we feel is a good answer to most of the requests made by the industry.

We have prepared a booklet with facts, ideas, materials, and a planning schedule for off-the-job safety activities. We believe this information will assist a company regardless of the number of employees it hires. Remember, too, we believe your efforts in educating employees—including your management—should follow the basics previously mentioned. Specifically, these off-the-job activities should be an extension of your on-the-job safety program.

During the past 18 months the committee, keeping within its scope the thought of "gathering, preparing, and disseminating material on off-the-job safety from other industries, organizations, and conferences," accumulated, reviewed, and selected material on off-the-job safety. We borrowed, so to speak, materials, ideas, and successful gas company off-the-job safety activities and put them between covers for your use.

The intent is to assist the industry with information to management and to develop and schedule activities on off-the-job safety. In detail, we tell you about the seriousness of the problem, the many benefits to be derived from company activities, along with data showing what off-the-job accidents cost. There are examples of how some companies

record and report off-the-job injuries, including exhibits of reporting forms.

In addition, there is an "off-the-job safety calendar" to assist you in planning your yearly activities. This calendar also gives an idea of how to tie in company promotional material with national themes, such as fire prevention week, poison prevention week, etc.

We can tell you of the many avenues available to get your message across to employees. There are bulletin boards, company publications, payroll inserts, films, meetings, safety publications, handouts—just to name a few. Examples of these activities in use today by gas companies are shown and supplemented with material sources in our booklet.

Let's assume, for example, you are interested in traffic safety and wish to distribute a pamphlet to your employees. If so, you need only refer to the traffic safety section of the booklet. Listed there are 31 subjects from accident statistics to winter driving, with names and addresses of 58 agencies where this material is available.

This, then, in part, is the committee's response to assist the gas industry in programming off-the-job safety. A lot more needs to be done. The committee is presently working on next year's plans to assist, promote, and collect off-the-job injury experience for the industry.

You must become part of these plans if we are to achieve a reduction in the number of employee accidents resulting from away-from-work mishaps. Telling your employees the full story on off-the-job injury experience in your company can help your accident prevention program.

Using this as one of many approaches in my own company of 2,900 employees, we have reduced off-duty accident frequency by 20 per cent in the last two years.

There is every indication that improvement is possible in the industry and that we can make progress in the reduction of off-the-job accidents if we put ourselves to the task. The job will not be an easy one. It requires, first of all, leadership—your leadership! This is vital in every project.

Second, it requires analysis of the problem. We must have accurate information concerning the problem. This requires ex-

perience, your company experience. You must maintain records of your employee off-duty accidents!

This leads to the third need: Planning activities for off-the-job safety must be approached with the same thought and care that the gas industry uses in tackling work accidents.

In the opinion of the Accident Prevention Committee there is no question of the need for off-the-job safety activities. As I have already mentioned, the average ratio of 38 companies for off-duty injury versus on-duty injury was 5.4 to 1. How about your own company's experience? Is it 19 to 1, or 1.3 to 1?

In addition to injury reduction, your company can also benefit in these three ways:

1. Reducing lost-time and operating costs.
2. Helping with company efforts to improve your on-the-job safety program.
3. Contributing to better public relations.

We are continually urging this industry to provide us with data about its off-the-job injury experience. We must have statistics for future analysis to plan additional activities. Our committee project, "Facts, ideas, materials and planning schedule for your off-the-job safety activities," was possible only through the experience and cooperation of a mere handful of gas companies. We need to get many more companies involved. We ask that you give this some serious thought.

The final need is effort. Few achievements come without working for them. Analysis and planning are wasted if they do not lead to action. Nor can our effort to improve the off-duty injury picture be of a "quickie" nature. The problem is too challenging for that simple a solution. Off-the-job safety will need action for a long time to come. The sooner we set about the job in earnest, the sooner we will begin to see improvement.

Off-the-job safety must be an integral part of every company's accident prevention program. Accidents occurring to our employees on the highway, at play, and at home are so serious that each company must commit all its resources toward obtaining this objective.

The record is alarming. I hope that this one fact will spur each of us to real leadership, effective action, and fulfillment of our ultimate goal.

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ACCIDENT INVESTIGATION

By HARRIS K. WILLIAMS

Coordinator of Safety, Southern Kraft Div., International Paper Co., Mobile, Ala.

International Paper Company has recognized the necessity of having an effective safety program for many years. I don't know exactly when or where the first safety program was established in our company; I have, however, found injury records that date back to 1917 and 1918. Evidently, accident investigations were part of the program back in those days because these reports tell of the high number of injuries classified as "unsafe acts" and the improvements that had been made in the area of mechanical guarding: "Now that we have our machinery guarded satisfactorily, we are compelled to exert the same energy and enthusiasm toward eliminating the unsafe acts of our employees."

One item outstanding in all these reports of fifty years ago is the plaguing question of how to eliminate unsafe acts. Like most everyone, they had something to blame the unsafe acts on; at that time it was World War I. Needless to say, we still have the problem, and I venture to say we will have the problem fifty years from now, simply because we are dealing with human beings, none of whom act or think alike on any given problem or subject.

Accident investigation in each instance of an injury serious enough to warrant the attention of a doctor has been regular procedure for many years in the Southern Kraft Division. Some changes in the procedure have been made over the years which have paid dividends.

In our division we have eleven mills and two wholly owned contractors doing work in these mills. Many injuries have been prevented by the exchange of information gained through accident investigations.

Basically, we have three accident investigation procedures; all are written procedures. One procedure is used in investigating a relatively minor injury or an injury that warrants the attention of a doctor. This is what we call our "routine investigation". The second procedure is what we call a "formal investigation," conducted in instances of serious or fatal injuries. The third procedure is followed when there has been a

"near-miss;" instances in which there was no injury.

The routine investigation is chaired by the department head in some instances, but most of the time it is chaired by the assistant manager or one of the top three people in the mill. In these investigations the injured is present, if possible, along with witnesses to the occurrence, the foreman, and the safety director. The investigation starts at the location of the accident; after everyone understands what happened, the entire group goes into a meeting. At the meeting, all witnesses are heard and the department head, as well as the foreman, give their opinions on what happened, even though they may not have witnessed the incident. After everyone is heard, corrective measures are discussed—exactly what should be done to prevent a recurrence is decided.

About the same format is used in the serious and fatal injury investigations, except that a representative from Division Safety is present for the investigation, and the meeting is chaired by the mill manager. All statements made by witnesses are written, and pictures are taken of the injury site. Needless to say, there are many more details to attend to in the event of a fatal injury than any other type. Many people have to be notified immediately; e.g., the insurance carrier, the state compensation commission, coroner, and many top officials of our division.

Investigation of near-miss accidents and incidents is usually made by the safety director with the department head, foreman, and the person involved. These investigations range from a loose nut falling and nearly hitting someone, to a lift truck that runs off a ramp. But in all cases, this type of investigation is made only where no injury was sustained.

We circulate all investigation reports on fatalities; and circulate quite a few of the routine investigations as well as the near-miss investigations. In a multi-plant operation, we have benefited substantially by all mills reporting the accident causes as well as corrective actions taken.

Accident investigations should include:

1. A study of the work place or area where the injury occurred, for the purpose of finding and eliminating the cause of the accident.

2. Investigation and study of job procedures and methods.

3. Investigation of the necessity for further safety education, instruction, training in the area of safe work procedure.

4. Develop a cause analysis of the injury for the purpose of studying the underlying or contributing circumstances.

The first three items are of instant value in any injury investigation. The last item, cause analysis, is of lasting value to any progressive safety program, because an analysis identifies the key factors, such as nature of injury, part of body, injury source, accident type, agency, unsafe act.

All these factors lead to another very important tool in any safety program—cost. The cost tool, if needed, sometimes works when the humane appeal fails. We use such tools as department injury cost and injury cost in a crew or shift. This being to bring to attention the high cost of injuries in certain departments or under certain supervisors. When we are talking to management, we use

such tools as injuries and their related insurance cost and rate, and injury cost per ton of paper.

We follow the National Safety Council's procedure for investigating accidents very closely. We highly recommend Section 4 of the National Safety Council *Accident Prevention Manual*.

In closing, I would like to leave these thoughts with reference to accident investigations.

1. An accident not properly investigated and corrective action not taken is a gold lettered invitation to a repeat performance.

2. The difference between a near-miss, a minor injury, and a major injury is often only a fraction of a second or a fraction of an inch. Investigations reveal measures that must be taken to prevent recurrence.

3. The cause for each accident must be determined by investigation and eliminated for every type of injury, in order to have an effective safety program.

4. The responsibility for preventing injuries rests with supervision. Investigations furnish the tools for corrective action. Unless supervision acts upon the agreed corrective action, these investigations are useless.

SAFETY & HOUSEKEEPING INSPECTIONS

By ALLEN H. WATTS

Safety Dir., Union Camp Corp., Savannah, Ga.

Twelve times a year, for more years than I care to recall, a member of our safety department calls the superintendent of every department in our plant (we have 27 departments) and schedules an activity we refer to as a "Safety, Housekeeping, and Sanitation Inspection." What follows is so unusual as to justify comment.

Our fellow and a fellow from each department involved stomp all through the department and observe safety, housekeeping, and sanitation conditions. Our fellow makes notes of all the untoward or unfavorable conditions observed in these three areas. Their fellow even helps our fellow find them. When the tour is over, our fellow sits down with the department superintendent and tells him,

orally, about everything that was wrong. Then he tells everyone else, including all the bosses, about the same things that were wrong in a written report.

When you consider:

1. That we don't work for these people, not even in their division, and that we are privileged to treat them so badly, yet they have no opportunity for reprisal (this is most unusual);

2. That our couriers have not met with accident as they make their appointed rounds in these areas is evidence of the fact there is a strong spirit of tolerance and brotherly love among us;

3. That our fellows and their fellows have never engaged in fistfights is evidence of the

effectiveness of the company's rules against such activities;

4. That this performance is repeated each month;

5. That it is highly regarded by management and top supervisory people;

6. That safety has adequate authority for these activities;

7. That the several departments involved actually compete for top honors in this area—these things are evidence that a satisfactory, adequate background condition has been established, against which this usual activity can be successfully conducted. We refer to this background condition or atmosphere or understanding or arrangement or authority or whatever you want to call it as "The Three P's of Safety, Housekeeping and Sanitation Inspections."

Policy.

Our company has adopted a policy which says we will conduct our operations in such a way as to avoid accidents and injuries to our people (*safety*); we will maintain our areas and equipment in a clean and orderly condition (*housekeeping*); we will provide adequate locker and rest room facilities which we will maintain in a sanitary manner (*sanitation*).

As with all policy matters, our resident manager has responsibility for its enactment at our plant. Without minimizing the importance of these matters and because he has a lot of other things to do, he delegates responsibility for these things to his several division managers.

For precisely the same reason, the division managers parcel out their responsibility for these things to their assistants; the assistant managers pass it on to the superintendents; the superintendents to the assistant superintendents; they to the general foremen; on to the foremen; and, finally, to the clean-up man. If the clean-up man was not the lowest man on the totem pole, he would pass it on to the man who was.

All of this is as it should be. The important thing to remember is that, in delegating this responsibility, no one gets rid of it, no one minimizes it. Instead, they *share* it with others.

Philosophy.

The second P stands for philosophy.

Management recognizes that the modern supervisor cannot be an expert in the several matters he has responsibility for; consequently, he needs help. There are experts giving him help in such areas as planning, cost, budget, engineering, quality, etc.

This same philosophy recognizes that while the supervisor can and should be the best safety man in his area, it is true he sometimes cannot see the forest for looking at the trees; that he probably has not developed talents for housekeeping because he had no special training in matters of cleanliness and orderliness; that his experiences had more to do with personal hygiene and less to do with industrial sanitation. So, again he needs help.

This help comes from the safety department. While some have been so unkind as to think of us as witch hunters, garbage hounds, and privy purveyors, we think of ourselves as safety, housekeeping, and sanitation inspectors.

This same philosophy says the safety, housekeeping, and sanitation inspector cannot know a great deal about all the operations involved, so he needs help. He gets his help from the supervisor who accompanies him on the inspection.

Thus it develops that two men, both experts in their respective areas, combine their abilities to sensibly evaluate these conditions for the benefit of those who have responsibility for them.

Procedures.

The third P stands for procedures. They are simple. We schedule the inspections with the department head. He has advance notice, and provides an associate inspector.

When the inspection is over, we review the results with the superintendent.

We deal largely in "opinions."

In a few areas, we deal in "facts."

Facts have to do with things that are above or below the line in the light of accepted standards. This is easy.

Opinions have to do with things that are above or below the line in the light of conditions we *think* should exist, based on standards that have not been accepted for plant use or based on our personal experiences. This is not so easy.

So much for the three P's.

In conclusion, we believe the activity now

has supervision's interest, supervision's enlightened participation, supervision's support.

If this is so, it marks our progress.

If this is not so, it marks our objective.

There lies the moral of our story!

This is the way we do it:

1. Establish a management policy.
2. Implement this policy with a sound philosophy.

3. Develop sensible groundrules in terms of procedure.

It works with us—it can work with you.

SAFETY INCENTIVES

By **BURL MCGARRAHAN**

Corporate Mgr., Safety & Workmen's Compensation, The Mead Corp., Chillicothe, Ohio.

Webster states that "An incentive incites or has a tendency to incite to determination or action." Therefore, a safety incentive which is properly conceived and developed provides the motive or stimulus for safe performance. Then by definition "true" or real incentives are favored by employees—for safety as well as for other areas of performance related to their job.

There have been many articles, both "pro" and "con," on the usage of safety incentives for employees. Many safety people argue that a good, well rounded safety program is sufficient, and workers should not be rewarded for safe performance since it is expected as a regular part of their job. It is true that safety incentives sometimes are mistakenly thought of as a panacea for poor safety performance, and, unfortunately, they sometimes serve as a substitute for the development and administration of a good accident prevention program.

On the other hand, many safety men are in favor of safety incentives as a means of stimulating safe work habits, and they see no inconsistency in rewarding persons for working safely. After all, a large number of organizations use incentives in sales and in production departments to stimulate extra effort; many persons believe that incentives can be used also to stimulate safe performance.

Of the employee safety incentives which have been used and are reported to have improved safety performance, many offer an incentive through a feeling of competition or through pride of accomplishment:

1. Individually framed certificates for years of employee injury free service (for 5,

10, 15, 20, or more years injury free work performance).

2. Plaques and bowls for company locations with excellent safety records, including also recognition meetings, dinners, picnics, and outings.

3. College scholarships for sons and daughters, at locations with superior safety performance, offer a real incentive to the employee with children of the right age group.

4. Trading stamps, cash awards, and merchandise gifts are used in both plant and departmental contests to reward good safety performance.

Of course, there are safety displays, safety slogan contests, lucky number drawings, personal letters to the homes, and many other gimmicks used in incentive programs. All of these have about the same purpose—to recognize safe performance and to encourage continued good performance, or to offer the incentive for improved safety performance.

In discussing incentives, we should not forget the importance of the supervisor in any safety program, with or without a safety incentive system. Effective accident prevention is essential for the most successful operation of a company, and it requires the same supervisory skills as quality, cost and waste control, and production. Therefore, the supervisor always has the responsibility for the safety of his personnel, whether or not an incentive system is in effect. If safety incentives are used they should complement his efforts.

In some companies, the supervisor is encouraged to promote safety of his employees by rewarding him in the form of a cash

bonus, or some other award, for safe man-hour records or for a time period of injury free departmental performance. Also, frequently in the annual performance review safety performance of the group supervised is considered in evaluating the overall work performance of the supervisor. Because most employees naturally want to please their supervisor, the supervisor can provide an incentive or motive for his employees to work safely by his evidenced interest in the safety program.

I am not trying to sell the merits of safety incentives, but if you use them or plan to do so, you should consider the following:

1. Some incentives appear to be highly effective only for a limited time, and they must be constantly reviewed to determine continued effectiveness.

2. Goals should be set and evaluation criteria should be understood and fairly applied. The incentive will be greater if the achievement of the goal requires a significant effort. Where possible, employees should be involved in goal-setting.

3. The safety incentive plan should be

evaluated in the context of other existing incentive plans for production, quality, and waste, and all such programs should be coordinated by management. It is important that awards be appropriate and that evaluation criteria be fairly applied.

4. The evaluation criteria, whether for disabling injuries, for "serious injuries", or for safe manhour accomplishments, should be meaningful for the size unit under consideration.

5. Although it is not normally the case, it is possible for safety and other incentives to be considered as a condition of employment, thereby subject to negotiation. Therefore, it is advisable to review the labor relations implications of any proposed incentive system.

In summary, where safety incentives are used they must be combined with a safety program which contains the best known principles of safety engineering, such as the well-rounded program outlined in the National Safety Council *Accident Prevention Manual*. Safety incentives may help to improve safety performance, but they are not a substitute for a good safety program.

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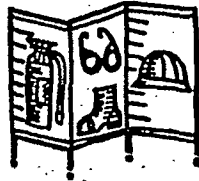
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CONTENTS

Locomotive Simulation	<i>Harold E. Woodhouse</i>	4
Changing Times	<i>L. W. Dutton</i>	12
Getting On and Off Equipment	<i>J. B. Malarkey</i>	14
An Address	<i>Ben W. Helneman</i>	15
Training of Train Service Personnel		18
Claims and Safety — A Cooperative Effort	<i>John A. Risendal</i>	23
Five Years of Future Dates for National Safety Congress		29
Officers of the Railroad Section 1967-68		30
Other Volumes in 1967 National Safety Congress Transactions		Back Cover

LOCOMOTIVE SIMULATION

By HAROLD E. WOODHOUSE

Gen. Sales Mgr., Western Railroad Supply Co., Div. of Western Industries, Inc., Chicago, Ill.

Western Railroad Supply Co. is deeply involved and has been for many years in the safety of the traveling public in relation to railroads, having pioneered the automatic gate and advanced the art of crossing protection to the highly refined state which we now enjoy. We were also very much involved in those safety oriented pieces of hardware along your right-of-way, namely, bumping posts, derails, switchpoint guards, etc. So you see, we are very much concerned with the matter of safety on and off the railroad property, and are one of the many supply companies which, through research, are attempting to make the railroad a safer place to work and the crossings of these railroads at grade a safer place for the traveling public.

A large measure of the success of any program in safety is due to the untiring effort of the safety committees on the railroads, and the acceptance of these safety standards by the traveling public can be quickly realized if you will look at a railroad crossing where cars are going to and fro and count how many cars actually stop and look down the track to see if a train is approaching. The public has, I fear, been to some degree led down the garden path of believing that all railroad crossings are as safe as being in their mother's arms. This we know is not true; but they have accepted the reliability of the protection equipment on the locomotives and on the wayside as infallible. Hence, we still experience entirely too many crossing accidents too often where too many people are killed or injured. Motorists must realize that a railroad crossing, no matter how well protected, or a fast moving freight or passenger train, no matter how experienced the locomotive engineer is, can in no measure take the place of an alert motorist behind the wheel of an automobile or truck.

Our partner in the presentation of locomotive simulators to the railroads is the Link Group Division of General Precision, whose entire history has been devoted to making systems available to the transportation industry to train their personnel in the safe handling of their various modes and types of equipment.

Going back to the early 1930's, when Link first developed the Link trainer, hitherto, a pilot learned how to operate an airplane simply by riding behind a second pilot and learning by doing, taking all the necessary risks involved in that very primitive type of training. The Link trainer for the first time allowed a man to make all his mistakes in the safety of a ground trainer, so that when he first approached the cockpit of a live airplane, he did so with considerable knowledge and feel of its operation. Down through the years, this has been developed to the fine art that we may see today in the simulator for the Apollo mission, built for NASA. This is the largest and most complex simulator ever produced. It provided training for the three-man crew of the Apollo spacecraft for flights to the vicinity of the moon and return. Simulated phases are complete, except for the sensation of weightlessness and gravitational forces for launch and re-entry. A complete visual system provides views through the sextant telescope and the windows of the spacecraft during each phase.

In this simulator, the men leave the atmosphere of the earth and arrive in the area of the moon, move from their Apollo craft into a smaller limb module and approach the moon surface and land. Then they may, still in simulation, leave the moon surface, rendezvous with their orbiting Apollo spacecraft and return to the earth. Every feeling, sight, and operational function of these craft are realistically simulated, and the astronauts go through exercise after exercise so that when they are aboard the real craft making this memorable trip, they will have experienced all the possible aspects of the flight and learned how to automatically cope with the many emergency situations which could possibly arise. This simulator includes replicas of the actual vehicles, all instrumentation, displays, and operational modes.

Sometime ago when one of the astronauts was circling the earth, he experienced difficulty with the altitude control and the vehicle started rotating rather violently. The astronaut took remedial action and safely landed the craft at its designated landing

area. This astronaut was very quickly able to bring this craft under control because he had experienced this many times before in simulation and knew precisely what to do and how to do it. Learning how to cope with an emergency situation before it occurs may only be accomplished in simulator training.

It may be well at this point to describe the differences between a simulator and a trainer. A trainer is a device to teach a student the operation of a type of vehicle. An example of this would be an automobile trainer to teach him to operate an automobile—no specific type or no specific manufacture—just an automobile. Whereas, a simulator teaches a man to specifically operate a certain type and a certain make of vehicle.

The simulator which Link has designed for locomotive engineer training is in this respect not purely a simulator. It is designed and will operate as a specific locomotive. For instance, one railroad is interested in an SD-45, and their simulator will be an SD-45 in every respect, dynamically and operationally, and the furniture in the cab will be that of an SD-45. However, the locomotive manufacturers have tended to standardize the furniture in a locomotive cab, and the simulator may very easily be programmed to act as two or more types of locomotives. You simply program in the various dynamics of the particular locomotives and allow the instructor to make the selection of the type of locomotive which he desires.

The history of locomotive simulation began in England a few years back at the plant of General Precision Systems, which was a subsidiary of General Precision, Inc. and brother to the Link Corp. The British National Railways converted two main truck lines from steam power to electric power, and they required some means of quickly instructing locomotive engineers to learn to operate this new power unit and to operate it in an experienced and efficient manner. They approached GPS, which was the largest manufacturer of aircraft simulators in England, with this problem. After considerable research and development, GPS delivered to the British National Railways a locomotive simulator for test. The results were so overwhelming that the BNR immediately placed an order for a second unit. The London Transit, taking the key from the British National, ordered a unit for the purpose of training motormen in the subways of Lon-

don. These three units are now in operation, and at least one of them has been in operation for three years. Their experiences have proven to them and to many railroad people from around the world, who have visited and actually operated the unit, that simulator training is a major tool in standard training of locomotive engineers.

Italy was then in the process of building a high speed line, and required simulation to train the engineers to operate safely at the higher speeds. Yugoslavia, Belgium, France, New Zealand, Argentina, The Netherlands, and many other countries entered into initial negotiations toward the development and purchase of simulators for their railroads. They anticipated not only the training of personnel and the upgrading of present operating personnel, but an area of research wherein they could test more efficient operating procedures and more efficient train handling techniques. They also desired to study the effect of various patent drugs on the abilities and coordination of their operating people. They felt, and rightly so, that the over-the-counter remedy in some cases could alter the reflexes and reactions of a locomotive engineer to the point where he could be unsafe to operate. These and many other bio-physical questions could only reasonably be worked out in a locomotive simulator.

Three years ago the idea of locomotive simulation for American railroads was brought to the Western Railroad Supply Co. for presentation to the railroads of the United States, Canada, and Mexico. Since that time I have had the opportunity of addressing more than twenty of the major railroads and three of the largest transit authorities in the United States and Canada. Their interest in a simulator was immediate, and their desire to enter into serious discussions regarding simulator training proved a deep and very real need in this area. However, it was necessary, before a locomotive simulator could be constructed for the railroads of this continent, to expand the parameters considerably. We found that the traffic requirements, the speeds of the trains, the distances involved and the tonnages of the trains were so very different than that experienced on the initial simulators in London, that it was necessary to completely redesign, modernize, and make more flexible the locomotive simulator.

It was almost immediately established that, initially, locomotive simulators must be in some mobile form, whereas the simulators as built and used in England are permanent structures housed within the buildings or confines of the structures of the railroads and subways. It was necessary to service the vast stretches of American railroads at many points so that simulator training classes could be set up at locations closer to the men who would be taking the training. Thus, the size of the engineer's training station must be cut down to the point where it would be operational within the confines of a baggage or passenger car or in a highway trailer. This has been successfully accomplished and the simulator as presented to the American railroads today is a completely mobile unit. However, in cutting down the size, realism of the in-cab configuration and furniture was not lost. A few feet of the left side of the cab was cut off, but this in no way minimizes the realism of a man in simulator training. He still has a complete feeling of actually being within the specific locomotive the simulator is designed to present.

In redesigning the simulator, it was found necessary to make it far more flexible than the British units in operation. If a railroad were to decide on, for instance, a U-33 locomotive for simulation, or a GP-30 or a GP-35, it certainly would not want to limit itself for a long period of time to this one and only locomotive for the purposes of training. Therefore, it had to be sufficiently flexible to incorporate changes as they became necessary—changes in the type of power, that is, to newer and more modern locomotives as they come along; changes in speed concepts, considering the higher speeds of your freight and passenger runs today; train weights vary from road to road. Some railroads are going to longer, heavier trains and this made necessary a far more flexible means of adjusting train weights in simulation, whereas the British unit had allowance for 0 to 1000 tons. The simulator as designed for the American railroads handles up to 20,000 tons and more—trains up to and including 200 cars. It also became immediately necessary to be able to change the weights of the cars. For instance, a train load of ore cars, regardless of the length, would certainly not equal a train of empty tri-levels. If you must realistically simulate a specific train, you must have the ability to not only adjust your train length

and number of cars, but you must be able to change the weights, and also to arrange the various tonnages within your train so that you could realistically represent a train having 20 or 30 empty cars on the head end, with the balance of the train being loads. This presents specific operating problems that can be simulated in no other way. Operating procedures, the terrain, the distances run, and the type of complex interlocking operations which we find in this hemisphere also contributed to the requirements for expanded parameters for the Americanized version of the GPS Link simulator.

The solution to all these various problems was developed in the Link Riverdale Division factory at Riverdale, Md. The systems employed in this solution were developed at the Link plant at Binghamton, N.Y. It is at this plant that systems development for aircraft, trucks, buses, and now locomotives takes place. The marriage of the talents of the many specialists in simulation has produced today for the railroads a locomotive simulator which provides virtual "real world" training for the student engineer. The weight of experience and knowledge of these specialists in simulation provided many choices regarding type of motion, type of visual display, type of student stations, and the type and size of the computer required to do all the many things necessary in realistic simulation.

Let me now describe to you the Link locomotive simulator as it has developed and is now presented to the railroads. First, we must realize that all simulators have certain specific component parts. There is the heart of the unit, the computer and its related interface network. Secondly, there is the training station. In the case of the locomotive simulator, this is the cab of the locomotive itself. Thirdly, we have the visual system, which will realistically present the view without distortion, without side blurring even at the lower speeds, and realistically present an infinity picture so that the man viewing it does not believe he is looking at a screen, but has the real sensation of looking into the distance. Fourth is the sound system which is operated by the computer, the instructor, and the trainee. The sounds must be realistic and be cued in at the exact instance that sound is required. Lastly, we have the motion system. This system must realistically represent acceleration and deceleration. It

must give the true feeling of a train moving through the turn-out with the side motion and sway. It must also in some cases, I am afraid, represent an engine operating over a rough track with some low joints, or as some railroaders say, "high centers". It must represent the superelevations on some of the higher speed curves and the very minor grade ascending and descending tilt. All this must be smooth, automatic, and instantaneous in response.

These five sections are now incorporated into a mobile form. There are two basic ways of doing this; one is securing the use of a baggage car or a secondhand passenger car and building the simulator into this unit right at the Riverdale plant. In most rail cars it would have sufficient room remaining for rooms for the instructor, maintenance man, classrooms, and whatever else may be required.

The second form is to house this in a 40-ft. x 8-ft. highway trailer. One of the advantages to the highway trailer concept is that it need not be located for training purposes next to a railroad or adjacent to a yard or service facilities. If the railroad desired, the setup for this mobile trailer can be at any convenient point close to housing or quarters for their trainees or next to a headquarters, which may be removed from the railroad by some distance. Also, the unit may be moved by highway or on a piggyback flat car. In either instance, the product of mobility allows the railroad to move the simulator from district to district, giving a wider coverage and extending the opportunities of simulator training to their entire system. This, of course, encourages participation on the part of the locomotive engineer trainee and allows him to, in most instances, live at home while he is undergoing the training.

I don't believe that it is necessary to point out the economic savings in this type of arrangement. However, we still must not forget that a stationary unit also has certain advantages in that regular schools may be established at various points which may in many cases not only serve the purchasing railroad, but lease time made available to other railroads operating in the area, setting up a zone type of instruction school which may then be expanded to include system instruction, and other type of classroom instruction which can more easily be established at single locations.

Both the mobile types of simulators would come equipped with complete and adequate air conditioning to maintain a constant temperature and humidity control over the full range of -20° to $+120^{\circ}$ outside temperature. This is very important to the proper function of the computer and the interface network. Under both these mobile systems, it is also possible to completely test out the unit prior to the time it departs from the Link plant at Riverdale, Maryland, so that the railroad may have the advantage of a complete and working unit the day it is delivered to their property. There is also one other advantage to this type of delivery in that, as part of the package, the Link Group at Riverdale will undertake the training of railroad personnel in the maintenance of the computer, motion system, and simulator as a whole, right on their property, working with the men who designed and constructed the unit. At the same time, the instructors who will be handling the unit on the railroad will have an opportunity to go through the training processes with the Link engineers prior to the time that they must step out and be instructors.

The maintenance man, who would be trained at the Link plant, would have a backup group second to none. There is at every location where there is a Link aircraft trainer, and these are many and spread throughout the country, a group of Link design engineers and service personnel, supporting various installations. These men, in most instances, are located quite close to most of the railroad terminal areas in this country and should a problem ever occur, which would require the services of such an engineer, he could be on their property in a matter of hours, no matter where the unit is located. This would insure constant operation, minimum down time, and an uninterrupted training program.

Now let us step into the simulator and examine some of its major components. The computer selected for this service is a SEL810A General Purpose Digital Computer manufactured by Systems Engineering Laboratory in Fort Lauderdale, Fla. Link, of course, makes many computers for their larger units themselves. However, their computer group selected this particular one as the one which would be most appropriate to this type of operation. This computer minimizes maintenance effort by utilizing self-

checking diagnostic programs. Reliability is field proven and it employs the newest in the art of integrated circuitry, thus improving the reliability of the overall simulator.

Into this computer are programmed the dynamics of the locomotive to be simulated, both general and specific information regarding the right-of-way, which is represented on the film; for instance, type of ballast, turnout size, road crossings, bridges, super-elevations, grades, etc.; all information which would require some response in the way of sounds, motions or visual cue. Also in this computer are the dynamics of the train in general—the various car weights, rollability on grades, their lengths, their reactions to forces, all the information which could affect the operation of the train, and which is called out by the actions of the student, the instructor, or the coded tape which is activated and controlled by the film and the film speed. There is in this computer approximately 67 per cent spare computer time and 31 per cent spare core storage, which means that as changes are required in locomotives, in operations or in the various track dynamics, they may be readily programmed into the computer by simply typing out a programme and feeding it. No down time is required as this can be done by the personnel who will maintain and instruct on the computer.

This was one of the major concerns in initially Americanizing the locomotive simulator. The British units utilized an analog type of computer which is an electronic or electro-mechanical type of computer utilizing axles with rheostats, etc., and should changes be required in power or track structure it would be necessary to physically go in and tear apart sections of the computer and rebuild them or add to the analog computer additional sections to take care of the additional dynamic information necessary in the storage. This, of course, could become a serious and expensive problem over the years to come, and as we expect locomotive simulators once placed in service to become even more useful to the railroads for many years, it is necessary that it be so designed that changes may be made from time-to-time quickly and easily.

The training station is actually the interior of the locomotive cab to be simulated. The actual stanchion for the controls, the power panel on the electrical control cabinets,

windshield wipers, deadman control, or any other system or appurtenance which you actually have in a cab of a locomotive will be in the car of the simulator.

A question was asked on one road regarding realism, and we pointed out that we would even install a water cooler, which does not work, if this extreme in realism was required. However, the realism is there right down to the last nut, bolt, and rivet just as the man would see it in the actual cab, and every dial and operating light are actually operating in the simulator just as they would in the actual cab. There are no dummy gadgets or dummy lights; everything is in working order.

Just to the rear of the locomotive engineer's seat is a flop-down seat for the instructor so that he may be immediately in back of the man in training, see the same view he sees, and be able to talk with him and discuss the various operational procedures. Across from the instructor is the instructor's panel. On this there are controls to change the track adhesion so that the instructor may, at will, induce rail slips or provide the realism of a wet track condition. Next to this is a dial indicating the number of power units in the consist. The simulator will realistically handle from one to five locomotives on the head end. Also, on at least two railroads its been requested to provide the additional controls for the operation of slave or control units back in the train. This could readily be accomplished by adding the hardware in the cab and programming in the dynamic effects of these units in the computer at any time.

Next to this power unit dial is a series of buttons. These buttons, when pressed, light, telling you how many cars you have on the train when lighted. There are ten buttons, each representing twenty cars. This, of course, is changeable according to the specific desires of the purchasing railroad. The unit which is now under construction contains ten such buttons. If you desire to add cars to a train, you simply press the appropriate buttons. If you want to take them off, you press them again and they release. It is also possible to tell whether these cars you are adding are loaded or unloaded as the button tilts to a load or unload position. Therefore, an instructor can set up an occasion where he might have 80 cars fully loaded with twenty empty cars on the head

end. This would certainly create some conditions, particularly on descending grades, where training procedures could save the railroads considerable costs in train derailments and subsequent equipment and lading damage.

There is one additional feature of this type of display, using the lighted buttons for the number of cars, which is quite novel. The computer, of course, has the dynamic effects of a locomotive programmed in and also that of the cars. Should the engineer operate his train in such a manner where a break-in-two would normally occur, it's going to occur in the simulator and the instructor, simply by glancing at the lights and seeing where the lights went out, can tell exactly where the train broke in two, and that's exactly where the train would break-in-two in actual operation. Hence, we then have a way of determining what the break-in-two stresses are under varying conditions of actual operation. Also, the instructor has the ability to, at any time, cause a break-in-two simply by pushing a button and extinguishing all those lights from that button to the right, which just cuts those cars off his train instantaneously just as it would occur in a break-in-two. Then the engineer experiences the full sense of the motion and acceleration or deceleration, as the case may be, of a realistic break-in-two and he must take the appropriate action.

Below this freight car loading panel and to the left is a button labeled *Torpedo*. The instructor may press this at any time and the engineer would experience the sound of a torpedo going off under the wheels of his unit.

Next to this button is an emergency brake application button. The instructor may at any time initiate an emergency brake application by simply pushing this button.

We then have a panel adjacent to this, labeled *Malfunctions*. This panel will vary from railroad to railroad according to their particular desires, but on two specific railroads these buttons will be labeled *ground relay*, *over-speed trip*, *penalty brake*, *dynamic brake loss*, *air-loss*, *hot engine*, and *low oil pressure*. Others can be added at the request of a purchasing railroad, or some of these may be deleted. This depends, again, on the desires of the specific railroad.

Below this group and to the left again, we have two dials which control the signal as-

pects. A signal program is inserted into the computer, providing a normal sequence of signal indication. However, the instructor has the ability to over-ride this control and these two dials are for that purpose. Above each dial is a little light marked *near*. One of these will be illuminated at all times. The instructor may then simply dial the type of aspect he wants on his near signal and do the same on the second dial; as the train approaches the first signal, the aspect which he has selected will be the one displayed. As soon as the train passes this signal, the near light goes out and the near light on the second dial is illuminated, because at this time that is the signal which is near. The instructor can at this time then redial the first one so that he can, for any given stretch of track or any given number of signals, select the aspects he wants. This gives the instructor the ability to simulate a clear failure on a signal and observe the action of the locomotive engineer. It is also possible to make signal tests with locomotive engineers by this manner by simply flipping his near signal while it is in his view to a stop indication. There are many ways and many varieties of experiences which an engineer can face due to signal manipulations.

One of the interesting portions of the British National Railways display is that at the end of each of the film sequences, something is on the track, such as a freight car, or an automobile, or a freight car fouling the mainline. The instructor, through the control, can provide clear signals all the way in so that an operator can come around a curve at the designated speed for that territory and find himself looking at a freight car sitting on the mainline track. You can imagine this can provide some rather interesting results in the way of reflex action. It is true that although a man knows he is in a simulator, the reactions and the feeling he senses are very real. However, it has been found that his ability to learn is considerably greater because he subconsciously realizes that his actions can cause no damage, thus he is more able to concentrate on what he must learn with less apprehension and be far more receptive to learning.

Next to the signal dials is a button marked *crash*. This was placed in there at the request of one specific railroad where they wanted a situation which could not normally be filmed and what has been done to accom-

plish almost the same thing is to provide a man a specific place to stop on a given piece of track with another train operating in his view and crossing over in front of him. If he does not stop he gets the full motion, sight, and sound effects of a collision. At the same time he exercises freeze and he knows he has been in a crash.

Next to this is a film rewind button which allows an instructor to go back over certain areas and do them again and again with his student, or to go back and review the student's action during a particular situation. Adjacent to this is a frame counter which will pin-point certain problems for repeat exercises.

Below this in the lower left hand corner is an emergency stop button which has a protecting guard over it. This stops everything. It kills the hydraulic system for the motion, stops the electrical handling of the computer, stops all visual display and sound. It actually kills the entire unit.

There is also a button for cab motion system. Under certain conditions it may be desirable to operate this unit without cab motion, and this can be readily cut out by the use of this button. Next to this is a tilting button marked DAY and NIGHT. Normally, the simulator is operated in a daylight condition, because the film is taken, of course, in the daylight. For the purpose of simulating night time operation, you flip the button to the night side of the switch and the illumination is cut down to the point where you appear to be in a semi-moonlight condition. Your signals, of course, are still as bright as they would be at night. They are not cut back at all and it is a very realistic night time scene.

Next to this is the exercise freeze button, whereby the instructor may at any time stop the film and stop the exercise immediately, and review the situation and the actions of the trainee, pointing out what his reaction was and what it should have been.

In the lowest right hand corner is a radio control with channel selections and a volume switch, providing radio communication with simulated end-to-end operation for simulation wayside to mobile operation. It is possible, if the railroad desires, to include tapes of various conversations which would normally come in over the radio and have the engineer react and respond to these various

calls from the end or from the wayside location.

The visual system placed before the cab consists of a specially built projector which provides a full range of motion in the film from 0 miles an hour on up to and including 79 miles an hour, and it is not impossible to have higher speeds on the film. Coupled with this is a tape code which is operated at the same speed as the projector film and gives the cues to the computer regarding the necessary sounds for the right-of-way and the crossing signals which may be passed. The information on this code determines motion, sound and visual display coordination. Coupled with this also are two groups of very small spotlights which handle the signal aspects along the right-of-way. The simulator has the ability to handle two signals at a time; that is, two signals each consisting of two or three aspects.

Over the past two years, in talking with various railroads in this country and Canada, it has become evident that a very real problem in training locomotive engineers exists now or is going to exist in the very near future. Railroads must consider forecasts which reflect the varying degrees to which the firemen's roster on each particular road has been reduced by application of Arbitration Award 282. This situation, of course, can vary sharply from railroad to railroad, and even as between operating divisions on any given railroad. Serious study must be made regarding the attrition of locomotive engineers, particularly in view of the latest awards regarding the retirement pay and age allowances.

But, let's consider the subject of simulators in a training process. Do not think we would be doing justice to this consideration unless we consider the order and long range viewpoint rather than just a short term program for accelerated training over the next few years. Mr. Reed, president of the Santa Fe Railroad, said in his address before the RS&MA on Motive Power Simulation back in March, "There is probably no other industry in the world that places more trust in its employees than do the railways, especially for the proper performance of duty by their trained service employees; and there is probably none that has its supervisory forces spread so thinly over its operations, with the result that the train service employees are subject only to random observation and

checking of performance. In a typical railway operating organization we have just a handful of supervisory officers responsible for the performance of crews operating over many hundreds of miles of line. This is enough to suggest the importance we have always attributed to the proper training and testing of crewmen, particularly those on the headend of our train." He also referred to "education by osmosis" and made the suggestion that this old process be revised by substituting accelerated programs of concentrated training in lieu of the three or four year period traditionally allotted to locomotive engineer candidates to prepare for promotion.

Certain specific questions have come up regarding education by osmosis:

Are we getting proper quality control in the training process?

Do our training procedures have gaps that become evident only from service irregularities and mishaps?

A determination is necessary as to what today's training processes really cost us and whether there are better ways, including the use of a locomotive simulator, to utilize more efficiently the manpower and supervision at the disposal of the railroad.

The major contribution can be made by the locomotive simulator in train handling and train operating. By "train handling" we mean that dexterity and experience in manipulating the throttle, brake valve, and other controls which produce a smooth, safe handling with avoidance of harsh slack action and resultant possibility of damage to equipment and lading. By "train operating" we mean point to point operation of trains in accordance with procedures prescribed by the book of rules, time table, and other regulations. A high standard of train handling can quickly and easily teach men the manipulative skill of train handling. If it is necessary to repeat certain exercises to make the response to emergency conditions automatic, they may be gone over and over and over again until the response to these conditions are second nature and automatic to the man in training.

The simulator may also be used to introduce experienced engineers to new types of locomotives, new types of brake equipment, and even to new configurations of train, such as the heavy unit coal trains recently put in service on many lines. It is in this area that

simulators would become most popular with the employees themselves. For instance, for a locomotive engineer to be able to actually handle a heavy coal train down a descending grade before he is actually faced with the real responsibility for doing this could be one of the most comforting and reassuring experiences that could be imagined. This could not only relieve engineers of anxieties, but it could also encourage experimentation with new techniques of handling these heavy trains, experience which could not possibly be made in real life for fear of break-in-two.

Thus, a simulator could become, in the words of Mr. Reed, "A computerized test track and proving ground on which new combinations of power and new techniques of train handling could be given preliminary and painless experimentation." Further, we must consider that there are those few individuals, who are found on some railroad divisions, who just don't have the knack of handling certain trains under certain conditions. Here intensive training on simulators set to duplicate the appropriate roadway conditions that give these men trouble should permit a better analysis of their faults and an early correction of their methods or procedure. In other words, simulators would seem to have the potential of upgrading train handling skills of the entire locomotive engineers Brotherhood.

Train operation from point to point as experienced today on the railroads is greatly influenced by the type of engineer at the throttle. The old "education by osmosis" method used down through the years has by and large produced many very excellent locomotive engineers. However, many bad habits have also been passed on from engineer to fireman and on down the line. These are the bad habits which affect the operation of a train from one point to another point. This lack of a standard training affects the braking distances, signal recognition and compliance, the efficient use of the power at hand, and can also affect the entire point to point run of a train as to downgrade the entire efficiency of an operating district. I was told by an engineer of one railroad that their training is so varied that even a normal service application to brakes can mean a difference of a half mile to a mile or more between one locomotive engineer and the second, simply because they were told those

things which the person who taught them thought were the most important, and the rest of this initial training has gone by the boards.

In visits with many railroads and discussions with their operating mechanical people, it has never been questioned that a new system of training locomotive engineers is sorely needed, and it has never been questioned that a standard system of training would add immeasurably to the safe and economical operation of a railroad. The locomotive simulator would be used as a tool for improving the training of new locomotive engineers; the upgrading of those presently on the job; and, finally, as a supplement to the old overall locomotive engineer program. I say supplement here simply because on the railroads, as it is presently on the air lines, a simulator would be used as an on-the-job training mechanism and would in no way ever replace the actual operational training necessary for the final qualifications on a locomotive. However, having gone through locomotive simulation training, a man will step into the cab of a locomotive with far more assurance and far more knowledge of train handling and train operation than any engineer over a lifetime of "osmosis" training.

A locomotive simulator is, I believe, the first step in locomotive engineer training and will, I believe, become part of an entire pro-

gram of education in the future. A program which will not only combine the operation and instruction on locomotives with instruction on the various systems of a locomotive, such as the dynamic braking and the electrical system, but will eventually be expanded for purposes of instructing shop personnel and electricians, the various other departments of the railroad in their own particular craft. It will eventually, by the sheer attractiveness of the education and the subsequent employment on a modern, forward-looking railroad, attract the young men coming from colleges and universities who will look to the railroad as the type of growth industry with which they will want to seek their future. The railroad industry, at present, is probably the one industry which has done so little in the way of education or on-the-job training for its personnel or prospective employees. Let us hope that in the years to come, through locomotive simulation and other training aids and educational procedures, the railroads will continue toward even greater goals in safe operation of the life lines of the United States, with their tremendous capabilities and their endless opportunities. To this end I believe the railroad should be dedicated, and as a member of the supply fraternity I believe it to be the common goal of both the supply industry and the railroad industry.

CHANGING TIMES

By L. W. DUTTON

Staff Representative, Railroad Section, National Safety Council

To you as individuals, one of the great values of Council membership is the opportunity provided to associate with people in your own field of work and exchange problems and solutions. Railroaders, like sailors, miners, and construction workers, are prone to get together with their own kind.

Times change, and the Council has tried its best to change with the times. Our chief function is of a clearing house for safety information. The most valuable information we can give our members concerns trends in the development of the overall national safety campaign. Campaigns (in the plural) is a

better word, for the total effort is greatly fragmented. The Council strives to act as the unifying element for the various and sometimes conflicting efforts in the various sectors—industrial, public, traffic, school, farm, and all the rest.

Within the Council's structure the greatest unifying factor—never fully brought to realization—is industry, including the railroads. Your interest in all the other phases of safety is a deep one, involving your own employees, on and off the job, and the public at large. Industry provides most of the Council's support, and industry has always ac-

cepted its responsibility for helping to promote the safety of the American public in all its activities.

There *are* new trends in safety, and the Council is doing its best to make its members aware of them and direct their courses to fit the trends. Perhaps the strongest of these trends is that toward federal intervention in various aspects of safety. The pattern is first, a Congressional investigation and, ultimately, Federal regulation. This ultimate stage usually involves Federally imposed technical safety standards, in which the interests affected may or may not have a voice in the formulation.

Directly involved in this process is the whole problem of safety standards, because government intervention usually occurs in areas where no safety standards exist—or where critics say inadequate standards are in effect.

This year marks the 52nd anniversary of the Railroad Section and the 54th anniversary of the National Safety Council. What have we learned about safety in those years? There is an old epigram which points out the difference between having 52 years' experience and having one year's experience 52 times.

A complete set of the transactions of all the National Safety Congresses is carefully preserved at Council headquarters. Any of you who wish to do so are invited to visit us and read the proceedings of the first session of the Railroad Section, which took place at the 1915 Congress in Philadelphia. There you will find talks presented by some of the early great pioneers of the railroad safety movement. You will find that they were setting forth the same problems we have with us today . . . and recommending the same methods we are using today for their solution.

They were great men; those pioneers—men like Isaiah Hale of the Santa Fe and Ralph Richards of the North Western. They were evangelists . . . exhorters. They could have stood before you today and brought tears to your eyes. Their like is not found among us now. They did their work well and left us a great tradition to follow. By their work and the work of all railroad safety men who have come after them, the annual toll of death and injury to railroad workers has been reduced by nine-tenths, compared to 1915.

But now it seems as if we have reached a plateau on which our accident experience continues at more or less of a level, and we can't seem to force it downward.

In view of the trend toward government intervention it might be well if we took a closer look to see what can be done to improve the design of all types of railway equipment to the end that all those who have to work with it and maintain it may do so with a minimum of exposure to mechanical hazards. This is especially critical in these times, when it seems every day there appears a new type of freight car, of car door, of draft gear—to say nothing of a new type of roadway maintenance machine. In the design of all these items of equipment, has enough safety engineering gone into the design to protect the switchman or the trackman who has to work with them, and the shop man who has to maintain them?

But granting, for the sake of argument, that the railway plant as a whole is in pretty safe condition, why can we not improve the record any further? There are those who have a ready answer—human failures. In other words, basically, "carelessness" is causing most of the accidents.

If only that word "carelessness" could be thrown out of the dictionary! For if a man is careless there is usually an underlying reason. Few people are truly careless about their own safety. The reason may be in a man's mental attitude, in some personal burden on his mind, in his physical condition—or it may be that he simply didn't know how to do his job safely. He may never have been taught how to do it, or his training may have been inadequate.

Or . . . he may not have been effectively supervised.

So we come to the point that the trend—the need—is for truly effective training in safety. We need to find new methods, or perhaps just to make more and better use of the methods which have always been available.

We need to train new workers effectively in the all around best method of doing their jobs, but above all it is essential that we train supervisors in how to teach and how to supervise for safety. The supervisor is the worker's contact with the company that employs him. The supervisor is the one man who is in a position to instruct, examine, and guide the worker.

Necessarily, then, the prime responsibility for the whole process falls on the supervisor's shoulders. This responsibility cannot be delegated.

The supervisor, in turn, is entitled to:

1. A clear definition of his training responsibilities.
 2. Instruction in how to do the training.
 3. Texts and aids to assist him in doing the training job.
 4. Allowance of time necessary for training.
- Training does not end at the end of the

schooling period. Earl Hannaford, author of our new *Supervisor's Guide to Human Relations*, has this to say: "Everything we do in directing the work force has some elements of training in it; everything we do in training has some elements of supervision in it."

Lessons learned may not be completely retained; various influences may cause the development of bad habits. Watchful supervision will correct these undesired developments. Supervision is, in part, a process of continual education.

GETTING ON AND OFF EQUIPMENT

(A film produced by the Southern Pacific Co. demonstrating correct ways of getting on and off rolling stock.)

Introduced By J. B. MALARKEY

Safety Supervisor, Southern Pacific Co., San Francisco, Cal.

Getting on and off cars and engines is an occupational activity common to all trainmen, enginemen, and all switchmen. It is necessary in switching cars, making up trains, spotting industries, and in picking up loads and empties. It is also a part of flagging and train inspection.

Unfortunately, getting on or off cars and engines is also one of the principal sources of injury to the men of the Transportation Department. In an attempt to pinpoint the major causes, and perhaps find an answer to this constantly recurring type of injury, the Safety Department has spent some time in filming many experienced employees engaged in their normal work, in the act of getting on or off many types of equipment, for the purpose of analysis and perhaps identifying the safest way of getting on and off the equipment.

There appears to be some variation in techniques used by different men.

Let's take a look at the techniques used by experienced men, many who have been performing this operation for years. One man gets off on the leading foot, while another gets off on the trailing foot; another man swings out and lands on his leading foot, while this man faces the equipment, stepping off with the trailing foot; again, yet another man who uses the trailing foot.

After close study of many experienced, accident-free employees, it appears that there is more than one safe method of getting on or off. The conclusion is that each man, through his own experience, develops an individual technique that may be, perhaps, best for him, which is borne out by his good safety performance. However, most of these men seem to have one thing in common: a smooth flow of movement that tends to carry them away from the car or engine as they make contact with the ground.

At this point in the study, it was suspected that perhaps faulty technique was not the major cause for most of the accidents of this type. A thorough analysis was made of the accident reports of all injuries of this type occurring during a one year period. First, the speed of the car was considered. This was not a significant factor. In only six per cent of the cases was the speed over eight miles per hour. Nor was darkness a factor; the accidents were evenly divided between daylight and darkness.

In the accidents involving moving equipment, 26 per cent occurred when getting on, while 74 per cent occurred when getting off. In accidents involving standing equipment, only 15 per cent occurred while getting on, while 85 per cent occurred when getting off. Yes, that's right! Eighty-five per cent in get-

ting off, where no movement was involved, where no skilled technique was necessary to maintain balance. This was an interesting clue as to the major causes of most of these accidents. Further analysis brought out that actually about 83 per cent of all the injuries studied were caused not by the way the injured man got off, but rather by an error in judgment: Stepping into a hole, onto a switch stand, mud, fallen dunnage, or other debris.

Thus, this study of over 180 accidents of this type, indicated that the major problem and its solution lies not so much in the mechanics of getting on or off as in the use of good judgment as to *where* and *when* to get off. The conclusions are that this type of accident can be most effectively prevented by, first, always being sure of the footing before detraining from either moving or standing equipment—being sure that the area is free of water, mud, sticks, stones, and other debris. If in doubt, don't get off. Stop the movement and then do not release your

handhold until your feet are safely on the ground.

Substantial sums are being expended annually in a system-wide program of weed control, and in a continuing program of cleanup of yard tracks, toe paths, and right-of-way. However, as is the case with any busy railroad, it's possible for lading to fall from passing cars and trains at any time, calling for constant vigilance and judgment when detraining.

Maintaining good health and physical fitness are also important to preventing this type of accident. Good physical condition means greater agility, alertness, and balance. You can further protect yourself with good high top shoes, no cuffs, good gloves, no hanging chains, and no loose clothing.

If you are a beginner, observe the techniques of the experienced men you work with. Develop a smooth flow of movement that carries you away from the car and avoid detraining at speeds that make it difficult to maintain your balance.

AN ADDRESS

By BEN W. HEINEMAN

Chairman, Chicago and North Western Railway Company, Chicago, Ill.

There is a waste in industrial accidents, with tragic consequences to employees and their families; loss of dollars to the corporation; adverse morale. No one gains from accidents; everyone loses. This is why, on the North Western, we have come to regard safety as one of the most vital programs on the railroad. While we won the Harriman Award of 1965, and over the years had a fairly good record compared to other railroads, we felt that we should do more.

The North Western's new safety program began January 1, 1967. To implement it, several key top management decisions were made. One of these was the decision to take the Safety Department out of the Operating Department, temporarily at least, so that we could take a whole fresh look at safety. We found that, in spite of our record, men designated as safety officers spent most of their time chasing down accidents that had already occurred, with little time left to cor-

rect the causes of accidents. In a few cases, the safety officer was an errand boy for the superintendent who used him for other matters than safety.

Some of you must be saying, "We would never allow this to happen—not on our railroad." I can only suggest: Take another look. You may be astonished at what you'll find. These problems are by no means unique to any one railroad, or, indeed, to any one industry.

My first action was to charge a special team of North Western's officers, headed by a member of the North Western's new Corporate Development staff, with conceiving, engineering and implementing a completely new train safety program for the railroad based on a systems approach, with top management controls and enforcement. A short time later, responsibility for safety administration was similarly removed from the Operating Department and placed under su-

pervision of the North Western's new Personnel Department, headed by a vice president.

The really important thing in all this was, of course, to firmly establish a rigid safety control and enforcement program on a systems basis for the entire railroad. Our objective was to follow a practice widespread throughout other industry. That is, to separate quality control from quantity control.

All this change was not accomplished without first giving the entire subject a thorough investigation. From mid-October to mid-December, 1966, a careful analysis by a team of North Western officers from various departments of the railroad indicated that the majority of dollar losses in train accidents were those involving in excess of \$50,000 each, with one accident costing us nearly a million dollars. Careful study of these \$50,000-plus accidents showed that roughly 75 per cent were derailments and 25 per cent were collisions—in terms of dollar losses. Again in terms of dollar losses, causes of these accidents broke down into 48 per cent mechanical failures, 27 per cent human failures, 18 per cent track failures and 7 per cent external circumstances.

But our analysis went deeper than this. We broke the property down into what we call railroad number 1 and railroad number 2. Railroad number 1 consisted mainly of heavy-density lines with fast trains and large tonnages. Railroad number 2 was made up mostly of switch runs, wayfreights, and little used branch and side tracks. While railroad number 1 accounts for only 20 per cent of the North Western's trackage, it carries approximately 80 per cent of the railroad's gross ton miles in a given year.

Our studies showed that railroad number 1 accounted for 90 per cent of all the dollar losses for accidents and that railroad number 2 accounted for only 10 per cent. Thus, it was reasonably clear that in looking at a safety program for the railroad, we were looking at the North Western as two separate and distinct railroads. It meant, of course, that railroad number 1 had to receive the lion's share of attention and money, even though it had only 20 per cent of the mileage.

I'll briefly summarize some of the mechanical steps North Western has taken to improve safety performance. Currently, North Western utilizes approximately seven months

of Sperry Car time per year to detect hidden rail defects. Presently under evaluation is a plan to install a year-round Sperry Car program.

A new team of car inspectors has been added to three of our main interchange points. This team has uncovered a host of defects that, had they gone unnoticed, almost surely would have resulted in derailments. These inspectors cost real money, but we have found that the cost is nominal compared to the results that have been obtained, because they are finding defects in cars before we ever accept them for movement over our line. We have embargoed certain types of equipment and certain loads from high speed trains.

We currently have 20 hot box detectors in use, and by the end of the year we will have installed an additional 10. These gadgets cost, as many of you know, roughly \$40,000 each. The capability of the hot box detection system is itself being expanded. Orders are being placed for loose wheel and dragging equipment detectors which will be integrated into the hot box detection system, and a check out mechanism is being worked on by the North Western's Communications Department. If successful, this will allow the equipment to be checked out immediately before and immediately after each train passes the detector location. Additionally, North Western is currently testing a hot box audit system which would be installed on trains at random. This device, as it passes a hot box detector, will trigger the detection system, causing a hot box reading to appear in the dispatcher's office if the detector itself is functioning properly. The dispatcher should then immediately notify the train which will come to a complete stop. If the train crew inspects the train for an overheated axle bearing properly, they should find the audit device attached to the wheel. If they don't, of course, the supervisor will want to know why.

North Western is the first railroad, to my knowledge, with a "systems" audit device of this type. Obviously, it will serve as a field testing system for dispatchers, the train operating employees, and the hot box detector maintenance crews throughout the railroad, as well as a traveling audit on the detectors themselves.

This brings us to the next major area of attention: *Human failures*. The finest mecha-

nized safety system in the world becomes nearly valueless if human beings responsible for the actual operation of the railroad fail to perform properly.

We found that periodic "safety lectures" by the division safety officer is not an effective tool. Men frequently did not show up for the meeting, and when they did, gave only grudging attention. We are experimenting with having division superintendents talk to the men about safety. Superintendents are about the busiest people on earth I know of, but we hope that by having the superintendent make a talk it will have a greater impact on the men—and on the superintendent.

But merely talking to the men about safety isn't enough. We're holding the division superintendent directly responsible for the safety record on his division. We are looking more and more toward a profit center concept in which the superintendent is responsible for all phases of operation on his division.

What we're seeking is to instill in each and every one of our operating officials the idea that these accidents are wasteful in a competitive industry that can't afford waste, and that we are all vitally concerned from top management down.

We've also sharply upgraded our rules instruction and enforcement programs throughout the entire system. Every single operating employee is now subject to annual review and testing on his knowledge of the operating rules. These tests are all machine scored in order to remove any possibility of bias. This is, to my knowledge, the first test in the railroad industry to be designed as a multiple-choice examination that does not discriminate against persons who may be educationally handicapped or labor under problems of poor penmanship, spelling, or punctuation. We are not testing their English; we are testing their knowledge. We have thrown out all oral examinations because they were not graded correctly. All tests are graded by a rules examiner at our Chicago headquarters.

In addition, the North Western is working with a group of railroads operating under a single consolidated code of rules. An agreement has already been drawn up between participating roads to finance the first set of programmed instructions ever to be used by operating officials in the railroad industry. A steering committee of the Consolidated Code

of Rules Committee is currently working with Encyclopedia Britannica to have actual programmed instruction material in the field by Spring of 1968.

Rules, of course, are next to worthless unless you enforce them, and here, too, we've made some major changes.

Recently, for example, North Western launched its Merit Pay Plan for all appointed officers. Number one on the list of performance qualifications, whenever a man comes up for promotion or a salary increase, is his safety record. I am aware that some of our good friends in the labor organizations have long scoffed at the notion that rules enforcement was applied equally to appointed officers and contract employees. I can assure them that it is on the North Western. Since we launched our new program, a considerable number of promotions and prospective raises for officer personnel have been turned down on the basis of a poor safety performance. In at least one case, I am told, poor safety performance has occasioned reduced pay for an officer.

Another new safety performance check instituted in recent months has resulted in the astonishment of some of our field operating officials: surprise inspections. A group of Chicago officers known as the Operations Status Team departs from Chicago's Midway Airport in the corporate aircraft en route to an unknown destination. Even they don't know where they're headed. Railroads are covered with telegraph wires, etc., and the word gets around. Only when this team is in the air is their destination revealed, providing something of a guaranteed surprise for the inspection visit.

Upon arrival, these officers, each a specialist in his own area, proceed to their area of responsibility—transportation, track, cars, motive power, etc.—and completely review the operation for eight full hours. Upon returning to Chicago, a deficiency report is submitted to the General Manager of the railroad. Within 48 hours thereafter, the division superintendent must have launched a program of improvement aimed at correcting every single item on the list.

Now that we've done all these things—purchased new hardware, created a new department, completely revamped management systems and controls procedures, increased vigilance and enforcement—you are entitled to ask, "Does it work?"

To date, the effects of our experimental program are easily demonstrated in sheer economic terms. For the first nine months of 1967, the North Western's train accident costs are 35 to 40 per cent below the comparable nine month period of 1966. By the end of the year, we feel that our train accident costs will average, for the year as a whole, 40 per cent less than in 1966. I have not been in railroading as long as some of you, but I have learned over the past 14 years that railroads have ups and downs and I feel that it will take a span of years to fully evaluate our program.

Beyond that time, projections become progressively more difficult. The ideal would, of course, be to completely eliminate all accidents. While theoretically possible, I suppose, we do after all live in a real world and not in an ideal world. Mechanisms do fail and humans do err.

I'm not suggesting that I think we've necessarily arrived at the complete approach even yet. We are giving some consideration to other steps that may be desirable.

Our idea never was simply to find out what went wrong. What went wrong was obvious. *Why* it went wrong was another matter entirely. We want to find out why and fix that; and that is what we set about doing. We don't have the only answer. We can learn from other railroads.

The effectiveness of our accident-prevention program is measurable by the savings of millions of dollars in its first year. We have focused upon the fundamental causes underlying our accidents and then followed with a "systematized" attack using the three major "E's": *Engineering, Education, Enforcement*.

While we are pleased with our accomplishments in the first year, we intend to continue pioneering technologically and organizationally wherever and whenever we feel additional progress and benefits can be realized. We think there is room for work in the area of personal injuries not connected with train accidents. We think we can avert tragedy from many homes and families, which will be rewarding to the men and to the officers of the company.

TRAINING OF TRAIN SERVICE PERSONNEL

A WORKSHOP

Presiding: George J. Barry, Superintendent of Safety, Chicago, Milwaukee, St. Paul & Pacific Railroad, Chicago, Ill.

Moderators: W. V. Hayes, Director of Safety & Training, New York Central System, New York, N. Y.

H. A. Linderer, Superintendent of Safety, St. Louis-San Francisco Railway Co., Springfield, Mo.

W. B. Groome, Director of Safety, Union Pacific Railroad Co., Omaha, Nebr.

J. H. Gilfillan, Superintendent of Safety, Chicago, Rock Island and Pacific Railroad, Kansas City, Kans.

Barry: We have for discussion a subject that has a wide variance on each railroad property: the training of train service personnel.

We are all convinced that training is vitally necessary for this group. A train service employee must be taught the proper and cor-

rect way to perform the various job functions he must perform. He must also be made aware of the job hazards that experience has taught us. If this effort is made, a drastic reduction in reportable injuries should result.

Train service employees represent approximately 70 per cent of the total personal injuries on each railroad property. It, therefore, is a proper subject to have an exchange of ideas between us to determine if perhaps our own program needs further reinforcements and improvements to make it more efficient.

We have chosen as moderators men who have had extensive background in operations before moving into the field of safety and therefore are equipped to handle the question outlined for our discussions.

(At this point the workshop sessions began. At the conclusion of the group discussions, the entire audience reassembled

and each moderator gave a 10-minute report based on the assigned questions. The moderators' reports follow.)

Hayes: First, we had to discuss the type of program, starting with the classroom. In the classroom area, we had to talk about how much time is allowed in the classroom itself. Here we ran into a bit of distinction; if a man is undergoing instruction out in the field, is this classroom? You might say this is an outdoor classroom. But, for the sake of adhering to our subject, we separated the indoor classroom from the outside, which we called field.

In the classroom, we discuss the type of classrooms that they have on the railroad; some companies have assembly rooms, conference rooms. They might be in the yard office or in the main office building. A passenger coach is often used. It is not a stationary item but travels from point to point over the railroad.

We also discussed hiring rooms in hotels or motels. It's true this is probably more expensive, but there are advocates who say you should get people out of the railroad atmosphere and into a room where they don't have distractions.

How much time is allowed for this in the field? Here we had quite a range. The Milwaukee, the Chicago Belt, and the Southern Pacific each spend one day in the classroom. The Frisco spends one day. The Florida East Coast spends nine days in the classroom. After the first three days in the classroom, they go out for 21 days in the field, then come back for six additional days in the classroom. They pay \$350 a month for their students, which works out to \$11.55 a day. The New York Central spends three days in the classroom; the EJ&E spends one day, part of which is out in the field, most of the day in the classroom.

Does anyone spend longer than nine days in the classroom?

Fred Laing (from the floor): "We have a four-week training period, four hours per day in the classroom and four hours on the track. This works out to a total of 12 days inside the classroom."

The Erie-Lackawanna spends three days in the field for student brakemen, the Milwaukee spends six days, the Chicago Belt spends four days, the Southern Pacific spends 14 days, the Frisco spends 10 days in the field and, as I mentioned before, the

Florida East Coast spends 21 days in the field.

We discussed the question, "What department on the railroad supervises this function of education?" Here we found that in every instance the operating people do the training. I asked whether any of the training people might come from another discipline, such as personnel, but those who do the training are all employees of the operating department. There are some people called training specialists and they are all employed by the operating department.

Another question, "What specific subject matter is covered in the training program?" This is very interesting. For example, New York Central and several others start with organization—the family structure of the railroad—so they know how we're made up. This might cover wage schedules, labor agreements. In this particular phase of orientation, other items are covered, such as proper type of dress for the work; weather (some people don't like to work in the rain, you know); some people don't like to work seven days a week, and you'd better tell them in the beginning.

We find that the Chicago Belt uses a model yard in which they show the student what you mean when you say a car is foul of an adjoining track. What do you mean when you say a car is put in the clear? They show him in this model yard. They also have CTC equipment which they use to describe to the student just how this electronic device functions. They've been hearing a lot about it so they should know something about it. Also, the 'phones—how to use a wayside 'phone, in the case of a road man. The physical activity on the job is discussed.

Films are used—what do these films show? In many cases, they show safety rule observation. Operating rules are covered, safety rules are covered and, of course, part of the time in the field is spent with the mechanical group going over equipment. What is a hand brake? How do you bleed a car? What's a cutoff lever? How do you operate it? How do you operate it safely?

"What benefits have been experienced from the program?" This is always difficult to measure. It's hard to measure how well you're doing. How efficient is a stop sign at a grade crossing? Who knows? How can you tell?

The Milwaukee had an interesting com-

ment. They kept a record of all of the train service men who have gone through their training program. Those men who went through their training program went five years without a disabling injury. I'd say that's pretty good. Another railroad said that out of 93 trainees one man had a fairly slight disabling injury.

What other benefits? First of all, these people tell me that they have better trained men. Their men are more safety conscious. They get them in the beginning and they instill this into them. They are much more aware of rule observation, conforming to the rules. They know what the rules mean.

Another very interesting point which will sum up my presentation is that the men who have gone through this training program have a better attitude, and this is good. Many men say, "Oh, hell, the management doesn't care if I get hurt." We know this isn't true. The people who have been through these training courses have a better attitude. If we can build a better attitude, whether it's in safety, in accident prevention, car costs, or whatever phase we're working on, we certainly have made a tremendous gain.

Linderer: The first task we had was to discuss specifically student trips; that was broken down into three sub-questions, one of which was, "Should the conductor have a checklist or some guidelines to govern his observations of the new student?" As might be expected in a group of 25 people there were some pros and some cons, but the consensus was if you are going to send the student out for student trips with the average run of conductors, the conductors would not take the time and attention to spend with the new student that they should and, for that reason, perhaps a checklist would not be beneficial. Now, if a student were put out with a selected conductor or crew known to be conscientious people, then a checklist would be of benefit.

The second part of the question was to "explore the use of a written examination at the end of the training period to test the impact of the training program," and, "If written examinations are not being conducted, does the group feel they have value?" Of the 24 people in our group, we had only two or three who gave specific written examinations to their new employees following their training program. This was not, by the way, in

the form of a written rules examination but was more to determine, in general, their knowledge about the various things: the hand brake, the air hose, etc.

I was very much surprised to find that this small percentage had any type of formal written examination following the student trip. The general feeling of the group was that there were benefits to be gained by a written examination if properly conducted and if the proper content went into the written examination.

The next question was, "How much time should be allowed for a training program with train service personnel, and how should the time be allotted?" Here again, we found great variance from one road to the other—all the way from a matter of two, three, or four days up to a maximum of 90 to 120 days that the L&N uses for their formal engineer training. I'm sure all of you have read the *Railway Age* and other national publications and have followed, as I have, the L&N's program. I think this is something that all of us are going to be into eventually with the 282 Award and various other things.

One other road, the Central of Georgia, had a 30-day formal training program that sounded to me like an excellent program. As I recall, for the first week they had four hours of classroom work on various types of mock-up equipment; the students were permitted to practice on these and then they had four hours out on the job, under direct supervision. The following week, they were given more time on the job and less time in the classroom; this carried on for a 30-day period.

"What specific subjects should be covered in training train service personnel?" We didn't hit this subject very hard. It would be elementary, of course, to observe and come up with what are the duties of the type of person you're trying to train; a brakeman, a switchman, a locomotive engineer or fireman and I think it would be quite easy to cover all of the subjects that should be covered with a new employee in that category he was going into.

"How many of the group had a formal training program for train service personnel?" Only three or four had a true formal type of training program where they had classroom work, mock-ups, and training aids and, as the student's knowledge increased,

carried on into the yards. It seems to me that this is an indication to all of us that we need to look very strongly into improving a formal type training for employees.

We discussed briefly how many of the railroads pay their students while they are learning; the number was somewhat higher than I had expected. About one-third of the roads pay the students while they are learning, whether it is the classroom type or whether they hired them, gave them a day's indoctrination, and threw them out to the wolves, so to speak.

We also discussed briefly the physical examination aspect, which is important. Happily, a large number, about 75 per cent, require the physical examination, including x-rays, in their pre-employment physical examinations. This will pay dividends in the years to come for those employees.

Groome: We had a very interesting discussion with between 25 and 30 railroad men, principally yard men, about problems that arise as a result of a training program for training train service personnel. For many years, the training of train service personnel has been pretty much the same on all of the railroads—after some indoctrination, a physical examination, you put the train service trainee with your freight crews and, as they progress, they even make a trip or two with passenger service. Certainly a train service trainee, a student brakeman, will put in much of his time in local freight service.

We talked a great deal about the training of yard service personnel. On the Union Pacific they now have joint yard and road rights, which means that the new men, almost without exception, go into yard service.

What has been the training of yard men over the years? I think it has been rather similar on all the railroads—an exposure type of learning on the job, observing the other employees working, then getting into the work himself, and, finally, by exposure learning enough about the work to do a more or less acceptable job.

Just a year ago, I learned of the first departure from this type of training for yard service employees—the centralization of yard service training on the Southern Railway at Atlanta. That's a wide departure from anything I've heard of before. They bring their prospective yard service employee trainees from various points on the railroad into Atlanta. They are trained at

this point on the actual work of the yard men; they learn the operating rules, are examined there and, finally, sent to the yard where they were hired, or where they may be needed.

Right away, our group got into some spirit of rebuttal on that type of training. One man said you couldn't train a student for work in Chicago and then send him to Detroit, because local practices vary that much. This central training concept seems to be expensive; you are faced with the transportation of trainees to the central training location, you put them up there and arrange for their board and transportation from the point of lodging to and from the yard. There seems to be considerable doubt in our group that the added expense brings about a better yard service new employee than training on the job in a local yard.

I went into some detail with our group on a change we made in training on the Union Pacific this year. Our Los Angeles yard is the second yard in switch engine shifts worked on in the entire system, Kansas City being the first. At Los Angeles, due to the amount of outside employment in demand for labor, we have a tremendous turnover. For several years, we've had a yard man from the ranks instructing students. There were a lot of complaints from engine foremen about the quality of students this fellow turned out. A competent yardmaster was chosen this year and placed in charge of training the student yardmen.

Students go through a physical first, including a back x-ray, and then report to the student instructor. We have a 45-minute motion picture, released this year, about Union Pacific, some history of the company, new developments, the CTC, the data processing system, new communications, etc. This gives them some idea of the scope of our company. From there to the freight loss and damage people because, as you know, that is a serious problem in train and yard service on all of the railroads. The Freight Loss and Damage Department representative explains his problems and the amount of loss in freight loss and damage. From there, to the Safety Department for from 45 minutes to 1 1/4 hours on safety on the job.

Then the student instructor takes the men out, shows them how to get on and off moving equipment, how to apply and release hand brakes, couple and uncouple air hose,

proper handling of cut levers and, particularly, the new long sliding type draft gear with the so-called trombone type cut levers. After this preliminary work, he puts them out with some of the better engine foremen. Our training period lasts from 12 to 21 days, depending upon the aptitude of the student; then they're brought in for rules examination and put out for work as extra yard men.

Our training instructor doesn't forget these men at that time. For the first week, in particular, he tries to follow-up with the engine foreman working with these new men and ascertain how they are doing. In case the student isn't doing right, he'll call him off to one side and get into the problem, whatever it may be. This has worked out very well for our railroad.

"What problems arise if training programs are conducted in several locations?" One of the problems would be the training of instructors; if they're not the recipients of centralized instruction, perhaps the students get varied training; the duplication of aids should not be too big a problem. Cost, certainly—the training of students at the individual locations would run considerably less than a centralized training location.

So, we find that with the exception of the one very advanced centralized training location of the Southern Railroad at Atlanta and some point training the New York Central has, most of the other roads train their students in train and yard service right in the territory where they will be used. As for the larger roads, the training in the yard service is at the local points. The consensus was that training should be done at local points, but that training personnel should be trained together to provide uniformity of training.

What problems arise if the training is conducted at headquarters? Of course, the transportation can be rather expensive. There would be differences in hand signals, and other local characteristics that a man would not get at a central training point but would be up against the very first day he went to work at a yard away from the central training point.

Another point made was the lack of personal interest or association that local training would provide. In other words, all too often at a central training point the students would not receive the careful interest of the instructors that they would from a man who

was with them from the day they went on the job.

On the other side of the coin, what problems arise if training programs are conducted in several locations? Possible lack of uniformity in the instruction the students receive; but where we have many yards under joint seniority, we don't find that is too important. It has never been much of a problem of one of our men moving from one yard to another.

On our railroad it has been history that the new man isn't hurt too often. The new man in train and yard service has a great respect for moving equipment. He's extremely careful getting on and off moving equipment and it's only until he's pretty well familiar with his work that the characteristic of the American employee will come to the front and he'll come up with a short cut to do the job easier; then someone gets injured.

We had an interesting discussion and it was felt by our group that training on the job at individual locations up to now has been proved satisfactory.

Gilfillan: Should an existing department on the railroad be held responsible for training train service personnel? Or should a new department be created to supervise the training program? The answer is yes. We'll go to the next one. Well, that is the answer! It was the consensus of opinion that all railroads should have a department for training people. These other fellows have told you what we should do after we get that department. They would help the operating department or the mechanical department in training men. But those men must be taken out to the field with a practical man to learn the rudiments of the down-to-earth application of what is taught to them in the classroom.

When I asked them whether their railroads were willing to entertain the thought of having a separate department, they all raised their hands. If the same group were asked if their railroad would pay for it, not many hands would come up. That is a problem we all have. Can we get the money to put on a training program? You've heard the benefits of a training program discussed; there's money in it, but it's expensive to form a training department.

The benefits to be derived from proper training of employees are hard to measure. Those of us who have worked with men for

many years see the need for it. Some younger fellows will probably enjoy working with training departments and doing a good job of getting good personnel and training them in the proper work habits.

Should the railroad require a certain length of service from new men to protect their investment in a training program? I think they should but we'd have a helluva time trying to get them to sign a contract with us. I don't think they would. How could we get a man to sign a contract to stay with us X number of weeks, months, or years after we had trained him properly to become a switchman, brakeman, engineer, conductor, or what have you?

One fellow came up with a fine thought. There's an obligation on the part of management to orientate this man so that he becomes a willing, loyal employee before he's turned out, as Linderer says, to the wolves. So perhaps it's not a question of whether we could get him to sign a contract. Perhaps management should take this position: "Let's bring this new man in, let's hire him and teach him the good things about our organization. Let's teach him those things that

he can expect from being employed with us—the conditions of his employment, so that we have properly indoctrinated him before he goes out into the field where he will have some discouraging things said to him, such as: 'you have to work nights, you have to work weekends, you don't have any set free days. If there are rest days available they'll be in the middle of the week, and not on weekends.'" So, I think that was a very good suggestion—that management take on the responsibility of orientating the man before he is placed out in the field.

"Discuss quality of training if the instructor is an operating officer charged with other duties." Many of you are operating officers. You know how much freedom you have in the course of your day's employment. You spend many hours with the new employee and teach him all you know about railroad-ing. We have felt that the quality of training decreases if you assign the man to an already busy officer. He just will not have the good type of training necessary. He will not have the type of training that can be obtained by having an experienced teacher or trainer working with the trainee.

CLAIMS AND SAFETY—A COOPERATIVE EFFORT

By JOHN A. RISENDAL

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It has been said that safety is everybody's business. With that statement I doubt anyone will quarrel. It follows that for a business to succeed the cooperation of all members of the organization is essential. With the business of railroad safety, as with any other operation, salesmen—good salesmen—are essential. Many have devoted their careers to safety and made selling it their life's work. In so doing they are offering a product or commodity, without cost to the recipient, but which, if accepted, will permit him to retain the many privileges he enjoys.

Claims men I place in this same category. They, too are vitally concerned with safety as each day in their work they become involved with the results of someone's failure to carry out his responsibility safely. Thus, they also attempt to sell this commodity at every op-

portunity, and for that reason I have labeled this brief presentation "Claims and Safety—A Cooperative Effort". My objective is to point out as best I can the economic effects of accidents on railroad property or involving railroad equipment and perhaps to acquaint you with some of the problems involving safety which face claim departments.

A number of you have been extremely successful in your activities. Your work on your own company properties and with outside agencies, such as law enforcement officers, school authorities, civic groups, and many others has paid huge dividends. Difficulty is encountered when an attempt is made to measure results, to demonstrate the effectiveness of your efforts, as it is impossible to point to the accident which did not occur because of your work.

Not all of us, however, have conducted successful campaigns. Some of us have had only limited success in merchandising our product of safety. This is apparent when we review the statistics. In the 1967 issue of *Accident Facts*, published by the National Safety Council, I was appalled to note the headlines on page 3: "10,800,000 disabling injuries in 1966". Of this number, 2,200,000 injuries and 14,500 deaths were sustained at work. It is estimated that the cost of work accidents in 1966 was \$6,800,000,000, a figure which staggers the imagination.

Let us look at statistics for the railroad industry for the year 1966. Compilations by the A.A.R. Bureau of Railway Economics indicate that in 1966 Class I carriers spent \$108 million in settlement of personal injury claims; over \$158 million in the adjustment of freight loss and damage claims, more than \$8 million for physical damage to the property of others, and \$23 million in clearing wrecks. These are direct charges to the accounts of the carriers and give no consideration to incidental or indirect but related expenses, such as delays with loss of time and productivity, administrative costs, loss of morale, loss of confidence in our companies and industry, and the possible resulting loss of business. At the same time, the grief, pain and suffering, inconvenience, disruption of family life, and other hardships suffered by individuals resulting from these occurrences cannot be assigned a dollar value. Even in the affluent society in which we live today, the most prosperous society in the history of man, can we afford these costs? I think not!

Looking solely at the economic picture, what do these expenses represent to our industry? Operating revenues of Class I railroads total about \$10 billion a year. In 1966, these roads had net earnings of approximately \$902 million, their largest earnings in recent years. Thus, it can be seen that the \$108 million spent in the adjustment of personal injury claims alone represents over 10 per cent of net income, and the total expenses arising from accidents approximately one-third of the net income. In other years within the past decade, when earnings were lower, these expenses have almost equaled in amount the net income of the carriers.

Roughly 75 per cent of personal injury claim expense incurred annually in the railroad industry results from handling claims of employees arising from on-duty accidents. As

it is in this area that the greatest economic impact lies, it will ordinarily receive the greatest emphasis. I have no statistics covering the number of injuries adjudged reportable to the I.C.C., now the Department of Transportation; however, Rex Manion, vice president of the A.A.R., recently remarked that the casualty ratio appears to be declining slightly. Although not expressly so stated, I assume he referred to the casualty rate on basis of a million man hours worked. One would assume the number of accidents should decrease substantially when we consider that employment in the industry has dropped from 1,400,000 to slightly over 600,000 in the past 20 years. However, the number of personal injury and death claims handled each year by railroad claim departments has not decreased proportionately. Records of carriers reveal that annually settlements are arranged in perhaps 25,000 such cases. The vast majority of these of course are minor, but too many others are not.

If the number of injuries was to remain constant, claim costs would still increase because this expense is affected directly by several factors. The two most important bases for any personal injury claim are loss of earnings or earning ability, and medical costs. The average hourly wage rate for railroad employes has increased over 50 per cent in the last 12 years. As an item of special damages, this would be considered in each personal injury claim handled.

With respect to medical expenses, a recent edition of *Labor* reported that during the past year alone hospital charges increased over 10 per cent. The *Wall Street Journal*, on October 17, quoted a report from the Bureau of Labor Statistics that fees for medical services rendered by doctors rose 7.8 per cent in 1966, and that in August, 1967, they were about nine per cent higher than 12 months previously. With these costs constantly mounting, they will have added impact upon the financial picture of the carriers, a situation which can be corrected only through improvement in our accident experience.

Today the matter of safety is receiving greater emphasis from persons in all walks of business, professional, political, and social life than ever before. The number of persons attending the sessions of the National Safety Council attests to that fact. Safety is also the

subject of congressional investigations, of debates in the chambers of other governmental bodies, editorials in each of our newspapers and periodicals, and is also discussed in labor-management sessions. Topics range from automobile and highway safety through pollution of air, water, and land; the food, drug, and tobacco industries; to the rat and other pest control problems.

The railroad industry is not immune. In the past few months it has received its share of publicity, much of it unfavorable. In a recent edition of *Railway Age*, and in the October 2 issue of *Trainmen News*, the president of the Brotherhood of Railroad Trainmen was quoted as stating that he was serving notice that if carriers did not move ahead on their own, if they did not start a real safety program and show results within six months, the Brotherhood will begin moving toward contract provisions giving them the toughest possible control over conditions under which their men work.

On October 11, the Federal Railroad Administrator announced that the Department of Transportation will shortly undertake a thorough and systematic review of railroad operating practices aimed at restructuring D.O.T.'s regulatory activities so they more appropriately reflect the real safety problems which the railroads face today. The primary objective for the department's Bureau of Railroad Safety will be to create a more analytical approach to railroad safety problems.

Although to some these statements may appear to suggest further government intervention and regulation and perhaps impossible-to-meet self-serving demands from the labor side, I prefer to place on them another connotation—that responsible government officers and dedicated labor leaders are genuinely concerned with safety and are anxious to design and implement programs which will eliminate the causes of work-connected accidents. To achieve the desired goals, complete cooperation of all parties involved is absolutely essential and we should enlist the aid and acknowledge the efforts of the others concerned. On our railroad properties assistance will be required from each individual worker, and officers at each supervisory level into the executive suite. Railroad safety officers must spearhead this drive.

Our industry today, as you well know, is in the midst of a form of industrial revolution. The use of computers, introduction of

marketing techniques, new budget controls, labor agreements that tend to stabilize work forces, as well as new relations with government, are all part of this picture. They mark not only change that has taken place, but more and faster change to come. Samuel Seeman, Director of Personnel Administration for the Pennsylvania Railroad, writing in the October issue of *Modern Railroads*, discusses these changes in an article entitled, "Higher Capacity Railroads Need Higher Capacity People". Mr. Seeman states that the industry's human resources, like its tools, are becoming steadily more expensive, and requirements of their jobs are becoming steadily more complex. To produce up to their potential they must be better selected, assigned, trained, developed and motivated. He goes on to say that for an industry with a \$5 billion annual payroll the opportunities for return on investment are immense. Just five per cent improvement in the efficiency of its people would produce \$250 million in reduced costs and improved output, for it is effectiveness of people that reduces overtime payments, train delays, equipment defects, loss and damage, and employee injuries. In fact, he says, it is what improves the service and sells it better.

Mr. Seeman has mentioned several areas in which I believe railroad safety officers must play a prominent part. Some safety officers participate in the selection of personnel. Whether or not this lies within your specific area of responsibility it is essential that you use your influence to make certain that only persons physically, mentally, and psychologically fit for the duties they must fulfill are accepted for these positions. The A.A.R. Medical Section, composed of chief medical officers of carriers, has recently adopted a set of recommended physical standards for all occupations. While individual carriers are not bound by these criteria, many have adopted them. As they represent the consensus of trained, capable professional people, knowledgeable in the requirements of our industry, I suggest that at no time should physical or mental standards lower than those recommended be applied. During periods of increased business activity, pressures may be brought to bear for exceptions or general lowering of the requirements. In my opinion, such action only leads to difficulty.

The requirements will undoubtedly change

as our industry constantly undergoes change. Members of the medical profession serving our railroads should be made aware of all such changes so that the standards may be altered as necessary. Psychological testing has many proponents and many critics. Some of the objections raised bear upon the type of tests utilized. In support of such programs, properly conducted, I might mention a study of work injuries in the automotive industry recently concluded by two physicians at Wayne State University of Medicine in Detroit. Their findings have been published in a series entitled "The Accident Process" which appeared in the *Journal of the American Medical Association*. They concluded that many accidents on the job occur to persons psychologically disposed to become injured, who have ignored safety precautions and instructions and are resistant to rehabilitation. Numerous examples are cited, tracing these tendencies to specific problems in the lives of the injured workers.

Not long ago a conference on absenteeism in industry was held in New York City and attended by medical directors of national corporations. Concurrently the group considered accident proneness and decided:

1. A small percentage of employees are responsible for a large percentage of accidents.
2. That the number of accidents these people suffer is greater than one would expect by chance.
3. If accident-proneness does exist, it is probably a relatively permanent characteristic.

The study also revealed that those who suffer many accidents have personalities different from those who suffer a fewer number, a finding which would appear to coincide with that of the Detroit physicians. Is it not essential, therefore, that every effort be made to identify such persons who possess such tendencies at the earliest possible date so they may be assigned duties which might better fit their aptitudes before an accident occurs?

Some months ago in the Claims Research Bureau we conducted a brief pilot study of severe injuries sustained by employees shortly after they began work on a given day. This covered the experience of several railroads over a two-month period of time, and certainly no definite conclusions could be drawn from the limited data available. It was be-

lieved that the fitness of these employees might have had some effect upon their work performance and thus led to the accidents in which they were involved. Thus the carriers were requested to determine the activities in which these men had engaged during the 48-hour period prior to the accidents. In several cases it was learned that injured employees had been moonlighting, holding non-railroad jobs during off-duty hours or relief days; thus perhaps had failed to obtain proper rest. Others during their off-duty time had engaged in activities such as traveling long distances by auto, or devoting many hours to sports, or do-it-yourself projects at home. Some were believed to have been under the influence of alcohol, or perhaps suffering symptoms of withdrawal following excessive indulgence. A number were believed to have been taking drugs, pep pills, tranquilizers, or medications which conceivably could cause drowsiness. In certain instances the medications may have been prescribed by personal physicians unfamiliar with railroad operations, or the nature of the man's occupation. In an additional number of cases it was believed that domestic tensions, financial worries, or other personal problems may have been the source of great anxiety, perhaps resulting in inability of the employee to concentrate on tasks at hand.

Undoubtedly in the majority of such cases these conditions had prevailed for some time and the day the accident occurred was not the first occasion. If the employees were actually physically unfit, might this not have been detected by careful observation when they reported for duty? For the protection of the individual, as well as that of his fellow workers, the public, and the employer, would not it have been better if each such employee had been withheld from service until such time as his physical condition permitted him to perform his tasks in a safe manner? Had they been sent home when their unfitness was noted, inconvenience and delay would have been caused. However, the subsequent accidents caused much more difficulty, and would not the prevention of the occurrences been worth the minor interruptions of service?

Training of employees, once they are selected for service, is an area in which the safety departments must take the lead. How to conduct successful training programs is not within my limited range of knowledge,

and it would be presumptuous for me to suggest the format for such programs. Because of the more sophisticated type of operations in which railroads engage today, because of the more complex equipment which is utilized, training programs are essential. All employees today must be thoroughly indoctrinated with the grave responsibility with which they are charged, and the precise manner in which they must perform. New processes, new products, and new methods are highly desirable if they improve work performance, but with each change new hazards may be encountered. Safety officers must analyze all factors involved in such changes and take steps necessary to guard against the possibility of accidents resulting from their acceptance.

What action should be taken to obtain strict compliance with rules promulgated for the safety of all individuals? First and foremost, management must accept the responsibility for the adoption and enforcement of proper rules and to condone no deviation. On many occasions an accident has occurred, an investigation has been conducted thereafter, and discipline assessed to individuals adjudged responsible. But how many times prior to the unfortunate occurrence have the same individuals performed in an identical manner, perhaps on occasions with knowledge of their supervisors, yet no disciplinary or corrective action was taken? If discipline is regarded as the proper step to be taken in the event of rule violations, this must be done in every case. No exceptions should be permitted. Let us take necessary action to enforce all applicable regulations before accidents occur.

The duties of safety officers are many and varied. We have mentioned a few in general terms, but specifically, how far does their responsibility extend? In my opinion it is limited only by boundaries of areas in which railroad employees work or equipment of the carrier is operated. As you know, claims of railroad employees for on-duty injuries are handled under the Federal Employers Liability Act, a federal statute which provides that a carrier is responsible in damages to an employee injured as result of railroad negligence. Theoretically, if there is no carrier negligence, there is no liability. William DeParcq, a Minneapolis attorney, prepared a scholarly treatise on F.E.L.A. litigation which has recently been released by Juris-

prudence Publishers in a volume entitled *Model Trials*. In his article DeParcq devotes several pages to a discussion of what constitutes an "unsafe place to work". He states, "It is recognized that the Federal Employers Liability Act imposes on railroads a continuing non-delegable duty to use reasonable care to furnish an employee a safe place to work. This is a duty that becomes more imperative as the risk increases. *Breach of this duty is probably the single most common ground for recovery in an F.E.L.A. case.*" DeParcq then cites many cases in which judicial decisions have held that in one particular or another the railroad failed to exercise reasonable care to provide a safe place to work. He points out that liability of a carrier might arise if an employee sent to work in an area not sufficiently lighted or guarded and frequented by dangerous individuals suffers injuries from an attack; that a carrier may be found at fault for requiring an employee to continue laboring in extreme heat or cold; that within its yard limits carrier must exercise reasonable care to prevent the accumulation of snow or ice in such quantity, form, or location as to be a menace; that a place to work may be rendered unsafe because of a clinker in the roadbed, oil on a cross-tie, or loose or unpacked gravel in a railroad yard; that a breach of the carrier's duty may be found where a baggage handler is required to maneuver his truck on an obstructed or narrow platform, or to force large mail bags through a door which will not open to its full width; that an area may be classified unsafe by reason of an obstruction between tracks at a place that is unsafely lighted, or the location of trees or shrubbery that obstructs the view of one whose duties require him to cross tracks near the growth; that a carrier may be held liable for failure to provide a reasonably safe means of access to the place of work.

There are many other cases in which a carrier was held responsible for an accident which occurred under conditions which reasonable people might find difficult to anticipate. Perhaps the largest payment in a railroad case on record—the highly publicized "Bug Bite" case—is a prime example. An employee alleged he was bitten by an insect while working, resulting in injury or disease necessitating amputation of both legs. In that case the carrier was found negligent in failure to remove from its right-of-way a

stagnant pool which was claimed to attract vermin and insects.

In another, an employe on premises of an industry to inspect a car was injured when struck by an object thrown from the car by an industry employe. In that case the railroad was charged with negligence for failure to inspect the industry premises, determine the possible hazards, and properly caution the employe.

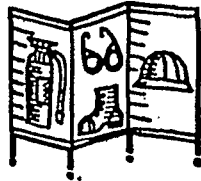
In yet a third, a maintenance employe was struck by a bullet. The point from which the weapon was fired was not shown, but the railroad was adjudged guilty of negligence for failure to post signs forbidding hunting on its right-of-way.

Mention of these cases is made not in the sense of criticism of the decisions, but merely to attempt to point out the vast areas of responsibility with which safety officers are charged. Imagination, ingenuity, foresight, and constant vigilance are necessary to

recognize these dangers and arrange for the elimination of these hazards.

In the article previously mentioned the president of the Brotherhood of Railroad Trainmen was quoted as saying, "All the safety we have on the railroads today is the result of a fight by organized labor. Labor has forced safety upon railroads by fighting for proper legislation." With this statement I must take issue! We recognize full well that labor has made many extremely valuable contributions to the safety program over the years. However, those working in the field of safety, their associates and their predecessors, have also accomplished a great deal. The time has now come when I believe management, labor, and government must join forces in a concerted drive to achieve a true, perfect safety record for the railroad industry. We will welcome the support of all interested parties in our efforts to reach this goal.

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Five Years of Future Dates for the National Safety Congress.....	4
Responsibility for Accident Control..... <i>Harry L. Duncan</i>	5
We Should Provide Incentives for Safety..... <i>Denton Shell</i>	7
Pro and Con of Employee Incentives..... <i>E. E. Sutherlin</i>	9
Caught Red Handed..... <i>Ross E. Scott</i>	10

JOINT SESSION WITH PULP AND PAPER SECTION

Effective Safety Training Techniques at the Woodworkers Level..	
<i>Frank Wille</i>	11
Safety Training in Mechanized Woods Operations..... <i>J. G. Huneault</i>	14
Using Educational Television as a Tool in Safety Education..	
<i>William B. Stuart</i>	19
Are Your Supervisors Your Super Salesmen..... <i>Robert A. Greenfield</i>	20

TEXTILE SESSIONS

How To Kill Your Safety Program..... <i>Grady E. Gant</i>	26
Middle Management's Responsibility Toward Safety in a Textile Plant..	
<i>Frank B. Williams</i>	2
Monsanto Company Loss Prevention Program..... <i>Edward G. Volz</i>	3
Management Audit of Safety Program and Its Performance..... <i>Cole Allen</i>	37
Officers of the Wood Products Section 1967-68.....	44
Officers of the Textile Section 1967-68.....	46
Other Volumes in 1967 National Safety Congress Transactions.....	Back Cover

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HIGHER EDUCATION SESSIONS

HIGHER EDUCATION SECTION TENTH ANNIVERSARY PROGRAM

By DENIS J. KIGIN

Assistant Dean of Extension and Professor of Industrial Technology, Arizona State University, Tempe, Arizona; Chairman, Higher Education Section, National Safety Council.

As you are all aware, organizations such as the Higher Education Section do not just happen by accident. These accomplishments are the result of planning, researching, and critical thinking—even scheming, along with some trial and error. Success has not come easily.

Although the Higher Education Section is celebrating its Tenth anniversary, the roots of the Section extend back much further. For example, the Section has this year completed a revision of the listing of "Safety Education Courses in Colleges and Universities." The exact date on which the National Safety Council prepared the first such listing is unknown, but we do know it was previous to 1938, when the School and College Department of the National Safety Council moved from New York to the headquarters in Chicago. During the years between 1938 and 1953 there was an active group of interested college and university people which, in 1944, was given official status as the Higher Education Committee. It was during this time that, in cooperation with the American Teachers College Association (now known as the American Association for Colleges of Teacher Education), the first national survey of safety education in teachers' colleges was conducted. It was during this period also that the first "Safety Monograph for Colleges and Universities" was published. There are now 23 of these monographs.

In 1953, due to monetary restrictions, the National Safety Council put the Higher Education Committee on inactive status, withdrawing staff help. A small group of men refused to be deactivated and continued to meet at Congress time. With more or less bootleg assistance from their former staff representative they managed to keep in touch with one another. Independently, this group called the First National Conference on Campus Safety at the University of Illinois, Urbana Campus. The National Safety

Council agreed to publish the proceedings, which became Monograph No. 2. The following year, the Second National Conference on Campus Safety was held at the University of Minnesota. These proceedings became Monograph No. 4.

During this time, the American College Health Association had asked for National Safety Council help in finding out what types of accidents were happening to college students. In 1955, the joint project of this group and the National Safety Council was published as Monograph No. 3.

By 1957, National Safety Council finances allowed for the hiring of a full-time staff representative for higher education, so some few months after the Russians spun Sputnik into its historic flight, unanimous approval was given by the National Safety Council's School and College Conference to the establishment of a Higher Education Section. Clayton W. DeMent of Purdue submitted the historic resolution on October 20, 1957.

On October 21, 1957, Lowell B. Fisher of the North Central Association, then Vice President for school and colleges of the National Safety Council, presented a resolution to the Board of Trustees, requesting approval. The Board approved the request, establishing the Higher Education Section. The Higher Education Section now consists of four divisions:

1. The Campus Safety Association, which became active during the years the Higher Education Committee was inactive and was instrumental in asking for permission to establish the Higher Education Section.

2. The Research Division, established with the Section.

3. The College-Safety Education Division, added in late 1957.

4. The College and University Division, established in 1960. The combined membership of the four divisions of the Higher Edu-

1967 National Safety Congress

cation Section now exceeds 1,100. The combined safety experience represented reaches a magnitude which defies numerical measurement.

The Higher Education Section is a voluntary association of college and university personnel dedicated to the cause of coordinating, promoting, and strengthening all aspects of college and university safety. Each division holds its own election of officers and develops its own objectives, terms of reference, and projects.

An example would be the national conferences on campus safety sponsored by the Campus Safety Association. These conferences have been held annually since the first meeting in 1954 at Urbana.

To make an organization as complex as the Higher Education Section functional takes many people. The Section has been fortunate in its leadership; in ten years it has had nine chairmen:

1957-59 John W. Hill, Texas A and M.

1959-60 Arthur Brandstatter, Michigan State University.

1960-61 Bernard Loft, Indiana University.

1961-62 Charles Peter Yost, West Virginia University.

1962-63 James Aaron, Southern Illinois University.

1963-64 Warren Huffman, University of Illinois.

1964-65 Richard Bishop, Florida State University.

1965-66 William Mann, Michigan State University.

I have had the honor of serving as chairman for 1966-67, completing the ten years.

The National Safety Council's staff has contributed greatly to the direction and stability of the Higher Education Section. Our staff representatives have been:

Prior to 1957, Vivian Weedon

1957 to 1963, Daniel Webster

1963 to 1964, William Burnette

1964 to and including present, Jack N. Green

Truly fine leadership.

The second ten years will start out in the firm hand of J. Duke Elkow, of Brooklyn College, as chairman.

This is the capsule story of the Higher Education Section, but I want to assure you, the Higher Education Section long ago "Decided for Safety." If we do make some mistakes, remember we are only ten years old.

THE RESPONSIBILITY OF THE STATE DEPARTMENT OF EDUCATION FOR SAFETY IN THE SECONDARY SCHOOL

By SARAH FOLSOM

Superintendent of Public Instruction, State of Arizona

The term "safety" has many connotations and covers a wide range of ideas, programs, and philosophies.

I am not an authority on safety education, but as a State Superintendent of Public Instruction, I know that I have a responsibility for supporting all measures that will enable us to provide a greater degree of protection against the physical, psychological, and social hazards of our present-day school environment.

School safety, like all the other areas of safety, has not been a well-planned or effective

program in the vast majority of our schools. State Departments of Education, through apathy or lack of funds or personnel, for the most part have not been able to provide assistance or lend support to programs of safety education within the elementary and secondary schools.

To a small extent, at least in Arizona, this problem has been attacked through increased State financing and the utilization of Title funds made available by Public Law 89-10.

On the other hand, we are too often faced

by an apathetic attitude toward school safety and safety education on the part of teachers and administrators. The incidental teaching of both health and safety has been substituted for a well-planned, well-taught program of health and safety education.

It has been my contention for many years that outside of the home the teaching of both health and safety to our children must begin at the kindergarten level and should be integrated or correlated with the entire elementary school program. On the secondary level, we should make efforts to provide some direct instruction in health and safety for at least one semester, preferably two. The Society of State Directors of Health, Physical Education and Recreation, in its publication, "A Statement of Basic Beliefs," strongly endorses the correlated-direct instructional approach for grades kindergarten through 12.

Another glaring weakness affecting our school programs has been the failure of our institutions of higher learning to provide our student teachers with even a minimum amount of information in the areas of health and safety.

State Departments of Education are faced by all of these problems and, therefore, must assume a leadership role in respect to programs of health and safety education.

I have mentioned the utilization of Title funds in providing the services of a qualified consultant of health and safety education. With the funding of the new Federal Traffic Safety Program, we have another means of implementing our programs on the state level, especially in safety and driver education. Also, many state legislatures have become quite concerned about programs of school safety and have approved budget requests for improving their effectiveness.

Providing legislators with information regarding the need for adequate school health and safety legislation and assisting in the preparation of such legislation is a responsibility of State Departments of Education.

Enabling legislation which permits State Boards of Education to adopt rules and regulations concerning school health and safety programs provides for greater flexibility and is more acceptable than rigid statutory requirements which are always difficult to amend or repeal. Board regulations may be changed to keep pace with new trends in education and architectural design.

With adequate financing and a qualified staff, state departments should be able to provide good consultant services to all secondary schools and, in some instances, supervise the preparation of plans for developing broad, comprehensive programs of school safety and safety education.

It is important that state department personnel working in the areas of health and safety be fully qualified through training and experience. They should not only be capable of participating in school-community planning but should also have the ability to communicate effectively with local boards of education, school personnel, and community groups. A school safety program is only as strong or effective as the support it receives from the staff and the community. Public relations, budgeting techniques, a knowledge of safety equipment and facilities and the actual teaching of safety in the schools are, in my opinion, prerequisites for state department consultants.

State Departments of Education should be in a position to provide programs of in-service safety education for secondary school personnel including teachers, administrators, bus drivers, and custodians. Such programs must be tailored to best meet the physical needs of the total school plant, the classroom, and the playground. Such seminars should be scattered throughout the state.

In cooperation with the schools, colleges, and universities, in-service education, workshops, conferences, and seminars should be offered by State Departments of Education not only to disseminate the latest safety information to all school personnel but also to provide a core of trained, qualified, and motivated safety coordinators for the secondary schools.

The preparation and distribution of educational materials relating to school safety should be a function of State Departments of Education. With limited funds and staff, the actual preparation of materials may not be possible; therefore, the preparation of a comprehensive bibliography on safety and safety education for secondary schools might be an alternative. Audio-visuals are available in all areas of safety, but such training aids are expensive and may soon become outdated. It is in this category that state departments may greatly assist the schools through the production of such simple and inexpensive, but effective teaching aids.

Within the last two years many states have prepared and published excellent guides and courses of study in health and safety education for both elementary and secondary schools. State Departments of Education should develop such guidelines and should revise materials of this type at least every three years.

Arizona's 1966 *Health Guide For Secondary Schools* was prepared for the State Department of Public Instruction through the cooperative efforts of a committee of outstanding educators who volunteered their time and services for this purpose. The curriculum committee included three special sections on first aid, medical self help, and safety. The section on safety contains twelve independent teaching units which may be taught separately or as a combination of units.

This is only one example of the nationwide interest in the subject of safety and safety education. State departments must assume a leadership role in respect to publications of this type and should utilize every resource in communicating the most recent and valid information to the administrators and teachers at the local level.

Courses in health and safety and teaching methods must be constantly upgraded. The responsibility here rests jointly with the State Departments of Education, our schools of education, and with the elementary and secondary schools themselves. The new conceptual approach in health education (including safety) made possible by the health education study is the innovative type of program that should be brought to the attention of teachers and administrators. Too often, our teaching of health and safety in the secondary schools is much too formal and lacks vitalization and realism. We cannot motivate our high school youngsters to a positive-type thinking in respect to health and safety if we continue to rely upon the typical "textbook approach" and fail to use new methods, new ideas, and new materials.

State boards of education, through the state departments, have added responsibilities for programs of school safety in the area of safety standards. If State statutes provide for the adoption of rules and regulations by the Board of Education, the State department is responsible for the promulgation of safety standards which may be adopted by the Board of Education.

In addition, the State Department of Education should be responsible for keeping school districts informed in respect to legislation affecting school safety and all the legal implications of legislation, standards, and rules and regulations. Liability has become a serious problem, even a threat, in areas such as California and Arizona where the supreme courts have ruled against governmental immunity. State departments are in key positions to obtain from state attorney generals' offices legal opinions concerned with any aspect of school administration, including the administration of school programs of health and safety. Information of this type should be communicated directly to the schools of the state.

I should like to emphasize another department responsibility. I have found that through association with the representatives of many disciplines on state-level safety committees or councils, a great deal of support may be obtained for school safety programs. Both our consultant for health and safety and I have participated in several such groups, including the Governor's Council on Traffic Safety. The membership of such organizations represent a good cross-section of community life; thus, through these people much information relating to school safety may be channeled to the various communities of the state.

In summary, I should like to enumerate some of the functions that should be performed by the state department staff.

The state director and his staff should be in a position to:

1. Provide expert consultative services on safety matters to local school systems and to colleges and universities.
2. Plan periodic visits to local school programs to keep abreast of trends, successful practices, and programs; to provide on-the-spot assistance; and to lend support to local efforts.
3. Establish and maintain effective communication with the other state and local safety agencies and groups and provide appropriate services and assistance upon request.
4. Initiate and conduct comparative and status studies as well as other special safety studies; encourage and assist in needed safety research.
5. Organize study groups and special

project committees to deal with particular problems or to take timely action.

6. Establish and carry out pilot and demonstration programs of school-community safety applying (a) New approaches to the planning, financing, and construction of school facilities; (b) New ideas in program planning and developing; (c) Ways of making greater use of safety resources; and (d) Other innovations and promising practices.

7. Work to improve the professional preparation of safety personnel and increase the supply of qualified safety coordinators.

8. Assist colleges and universities to upgrade their curricula for pre-service and in-service education of teachers.

9. Establish high standards for the profes-

sional preparation of safety personnel employed by the schools. Such standards should be similar to those of other areas of instructions but should also require appropriate preparation for community leadership in safety. Help set up state board or department policies and procedures relating to the qualifications and selection of school health and safety personnel.

10. Where appropriate, take the initiative to organize or strengthen a state interagency committee on safety, or some similar medium for effective cooperation among the state agencies.

11. Interpret and publicize the safety interests and services available from the State Department of Education.

WHITHER COLLEGE AND UNIVERSITY SAFETY CENTERS?

By **CHARLES H. HARTMAN**

Director, Education and Manpower Development Division, Automotive Safety Foundation,
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Federal legislation enacted last year offers compelling reasons for overcoming obstacles to progress without further delay. Under the Highway Safety Act of 1966 enlarged opportunities for university service are provided by means of:

1. *Training* of two types to provide the higher degree of official competence required to meet the objectives of the Act. These include:

a. On and off campus in-service short courses for traffic safety workers employed at state and local levels of government.

b. Undergraduate and graduate degree instruction for career safety people who are in short supply.

2. *Consulting assistance* in resolving technical problems as requested by the state and its local political subdivisions.

3. *Planning assistance*, particularly among the counties and towns, to develop comprehensive accident control programs in conformance with the state program and as required by the Act.

4. *Research* into accident causes and the development of countermeasures contribut-

ing to the solution of traffic safety problems peculiar to the state and its local subdivisions.

The Act provides several incentives for stepped-up state and local activity which may be of interest to the state universities. Among these are:

1. The promulgation of Federal safety performance standards to be met by the states and their local subdivisions.

2. The requirement that each state periodically evaluate its progress in each standards area and report thereon to the National Highway Safety Bureau.

3. Federal-aid matching funds to help the state meet the standards. Forty per cent of these must be expended for local programs.

4. Direct Federal grants to qualified institutions for safety research, training projects, and demonstration projects.

5. The long-range possibility of cutbacks in Federal aid for state highway construction in event of failure to meet the prescribed safety standards.

So much for the need. What are the problems, the obstacles to progress?

Four factors appear to be basic:

1. *Money*—there is a well recognized shortage.

2. *Manpower*—less well recognized as being in short supply, but equally as critical a problem.

3. *Inadequate definition of function and goals*—a seemingly chronic ailment that blocks understanding and support on all sides.

4. *Support*—without it the money, manpower, and other needs can't be met.

The money, manpower and support factors are largely self-explanatory. Hence, I'll comment only on my contention that university safety centers are seldom well defined and interpreted. Functions and goals would be easier to understand, and thereby more likely to gain support, if greater care were taken to both determine and define:

1. *The Center's area (s) of concern.* Is the goal traffic, industrial, home, fire, or some combination of these "safety" fields? If traffic, does this embrace all traffic areas such as enforcement, education, engineering, or just some aspects of the total field?

2. *The Center's scope of service.* Will there be a teaching program? Research? Service and assistance to others? Combinations of all?

3. *The Center's target group(s) to be served.* Are the intended beneficiaries at the local, state, or national level? Is it the professional or the man-in-the-street who is the target of the Center's efforts?

Providing answers to the above questions will mark only a beginning in the search for purpose, manpower, money and support. All of us are obliged to join in the search.

WHAT ARE THE CHALLENGES FOR SAFETY CENTERS?

By WILLIAM T. RICHARDS

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Madison, Wis.

Why school safety programs? Obviously, because there is a school-age accident problem.

But how serious is the problem? It is difficult for us to generalize. Statistics have been found to be of little interest to most people. Fifty thousand killed on our streets and highways has become a part of the American way of life. Apparently our psychological make-up will not allow most of us to envision ourselves becoming part of these statistics.

School safety specialists agree that there is a school-age accident problem. The quantity and quality of school safety programs vary from "Absolutely nothing visible or identifiable" to "Excellent, comprehensive programs."

Why the difference in the quantity and quality of our school safety programs?

It appears that these differences exist because:

1. There never has been an adequate accounting or accident-reporting system initiated in too many schools.

2. There is no interested, qualified individual

in too many schools to provide the leadership necessary for initiating and conducting a good, school safety program.

3. The schools have taken on more and more responsibilities and tasks, so some school officials have not believed that safety education should be their responsibility. These same persons believe that there is no time and not enough money available to support such a program.

4. We have had relatively few universities offering in-depth, quality safety-education programs for adequately preparing school safety coordinators. Thus, the quantity and quality of school safety coordinators have not been available to our schools. No wonder the leadership has not been available in our schools!

5. State departments of public education have been slow to add qualified safety personnel to their staffs. These departments too often have not developed a well-coordinated safety program at the state level. So, I am really saying that at the state level too often the leadership and the consulting help has been lacking.

6. It appears that there is a real shortage of well-qualified safety coordinators at the local and state level and, as serious if not more serious, there is a real shortage of qualified college-university safety professors.

7. To date, many, if not most, of our states have not developed certification standards for school safety coordinators. Thus, there is little identity and no credential for those who are attempting to carry the responsibility of a "School Safety Coordinator."

8. We have not defined the need or role for school safety programs effectively.

9. We have not communicated the "School-Safety-Need" message to the decision makers effectively.

I believe two of the basic reasons we do not have the number and the quality of safety centers that we need is because: (1) Our schools have not demanded nor sought the services that a safety center can provide, and (2) State Departments of Education have failed to do this also.

A study entitled, "The Role of Higher Education in the Professional Preparation of Traffic & Safety Specialists" is being conducted for the primary purpose of improving the preparation of personnel in this field.

This study explores the problems of colleges and universities in Wisconsin which prepare traffic and safety education personnel, conduct research, provide extension courses in this area, and provide accident prevention clinics, conferences, and services.

Principally, this professional preparation is designed for elementary, secondary, and university teachers. Some of these persons do enter industry, or business, or governmental agencies upon completing college courses and/or degree programs in the area of traffic and safety education. Too, there exists a real potential for providing new courses and safety services for industry, business, and governmental agencies.

Because this discipline is comparatively young, it faces serious problems. Among the predominant problems to be cited are lack of (1) Sufficient financial and administrative support, (2) Qualified professors, (3) Adequate laboratories, and (4) Proper identification and articulation of the traffic and safety education program.

These problems are being studied by several research techniques. It is proposed that these techniques include historical, case

study, interview, mailed questionnaire survey, and philosophical approaches.

Interviews have been conducted with the key college-university administrative staff members and the college professors in this field. In the twelve college-universities in Wisconsin with traffic and safety education programs, more than seventy interviews were conducted. The investigator did the interviewing at each college-university site.

A historical background, an analysis of present major components of the program, and an analysis of future plans of each university program will be compiled.

These aforementioned techniques will help gather the needed data. This data will be charted, with the use of bar graphs, in order to show relationships of major components of each individual university program in comparison to the other universities offering such programs.

These findings shall indicate trends, strengths, and weaknesses of the individual college and university programs, as well as the weaknesses and strengths of the twelve college and university programs on a collective basis as compared with already existing national recommendations.

The findings and conclusions will be based upon newly developed standards by the investigator. These standards shall have been criticized and refined by a national board of judges. The investigator formulated his original standards based upon past national studies, past national conferences on the subject, authoritative literature in the field, and past experience of the investigator from his working on national committees in this area. These standards will be finalized with the help of these authorities.

From these newly developed standards for Wisconsin college and university traffic and safety education programs and from the findings of the study, recommendations will be made.

This study will then be presented to the Coordinating Committee for Higher Education for its use in identifying the role of a selected number of Wisconsin colleges and universities in traffic and safety education. The study shall not only analyze the present status of existing programs and needs, but it shall recommend what the programs should be.

Another part of this study dealt with an analysis of the supply and demand for traffic

and safety specialists in one state, Wisconsin.

Another part of the study surveyed driver education teachers and school safety coordinators. They were asked:

1. What their future vocational plans are in our field.
2. What degree programs they would be interested in.
3. From a list of eight additional courses, which would they like to see offered.
4. What their "role" is in their present job (a breakdown of tasks).
5. What they have done to upgrade their own competencies in this field within the past twelve months.
6. What additional inservice experiences and programs that they would like to have offered.
7. What competencies they believe are necessary to make an ideal driver education teacher.
8. What units they are presently teaching in their classroom course of driver education.

The study should be able to indicate to institutions of higher learning and a proposed safety center the following:

1. The supply and demand for traffic and safety personnel.
2. The basic thinking and desires of school superintendents for personnel in this field.
3. The desires of present teachers for pre-services and inservice courses and programs.
4. The tasks that this personnel is presently performing.
5. What is being taught in the classroom phase of driver education.

I believe that with this information our institutions will be in a better position to redefine their own individual roles in traffic and safety education.

I would like to conclude by examining one of the prime functions that a safety center could provide—the planning and execution of applied research.

It would appear to me that most State Departments of Public Education and local school districts make their educational decisions based upon past experience, biases or prejudices, pressures, "hunch" or guess, and subjective thinking.

I believe we have found the answer in most states in initiating programs in our schools. We have quantity of programs in many states. But do we have the quality that we need?

We now need to devote a great deal more attention to improving the quality of these programs. We have upgraded our certification requirements for driver education teachers, at least sometimes in numbers of courses and total number of credits. In order to help insure standard quality programs, we utilize minimum standards. These standards too often have become the guidelines which school districts have adopted as ideal standards.

Because the field of safety and driver education is a comparatively new field (with little more than 30 years experience), there is little research upon which to base the minimum standards which we have adopted and enforce for our driver education aids program.

I would like to suggest that the following are among the problems facing our State, and I wonder if these same problems aren't facing most states.

Is it best to schedule the classroom phase in a block manner, once a week for the entire year, or twice a week for one semester or two semesters?

What certification standards (total credits and specific courses) are necessary for competent teaching?

What should be an acceptable driving record?

How can the effectiveness of driver education programs be measured?

How can the scheduling of the various laboratory methods—driving simulators, multiple-car-range, and dual-control-car-on-the-street—be best planned?

What is the role or the task of the driver education teacher?

What is the role or the task of the school safety coordinator?

What are the total number of clock hours that should be provided in the classroom and the laboratory phases of driver education?

What are the minimum standards that states (total and combination) should require for scheduling the utilization of driving simulators and the multiple-car-range?

What are the minimum lengths of time (total number of weeks) that should be required for scheduling the classroom and the laboratory phases of driver education?

What is the over-all school age accident problem in individual states and how can it be improved?

Are there particular subject areas in our

schools which experience a disproportionate number of school accidents?

Are special provisions (special teachers, scheduling, and materials) made for the exceptional child in safety and driver education?

What is and what should be the role of the state supervisor in his visitations to a school setting?

What are the ingredients of: A. good driver education program? A good comprehensive school safety program?

What impact does the state supervisor have on school programs? Does it make a difference that visitations have been made? What should the follow-up be?

How does the safety and driver education teacher work with other school colleagues and members of the community in performing his job?

How are emergency procedures taught in our driver education programs?

Does the course content appear to be uniform in our state? Should it be?

How do high school driver education students evaluate the effectiveness of their driver education programs? How do parents evaluate the effectiveness?

Is there a relationship between accident involvement and:

A. Intelligence?

B. Grades?

C. Extra-curricular activities participated in?

D. Completion of high school?

E. "Kinds" of courses taken?

Does the school building, grounds, and the total school environment (one story only or two stories, floor surfaces, etc.) have a bearing on the school districts' accident experience?

What impact does the charging, or not charging, of a materials fee have on programs, students, and families?

How effective are night courses in relationship to the regular school day courses?

How are summer programs scheduled in relationship to regular school year programs?

What should the maximum (ideal) instructional period (minutes) be for the laboratory phase?

What is the maximum length per instructional period that should be allowed in the classroom phase?

What is the effect of children and youth, as transmitters of safety information, upon the safety attitudes, knowledge, and practices of their parents (as in the utilization of seat belts)?

How should the laboratory (simulation, multiple-car driving range, and on-the-street driving) phases be scheduled in regards to sequence? Can the simulation phase follow the range instruction with beneficial results? It is generally and widely believed that the range instruction must follow the simulation laboratory instruction.

THE PROBLEMS ARE...THE SOLUTIONS MAY BE...

By **DOUGLAS TOMS**

Director of Motor Vehicles, State of Washington

In the past ten years (1957-1967), fewer than five major safety centers have been developed as a part of our nation's colleges and universities. In the ten year period between 1947 and 1957, a sizeable number of safety centers were founded.

Can we assume that those centers (such as California's ITE, Michigan's HTSC, and New York's CSE) have sufficiently filled the void so that subsequent safety center development became unnecessary? I think not.

The growth, the expansion, and the complication of the traffic problem in the United

States is considerably more severe today than it was in the period 1947-1957. The need for the services that such centers can provide is greater now than ever before.

I doubt that anyone will challenge the desperate need that this country is experiencing for talented and able workers on the traffic safety scene. If we can then accept that there is a desperate need for educated personnel in the traffic safety field, why then has there not been a greater development of traffic safety centers?

Certainly traffic safety is not the only

problem confronting today's society in the United States. Last year's Chrysler Corporation Opinion Poll indicated that crime was the number one problem on the mind of the nation's public. Air pollution, water pollution, mental health, urban renewal, all aspects of the racial problem, and a long list of other issues could easily be defined as being terribly important to today's society. Traffic safety must compete with that list for attention. I do not see crime research centers sprouting up on our campuses of higher education, nor do I see centers for air or water pollution. One can only conclude that our nation's leadership does not view the development of such centers as a major solution to the problem. I think that we must accept the fact that safety center activity is supplemental to the solutions of such problems.

Certainly such obstacles as money, public support, and the lack of personnel to staff such centers can be readily identified. I doubt that anyone would challenge the fact that money is always hard to acquire, however desperate the need. Additionally, no one will probably challenge the difficulty of obtaining public support for any expensive activity. The very crux of the problem, i.e., a shortage of educated personnel, also bears directly on any explanation as to why safety centers are not being created.

I think that we must be careful that we do not place more emphasis on the acquisition and development of safety centers than is warranted by the existing public and official support. There are professionals hard at work in many other fields. They are competing for the same money that we are. You can ask any legislator and he can give you a pretty good idea of the competition for the taxpayer's dollar. So, we must keep our objectives in proper perspective.

There is one common denominator that prevails in the solution to any problem. It is money. In the traffic safety business we are blessed with a lot of support from the private sector. A great many foundations, committees, and cooperative agencies receive money from the private sector for dispensation to grass root agencies. The Automotive Safety Foundation, the Insurance Institute for Highway Safety, the Inter-Industries Highway Safety Foundation, and many others have been supporting traffic programs for a long time. Without them most of the existing traffic safety centers would be hard pressed

to maintain their present programs. I think that we should continue to look to them for much of the support that would be needed to broaden safety center activity in the United States.

No one has attempted to review the national scene as it relates to safety center activity. Certainly some safety centers should modify their existing structure. For example, the Institute for Transportation and Traffic Engineering does little or no teaching. On the other hand, the Highway Traffic Safety Center places a heavy emphasis on their instructional programs. From a geographical standpoint, southern California students cannot afford to journey to Michigan in order to attend classes. Conversely, some of the work done at the ITTE is not particularly applicable to the problems facing the citizens of the State of Michigan. A degree of orderliness and a review of regional concerns would be a help in this discussion.

It would be my recommendation that the DOT or a national agency from the private sector undertake a nationwide survey of this problem. For example, there is absolutely no safety center activity in the Northwest. Yet, the growth of the Northwest in the past five years has created a need for the services that a traffic safety center could offer.

However, such a recommendation should not be misinterpreted so as to mean that the private sector should take the total responsibility for the development of future safety centers. The majority of the existing centers operate out of a publicly financed college or university. Of this majority, the bulk of them are state rather than city or county financed institutions. Because of this consideration, popular support is a necessity. State legislators will not back the creation of a safety center at one of their local colleges and universities without strong public support to do so. In that sense, it is we, the "leadership," who must assume the responsibility for the creation of future traffic safety centers.

Certainly the future appears brighter. Although the past ten years has seen little or no development, I predict that the next ten years will again see the creation of a number of such centers. I think that we can understand why such things seem to move in cycles. We experience a good deal of activity and then we sit back contented that we have done something about the problem. The problem then has to grow worse again be-

fore we are spurred to future action.

The need to be spurred to such action appears to be commonly felt across the country today. Last year there were two bills in our

state legislature to create a traffic safety center. I am sure that this situation is not peculiar to the State of Washington. I am confident that it has been felt elsewhere.

SUPPORTING ELEMENTS OF AN EFFECTIVE MAJOR AND MINOR IN TRAFFIC AND SAFETY EDUCATION

By **AUGUST J. SCHULTZ**

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Any discussion of majors and minors in traffic and safety education forces one to realize that this subject is not only comprehensive in scope, but that it is also a subject most difficult to document with current accuracy.

Supporting elements include: The selection of qualified instructional staff; sufficient academic references; identifiable courses and content; and, use of flexible instructional methodology. The order of acquisition, and the strength, separately and collectively, of these supporting elements will to some extent determine the effectiveness of the overall Traffic Safety Education Program within a given institution of higher education.

Before discussing the supporting elements, let us review earlier historical efforts related to the growth of traffic and safety education courses and programs.

A little over 41 years ago, a survey of selected institutions of higher education obtained a variety of "vintage" convictions concerning the opportunity of teachers in training in accident activities. Some typical responses from widely separated geographical areas were: (1) "The tendency to add new courses to our curriculum has already gone too far, but I do think the subject is worthy of some consideration and attention"; (2) "This kind of work is desirable, but there is doubt if it should require full time as a formal course"; (3) "Organized material is scarce. We would be glad to do more along this line if material organized for teaching is available"; (4) "This varies greatly according to instructor. During each year we have half a dozen in charge of this work"; (5) "This state has so many laws now about teaching fire prevention, humane-

ness, narcotics, alcoholic drinks, and the like, that it is actually impossible to obey the laws"; and, (6) "I shall be interested in a statement from you as to what more can be done than we are doing to prevent accidents in our school."

It is known that there are officials in higher education who are actively voicing today the same type of comments recorded forty-one years ago.

By 1941, only 18 states had developed state courses and only six required that safety be taught in elementary and secondary schools. The slowness of growth was attributed to the lack of higher education to give proper recognition to safety education within their institutions.

Later, in 1958, a survey revealed that 328 colleges and universities offered a total of 975 offerings available for educating personnel in the fields of highway safety and highway traffic.

Finally, a more recent survey of higher education in 1966 revealed a total of 39 institutions in 21 states offer safety education minors for a Bachelor's degree. In addition, 13 colleges and universities in ten states offer a minor in a Master's degree program, and seven schools in six states permit doctoral candidates to minor in safety. Further, majors in safety may be obtained in a total of 22 institutions in 18 states at the bachelor, master, or doctoral level.

The survey of 1966 reveals the growth of traffic and safety education courses and programs over the years since the initial survey, carried out in 1926. The recent passage of the Highway Safety Act of 1966 has stimulated renewed interest in higher education personnel relative to the establishment or ex-

pansion of programs in traffic and safety education.

It is toward this renewed interest in higher education that this discussion of the supporting elements is directed.

The element which I consider to be number one in any major or minor traffic and safety education program is an interested and qualified staff. According to *Policies and Practices for Driver and Traffic Safety Education*, published by the National Education Association, college and university instructors in driver and traffic safety education need competences beyond those expected of teachers in the secondary school who teach the beginning driver. College and university personnel should hold at least the master's degree with a major in safety education and should have had administrative or instructional duties, preferably in a secondary school.

Policies and Guidelines—Teacher Preparation and Certification supports the recommendations of *Policies and Practices* and further relates that, since driver and safety education draws upon the contributions of several disciplines, responsibility for coordination of the program should be delegated to a person who is well qualified in general education as well as in safety education and accident prevention. In addition, faculty members should be carefully selected on the basis of preparation and interest.

Another important consideration in the selection of staff for traffic and safety education programs is to select staff that are able to work effectively "outside" the academic atmosphere. Traffic and safety education activities are restricted when they are limited to the confines of the college or university campus. The support, understanding, and cooperation of the community is vital to any effective Traffic and Safety Education Program.

The second element which I consider to be important in any major or minor traffic and safety education program is sufficient academic reference. This area is probably the most overlooked aspect of developing the major or minor program. Only recently have sufficient numbers of text become available to support already existing courses in the area. However, all too often the supporting references in college and university libraries are lacking in both quantity and active holdings.

An effective major or minor program needs the general holdings of the university library, but it also needs specific holdings within the discipline. These holdings will not be there unless the person in charge of the program works with the library staff in the acquisition of the needed references. Items such as course texts, interdisciplinary references, comprehensive periodicals, doctoral abstracts, doctoral holdings (which are now available in microfilm and Xerox copies), and indexing and abstracting services related to the specific discipline are all vital to a program.

A basic holding in periodicals could include the following: *Journal of the American Society of Safety Engineers*; *Current Literature in Traffic and Transportation*; *Family Safety*; *Highway Research Abstracts*; *Home Safety Review Holdings*; *International Occupational Safety and Health Information Service*; *Journal of the American Association for Health, Physical Education, and Recreation*; *National Safety News*; *Journal of the Society of Automotive Engineers*; *Safe Worker*; *Safety*; *Safety Education* holdings; *School Safety*; *Safety Journal*; *Safety Maintenance*; *Safety Standards*; *Traffic Digest and Review*; *Traffic Engineering*; *Traffic Quarterly*; *Traffic Safety*; *British Journal of Industrial Safety*; and, *The British Journal of Commerce Safety*.

The third "element" needed in the development of a major or minor is the identification of course content and subsequent courses in traffic and safety education. A review of course titles presently offered in selected colleges and universities can provide direction to schools who hope to extend their traffic and safety education programs. Fifty-eight course titles are offered at colleges and universities on the undergraduate and graduate level. The variety of course titles would tend to suggest that there is a wealth of "content" available in the field of traffic and safety education. However, no effort has been made at the national level to ascertain what kind of uniformity or similarity exists between the different titles of presently offered courses.

The final element needed in the development of a major or minor is the "use of flexible and appropriate instructional methodology."

Courses in educational methodology urge prospective and in-service teachers at the

secondary level to utilize an appropriate method which will present the content in the most stimulating and most meaningful way. Yet, few colleges and universities provide the necessary facilities and equipment to allow their staffs to "practice what they preach." Lecture courses are necessary and appropriate, but traffic and safety education instructional staff should also utilize such methods as role playing, projects, audiovisual methods, psychophysical testing, surveys, accident analysis, group discussion-decision, field trips, resource persons, demonstrations, educational television, simulated experiences, and individual field experiences. Each of these methods can add to the interest and the self improvement of all who are exposed to them.

In conclusion, it is apparent that traffic and safety education majors and minors will accelerate at a much faster rate than they did in the first 67 years of this century. However, their success will depend to a great extent on how they select their staff, how they organize and gather educational

references, how they identify courses and content, and how they employ methodology in the courses taught within their respective institutions. Each of the individual elements have a major contribution to make to the overall success of the major or minor in traffic and safety education. Our task is to work for the improvement of all four.

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GRADUATE PROGRAMS IN SAFETY EDUCATION

By A. E. FLORIO

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When we look at graduate programs today we find quite a variety of patterns. We have five year programs of undergraduate and graduate work culminating in a professional degree which may or may not be a Master's degree; one year graduate programs for teachers or professional personnel; one year research oriented programs as a first step toward the doctorate; a two year program leading to a professional degree; a three year program, without foreign language and a formal dissertation, (this is usually the Ed.D. degree); and the three year program with foreign language and formal dissertation requirements, terminating in the Ph.D. Through these varieties of patterns, graduate schools attempt to fulfill the needs of the students.

What does the safety educator need? Regardless of the type of degree, I believe the graduate programs that (1) add to the stor-

age of knowledge through basic research, (2) prepare scientific research workers and humanistic scholars for colleges and universities, business, industry, and government, and (3) provide advanced study for teachers, specialists, and administrators for school should all be available for those interested in the entire field of accident prevention and injury control.

Graduate work in safety education was first offered at New York University in the mid-1920's, but several theses and dissertations in this area were completed at Columbia and the University of Chicago before 1930. In 1938 the Center for Safety Education at New York University was established and probably to this day is the leading university in this field for providing opportunities at all graduate levels.

One of the major questions confronting us today concerns the nature and purpose of

graduate study. What is the difference between "graduate work and degrees" and professional work and degrees? A conference of Deans of Southern Graduate Schools made the following distinction: It thinks of "professional" graduate curricula as having an emphasis on application and that instruction is chiefly concerned with "training" in the skills and techniques of practice in a field of endeavor. It thinks of "graduate work" as being concerned with the history and theory of a subject as being occupied evidently and critically with the materials of knowledge in a field.

Major Issues and Problems.

The major issues center around the question of where emphasis in graduate education should be placed. Should it be primarily professional or academic in nature? Should the emphasis be placed on vocational preparation or on advanced study and research in an academic field? Should it produce the educated man or the skilled specialist? What kind have we produced in our field in the past twenty years? Part of the difficulty or controversy arises from the fact that methods for advanced study differ for the various disciplines. The scientific method which has been used effectively in the biological and physical sciences may not be applied as effectively in the humanities and social sciences; yet the scientific method has certainly had an undue influence on the nature of graduate work.

Regardless of the point of view regarding the basic issues, many other questions remain to be answered:

1. By what graduate programs and methods are teachers for schools and colleges best prepared?
2. How can the undergraduate and graduate programs be articulated effectively?
3. Should graduate research be directed primarily toward the advancement of knowledge or toward the education of the student?
4. What constitutes an acceptable dissertation topic? How should the M.A. or M.S. thesis differ significantly from the Ph.D. dissertation?
5. Should foreign language be a requirement for the Ph.D.?

These are some questions that must be answered, particularly for those institutions starting graduate programs.

Additional factors of over-all concern are

the various types of degrees that should be offered or, more importantly, what type degree the college and university is qualified to award. Does the graduate faculty have the qualifications and specializations needed to offer the master's, intermediate, or certificate program, the doctoral and post-doctoral program? What criteria should be used for selecting graduate faculty? Should graduate teaching be limited to only those having a doctor's degree? Certainly they should have sufficient preparation in a selected phase of the discipline to assure a high degree of competence and provide background for significant research or creative production in the specialty. They should be well qualified to do scholarly work; be competent teachers, perform research, as well as guide research activities. They should also have ability for creative activity and thinking in order to develop creativity in students and, finally, should also be involved in college and community service.

What should be the instructional and research resources essential for quality graduate study? Quality graduate study demands an excellent library, special laboratories, data processing, special institutional research resources for funding pilot programs and research exploration for faculty and staff. Scholarships, fellowships, and assistantships should all be a part of the resources of graduate education.

Graduate Program of Study in Safety Education—Degrees and Expected Outcomes.

The master's degree in safety education, generally speaking, is designed to prepare teachers, coordinators, and supervisors for elementary and secondary schools, school districts, and junior colleges. The program likewise is designed to prepare personnel for government and private agencies, service organizations, and industry. It should also provide the necessary competencies for those wishing to proceed to an intermediate certificate or degree, or the doctorate.

Graduate study programs leading to an intermediate degree or certificate beyond the master's degree consist of 30 or more credits and are designed to provide opportunities for specialization of a terminal nature or as a basis for advanced study.

The doctor's degree with an emphasis on safety education is designed to provide competencies for those wishing to teach at col-

leges and universities, researchers, directors of university safety centers, and for high level supervision in schools, colleges, universities, industry, private and public agencies, and governmental agencies.

Admission Requirements.

They should be the same as those for other graduate specialization at the particular institution. The institution should meet at least the minimal standards of an appropriate accrediting agency.

Degree Requirements.

Briefly, the applicant for the master's degree must have a baccalaureate earned with a grade of B or better from an accredited institution. Those below B may be admitted after demonstrating their capacity for advanced study. The degree requirements should be equivalent to a minimum of one year of academic work beyond the bachelor's degree. At least three-quarters of this work should be completed in residence, and at least one-half of the course requirements should be in the area of safety education, accident prevention, and injury control. The candidate should also provide evidence of his capabilities by meeting requirements such as a thesis, supervised field experiences, and written and/or oral comprehensive examinations.

The candidates for the intermediate degree program shall present a master's degree from an approved institution and also receive approval from the appropriate safety education department. Two years of professional experience or its equivalent are desirable. While this degree or certificate program should be planned on the basis of the background and professional goals of the candidate, all should include a minimum of 30 semester hours of graduate study, two-thirds of which are recommended to be in safety education or closely related fields. Other requirements may be field experience, research projects, and in addition to these professional work experience should be required.

The doctoral degree candidate, besides meeting formal requirements demonstrating his competencies and capabilities for pursuing doctoral study, must manifest a desire to advance knowledge and provide quality service in safety education, accident prevention, and injury control.

The doctoral program should be based on a comprehensive core of knowledge in safety education. The candidate should show proficiency in this core and through his formal work should keep up with the core of knowledge that will prepare him to understand research findings and synthesize them for professional application and give him a better understanding of the techniques for influencing behavior.

The culminating experience should be a major independent scholarly undertaking which through research or other creative efforts produces a significant contribution to the field. The post-doctoral program should provide opportunity for intensive and sophisticated research in safety and accident prevention.

The Core Body of Knowledge.

The core of safety education embodies the fundamental concepts of human behavior, philosophy, educational techniques, measurement, research methods, and epidemiology which leads to the development and understanding of the psychology of accident prevention and injury control. These concepts and understandings have application in such settings as traffic, home, public, work, school, farm, sports, and recreation, where accidents are a major problem in our society.

The breadth of the core programs should be much the same for the master's and doctoral candidates; however, greater depth of knowledge, informed grasp of synthesis, and additional competencies for application should be expected of the doctoral candidate. The same should be true for competence in evaluation and research, with differences primarily on emphasis.

In order to fulfill the requirements mentioned, the college or university should provide a series of sequential courses involving lectures, seminars, and independent research.

The following are guidelines for sequential course programming:

General Courses

Social and philosophical foundations of education.
Psychology of learning.
Social psychology.
Statistics.
Human growth and development.
Adolescent and child psychology.

Specialized Courses

The philosophy and science of accident prevention.
Principles of safety education.
Problems of safety education and accident prevention.
Driver and traffic safety education programs.
Problems in driver and traffic safety education.
Psychology of safety education and accident prevention.
Safety engineering.
Highway and traffic engineering.
Traffic safety management.
Research methodology in safety and accident prevention.
Research in safety and accident prevention.
Organization, administration, and supervision of safety education and accident prevention programs.
Organization and administration of industrial safety programs.

Interdisciplinary aspects of safety education and accident prevention.

Field experiences for the safety specialist.

Independent study.

Dissertation and thesis seminar.

Additional types of learning experiences in safety education include externships in such organizations as the National Safety Council, State Departments of Public Instruction, highway safety divisions, governmental accident prevention divisions, and other national organizations responsible for accident prevention programs; and interrelationships with other divisions of the university dealing with aspects of safety education and accident prevention, such as the university safety coordinator, the legal staff, and the physical plant personnel.

The above has been adapted from the booklet, *Graduate Education*, AAHPER, 1967.

SAFETY EDUCATION COURSES—SURVEY AND ANALYSIS

A SUMMARY

By DANIEL P. WEBSTER

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In essence, the quality of the safety and driver education programs which we administer and conduct, and the stimulation which we provide, have immeasurable impacts upon the youth of America. Out of these brief comments on the listing of college safety education courses, I hope that you will agree that the growth of course offerings is gratifying. However, you also may find some facets which may be disturbing and challenging, and worthy of further exploration.

At the very least, you may want to consider whether or not these listings are worthy of the time and expense which they involve, the changes which may be made both in scope and to assure accuracy and completeness of content for guidance of future committees which may be charged with this responsibility.

Looking back, it appears that these sum-

maries of safety education courses have undergone three overlapping stages of development. The first listings, developed by Marion Telford of the National Safety Council School and College staff about 1938 and earlier were simple one and two page mimeographed lists showing teacher-preparatory institutions where teachers could take summer courses in safety education. Continuing this function of providing information to teachers, the listings expanded rapidly and became an annual feature of *Safety Education* magazine, beginning in 1939.

But the listings quickly began to serve a second important function. I hesitate to use the word "rivalry," yet the identification of participating colleges and universities undoubtedly served to stimulate other colleges to "get into the act."

Finally, in recent years, the periodic compilations of course "data" have served as a

subjective, nevertheless useful, yardstick to evaluate the status and trends in curriculum development, course offerings, and requirements.

Overly simplified, the mechanics of the current survey were to devise a survey form, develop a listing of colleges and universities and other appropriate representatives to whom they were to be mailed, and to list the returns by colleges within states. Because of the growth in numbers of colleges and courses being offered, the preparation of listings of colleges and universities to be mailed survey forms was delegated to members of the College Safety Education Division, each assigned one or more states as listed in the preface of the report.

It also was necessary to decide upon a number of definitions and delimitations. For purposes of this survey, a safety education course was one in which the major purpose and content was in safety and driver education. Short courses were not to be included; only those conducted during the regular academic year and for which credit was given. Catalog pages describing the courses were requested, as was information about minor and major curriculum offerings, with definitions left to the responding college or university.

As you may note from the listing, the "honor" system of listing applicable courses has its weaknesses. It is recognized that some institutions listed courses which might be cancelled in event of inadequate registrations. Others, at least by course title, such as First Aid, Police Traffic Control, Industrial Safety or Fire Prevention, or Alcohol Education for the Classroom and Community, may have fallen outside of the stipulated definition. Because few institutions submitted descriptive literature, the committee felt bound to accept the report of the participating institution, and these courses were listed.

Another limitation of the summary was the failure of the committee to receive survey reports for any colleges in the States of Alaska, Delaware, Hawaii, New Hampshire, Rhode Island, and Vermont. In other states it also is likely that reports were not received from certain colleges offering courses due to personnel changes or vacations resulting in inquiries being misdirected or unanswered in accumulations of waiting mail. Basically, however, the questionnaires were sent to all institutions having departments or colleges

of education, by name and title of the director of safety education, or the department head if known.

In spite of this somewhat incomplete reporting and inconsistencies in titles of courses reported, it is gratifying to find that a total of 235 responding institutions indicated a total of 778 courses being offered during this academic year, or an average of about three credit courses for each of these institutions. Of the 778 courses, 668 or about 85 per cent provide credit on the semester-hour basis.

What "significant" observations or conclusions can be derived from this listing?

1. It is likely that no one will ever again come up with an original course title—at least it would appear so from the variety of titles listed. This may pose difficulties for individuals seeking specific course information if descriptions are not provided, and in the transfer of credit for certification.

2. It appears that variations in course content and level, in relation to credit given, is as inconsistent as it possibly could be. In some instances the variations are considerable, with one institution giving double or more credit than that given at another. It is admitted, however, that this judgement is necessarily tempered by course descriptions. Again, these inconsistencies would appear to pose problems in reciprocity of credit for transfer students, or when submitting credentials for certification.

3. Disconcerting is the number of states, excluding the six from which no reports were received, which on the basis of this listing have no college or university which offers the three and six credit courses recommended as minimum for teacher preparation in safety and driver education. It would appear that unless other courses are offered in off-years, the District of Columbia and the States of Maine, Massachusetts, Mississippi, Montana, Nevada, New Jersey, Oregon, South Carolina, South Dakota, Virginia, and Wyoming do not offer a combination of such courses or their equivalent as recommended by the National Conferences on teacher preparation in Safety and Driver Education. For students residing in or attending colleges in these states it would mean travel elsewhere to receive this equivalency training.

4. At the other extreme, the growth in colleges offering a wide range of courses is notable. Leading the list is New York Uni-

1967 National Safety Congress

versity, with 21 credit courses. Others in the "top five" are: California State College at Los Angeles, 19; Iowa State University, 15; Southern Illinois University, 14; and West Virginia University, 14.

Finally, it is interesting to note that, of the 235 reporting institutions, 45 now offer a minor or major curriculum in safety or driver education. This is a notable advance as we look back only a few years when the number could be counted on one hand. Even here, the variations are many; this peculiar listing may help to explain the spread:

<i>Safety Education—Minors and Majors</i>		
Key: U or u—undergraduate.	u	22
G or g—graduate.	U	4
Lower case—Minor.	u, g	5

Upper case—Major.	u, U, g	1
	u, G	1
	u, g, G	4
	U, G	4
	u, U, g, G	4
		45

In regard to minors and majors, you may find some curious situations, possibly due to errors in reporting or the fact that some courses are offered only in alternating years. Some colleges offer minor curriculums with only two or three listed courses. One college offers undergraduate and graduate majors, but courses are listed at undergraduate level only. Another indicates an undergraduate major, but lists only one two-hour course.

A STUDY IN DEPTH OF THE CORNELL UNIVERSITY DORMITORY FIRE

By ROBERT GAUDET

Fire Investigator, National Fire Protection Assn., Boston, Mass.

At approximately 4 a.m. on the morning of April 5, 1967, a fire of unknown cause began in the basement lounge of a dormitory at Cornell University, Cayuga Heights, New York. Nine occupants died of asphyxiation, and several of the other 60 occupants suffered injury. The property damage was estimated at \$50,000.

The Dormitory Building.

Built in 1953, the fire-resistive unsprinklered two-story-and-basement building had been occupied as a residential club housing university guests. It was purchased by Cornell University in 1963 and converted to a dormitory in 1966. The 278-foot-by-42-foot main residential section of the building was of brick and precast concrete construction. A 40-foot-by-56-foot one-story section adjoining the rear of the main section contained a lounge, a kitchen, and a dining room. The fire, which originated in the basement lounge of the west wing spread to the corridor and also to Room 54 in the basement of the west wing. The one-story section at the rear contained the kitchen and the dining room. Two hatchways in the roof were

accessible from the stairway enclosures at the center of the building.

The two enclosed stairways, which extended from the second story to the basement, were each located adjacent to the entrance foyer in the center of the building and had doors leading directly outside at the first-story level. Both stairways were accessible from the corridors in all levels, except that the west stairway opened directly into the basement lounge, where an ordinary glass panel and a solid-core wooden door had been installed by the university. A wooden door with an ordinary glass panel beside it separated the basement lounge from the west stairway. There was extensive fire damage at the bottom of the stairway, where the plywood paneling completely burned away.

Lighted exit signs were provided at each stairway door. The foyer was two stories high and had an inside balcony at the second-story level. The 100-foot-long corridors, which opened into the foyer, had dead ends in the first and second stories. The basement had an outside door at the west end of the corridor (the west end of the basement was

at grade level because of the slope of the site). Grade level at the east end of the building was at first floor level. There were no exits at this end of the building.

There were five separate furnace rooms in the basement; two in each wing and one in the center of the building. Large sections of the basement area were unexcavated. The corridor, six bedrooms, and lounge in the west wing of the basement had plywood-covered walls. The west stairway also had plywood finish up to the landing between the basement and the first floor. All the plywood paneling was attached to wood furring strips. The university had replaced combustible acoustical tile ceilings in the lounge, corridor, and basement bedrooms with suspended ceilings of glass fiber supported by metal channels.

The plywood paneling burned from the opposite end of the corridor in the west wing to the door leading to the outside. The bedroom doors in the basement were of hollow-core wood. The east wing of the basement contained no living quarters. The first and second stories had 24 bedrooms each. The walls and ceilings were plaster finish.

The building had no interior manual alarm system; the only means of fire protection were portable extinguishers located throughout the building. The decision to install a partial sprinkler system had been reached in March, 1966. Delays in completing the installation were reportedly due to a strike at the manufacturer's plant. Installation of the inside piping was scheduled to be started soon. The areas to be protected by sprinklers included the basement, the two stairways, the corridors, and the entrance foyer. The university does not have its own fire department; fire calls received by the Safety Division are immediately relayed to the Ithaca or Cayuga Heights Fire Department.

The Fire.

On the morning of April 5, at approximately 4 a.m., the 69 occupants were asleep in the building. The fire originated in the basement lounge and completely destroyed the contents. Only charred wooden nailers remained after the plywood paneling had completely burned off. Although the suspended ceiling tiles did not contribute to the fire, the heat twisted the metal channels, and

ceiling tiles fell to the floor. Both the door to the west stairway from the lounge in the basement and the door leading from the stairway to the first-floor corridor were wedged open (reportedly, there had been constant difficulty in preventing stairwell doors in the building from being wedged open). The doors leading from both stairways to the second-story corridor had been removed by an outside contractor for shortening after installation of carpeting.

The fire produced dense smoke that spread through the basement and through the rest of the building by way of the open west stairway and the two-story-high foyer. There was complete destruction of the plywood paneling in the stairway. The paneling terminated at the landing. The intensity of the fire in the stairway was evidenced by the destruction of two wooden doors which were directly opposite the open stairway door across the five-and-one-half-foot-wide corridor. Awakened by the smoke, the occupants of the basement bedrooms were able to escape through the door at the west end of the corridor, and through bedroom windows. These occupants stated that they saw smoke in the hallway but that no flames were visible during their escape.

The fire in the room of origin fed on the plywood paneling and all the combustible contents, including five couches, three chairs, eight plywood tables, a wooden TV cabinet, and a bookcase, all of which were destroyed. The fire spread from the lounge in the basement of the west wing to the corridor leading to the six bedrooms in the lower level of the building. A door at the far end of the corridor led outside at grade level. There were left only charred remains of the wooden strips to which the plywood paneling had been attached on the concrete-block corridor walls. Distorted metal hanging from the overhead had held the glass fiber ceiling panels.

As smoke and heat traveled up the stairway to spread throughout the building, a professor who occupied Rooms 24 and 25 in the first story telephoned the Cornell University Safety Division at 4:08 a.m. The Safety Division immediately called the Cayuga Heights Volunteer Fire Department, which responded with two pumpers and the chief's car. By the time the firemen arrived, many of the occupants of the building were at their windows. Some jumped to safety; oth-

ers used sheets and blankets tied together to lower themselves to the ground.

Upon arrival, the Fire Department requested assistance, under a mutual-aid plan, from the Ithaca Fire Department, which responded with one pumper and one aerial ladder truck. The fire fighters used protective breathing equipment during their initial rescue efforts and helped some of the trapped occupants over ladders and led others out of the building to safety. Some of the occupants of the first- and second-story rooms managed to escape unaided through the front entrance, but many others, finding the corridors filled with smoke, returned to their rooms. Some of those who tried to escape through the front door were overcome by smoke. Occupants first awakened to the odor of smoke alerted others by running from room to room pounding on doors (the building had no alarm system).

The fire department succeeded in confining the fire to the basement and stairway of the west wing. The lounge was destroyed, and fire spreading down the basement corridor entered Rooms 53 and 54. There was extensive fire damage in Room 54. The two occupants of this room, awakened by the shouts of others, attempted to enter the corridor but were driven back by the heavy smoke. They escaped through the bedroom window. Fire fighters used three 2½-inch hose lines from two hydrants. One line was laid directly to the rear of the west wing to extinguish the fire in Room 53 and the stairway. The other two lines were connected to pumpers. Several 1½-inch and booster lines supplied by the pumpers were used to extinguish the fire in Room 54, the lounge, and the basement corridor.

The actual fire damage was limited mostly to furnishings and interior finish in the basement and the first story. The building itself did not contribute fuel to the fire.

One student died in Room 21 in the first story, another in Room 27 in the second

story. Both of these victims had left their rooms after the fire started and then returned, apparently leaving the doors to their rooms open during their absence. Three students died in the foyer and one on the foyer balcony. Two students died in the second-story corridor. The professor who occupied Rooms 24 and 25 perished in the first-story corridor just off the foyer. Asphyxiation was the cause of all nine deaths.

The Life Safety Code On Dormitories

To those college administrators who are reassessing the life safety of their dormitories, we recommend consideration of the provisions of the NFPA *Life Safety Code*—in particular, Section II-4, "Dormitories." Among the provisions are the following:

(a) The travel distance from any point in an unsprinklered building to an exit shall not exceed 100 feet. In sprinklered buildings the maximum travel distance shall be 150 feet.

(b) Dead-end corridors are not permitted.

(c) Every sleeping room in a dormitory housing more than 10 persons must have access to two separate and distinct exits in different directions with no common path of travel.

(d) Exit stairways and other vertical openings shall be enclosed, except that in existing buildings that are not more than two stories high the authority having jurisdiction may permit unprotected vertical openings if the building is completely sprinklered or if every sleeping room has direct access to an outside exit and the building is equipped with a complete automatic fire detection system.

(e) The interior finish for exits and access to exits must be Class A or B, and at least Class C elsewhere.

(f) Unless the dormitory is equipped with a complete automatic sprinkler system, it shall have a manual fire alarm system.

(g) Fire exit drills shall be held regularly.

School Transportation Section

THE 3 R's OF SCHOOL TRANSPORTATION

By A. C. FINCH

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School administrators know that today's schools must be concerned with more than the familiar "readin', 'ritin' and 'rithmetic." To these modern needs have added the 3 R's of transportation—recruitment, replacement, and reimbursement. But this is only the beginning. The scientist, the legislator, and others are demanding *records, research* and *redesign*.

Some years back several of the bus manufacturers started testing their product in crash impact studies. These were followed by the much publicized school bus tests conducted by the Institute of Transportation and Traffic Engineering of the University of California at Los Angeles. The tests, commissioned by the National Safety Council and financed in part by a \$15,000 grant from Allied Chemical Corporation, have opened the flood gates of curiosity and spawned a wholesale deluge by free lance writers.

Unfortunately, in the translation from idea to the completed tests and reports, some writers have overlooked the fact that the tests were planned by school transportation administrators, school bus manufacturers, and others in the voluntary sector of our economy. Because these people, many of them in this room, had a progressive curiosity and courage to seek new information should they now be criticized by Johnny come lately writers who pick up bits of research and even twist facts to suit their own crusading purpose?

Such is the penalty for research. Little wonder that some sectors resist research or any mention of change or innovation.

Team mates of research are records and adequate reporting programs. Out of the smoke and heat generated by the scientific approach to pupil protection has come the perennial cry for better school bus accident records. This time, however, such demands will not be denied too long. Several groups who have suddenly become aware of such a thing as school transportation are painting some very ugly pictures, simply because they

suspect that they are not getting the full text on school bus accidents.

A serious deficiency in records is a drawback to creditable research programming. As bad as this is in terms of research, it can be even worse when it comes to sifting all the information in preparation for short and long term planning. Without records, you may be faced with changes not justified by long term experience.

The entire subject is highly charged with emotion and it's no trick for a clever writer, speaker, or lobbyist to sway support without proper identification of all the facts. Apparently, it's not news that the school industry volunteered to study their needs, but it is news that a bus body shifted 17 inches in a violent head on crash. As close as I have been to this experiment from the very beginning, I couldn't venture to say that this shearing action was good or bad. Yet, some self styled experts pounce on this unfinished piece of business as if it revealed a shocking neglect by the manufacturers. I say, until they test, under identical conditions, another bus that doesn't shift, and measure the forces transmitted to the anthropomorphic dummies, it could be anybody's guess whether shifting absorbed energy or intensified it. If we had pat answers to begin with there'd be no need to test crash, would there?

Not once have I read or heard anyone, including the new Department of Transportation, say in a loud clear voice for all to hear, "Gentlemen of the school transportation and school bus manufacturing industries, hats off to you for being progressive, for being courageous, for seeking new information. Hats off for choosing only the most talented crash impact teams in our nation. Hats off for approaching the follow up period with studied application of new information. Hats off for not losing your heads like so many good intentioned but inadequately informed crusaders are doing."

Ill-conceived legislation such as seat belts for present day buses without modification

would have been costly and would even have contributed to more injuries. Hopefully, premature action will not be taken. I am sure that everyone is anxious to implement new technology but there is always a danger of going too fast too soon. With the proper

guidance from knowledgeable school transportation people, I am sure that all concerns can be meshed so that we have a smooth functioning progressive machine. We must all look for that proverbial "monkey wrench".

SCHOOL BUS SAFETY AND FEDERAL ACTION FOR HIGHWAY SAFETY

By DR. NORMAN KEY

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National Education Association, Washington, D. C.

Safety legislation has been spotlighted in recent months by the following:

1. Highway Safety Act of 1966
2. National Traffic and Motor Vehicle Safety Act of 1966
3. General Services Administration—Federal Standard No. 515
4. Amendments to Fair Labor Standards Act; and Hazardous Occupations Order No. 2

In February of 1959, following a congressional mandate made in 1956, the Secretary of Commerce transmitted to Congress a 232-page report on "The Federal Role in Highway Safety." This report is a prologue to present-day developments in highway safety. Here is what the report said about school transportation (p. 129):

"Another phase of traffic-safety education is that of school bus transportation safety. The enormous expansion of school bus transportation, now carrying nearly 8 million pupils, (about 17 million now) daily, has been a major challenge to school administrators. The school bus safety record appears to be exceedingly good; only 31 fatalities for the year 1957 (with 37 States reporting). The National Conference on School Transportation has made a large contribution to the standardization of school buses and in programs for the improvement of their operation."

Congress passed Public Law 88-515 in 1964 which required the General Services Administration (the custodial agency of the Federal Government) to establish standards for safety devices for automotive vehicles

purchased by the Federal Government. The Federal Government purchases about 60,000 vehicles each year, including buses for pupil transportation. This same year the so-called Baldwin amendment to the Federal Aid Highway Act was passed. Its purpose was to require each state to have a highway safety program that would comply with certain performance standards to be developed by the Bureau of Public Roads.

Federal Standard No. 515 was published in the *Federal Register* on June 30, 1965, to become effective one year and 90 days later (on October 1, 1966). Several proposals designed to affect the design and construction of school buses included these items:

- Anchorage for Seat Belt Assemblies.
- Anchorage of Seats.
- Hydraulic Service Brake Systems.
- Windshield Wipers and Washers.
- Glare Reduction Surfaces.

GSA published an amended Federal Standard No. 515 on July 15, 1966, to become effective on October 13, 1967. The National Traffic and Motor Vehicle Safety Act of 1966 (Public Law 89-563) was signed into law by President Johnson. This law requires the new U. S. Department of Transportation to establish Federal Motor Vehicle Safety Standards. National Highway Safety Act of 1966 (Public Law 89-564) was also signed into law by President Johnson. This law requires each state to have a highway safety program that is in accord with uniform performance standards promulgated by the Secretary of Transportation.

Federal Standard No. 515 became effective

School Transportation Section

tive on October 1, 1966, requiring certain standard safety devices on automotive vehicles purchased by the Federal Government. The U. S. Department of Commerce published in the *Federal Register* of December 3, 1966, the "Proposed Initial Federal Motor Vehicle Safety Standards," called for by P. L. 89-563. Several of these proposed standards were designed to affect school buses, as well as other types of vehicles. For example:

1. *Transmission Shift Lever Sequence (P-R-N-D-L)* on automatic transmission vehicles

2. *Reflecting Surfaces*, designed to reduce glare

3. *Lamps, Reflective Devices, and Associated Equipment*, designed to increase the visibility of motor vehicles from the side as well as the front and rear.

4. *Glazing Materials*, specifying requirements for the kinds of laminated windshield that have already been proved to reduce the severity of injury when people are thrown against them in collisions, (thinner glass, with thicker laminate sheet between the two pieces of glass.)

5. *Seat Belt Assemblies.*

These motor vehicle safety standards were patterned in part on the GSA standards developed earlier. The expectation that further work by the General Services Administration would be copied, at least in part, by the new U. S. Department of Transportation has caused people to watch GSA developments closely. The GSA, proposed some revisions and extensions to the Federal Standard No. 515 last March 6. On that occasion, Dr. William Haddon, Jr., of the Department of Transportation, and Commissioner Abersfeller of the General Services Administration both made it clear that the two agencies would work together in order to develop compatibility in the motor vehicle safety standards their two agencies must develop under the provisions of two separate laws.

The latest word, as of September 29, is that GSA safety standards have been revoked; thus, the proposals which GSA presented last March will not be followed through by GSA, since the responsibility now rests with the National Highway Safety Bureau.

On February 1, 1967, as a result of amendments in 1966 to the Fair Labor Standards Act, student school bus drivers under 18 years of age would not be able to

be employed any longer. The ruling was postponed until July 1, 1967. I shall discuss more about this development later.

On February 3rd, the U. S. Department of Commerce published the "initial Federal Motor Vehicle Safety Standards" in the *Federal Register*, to become effective January 1, 1968.

On February 16, 1967, the National Highway Safety Agency (now Bureau) issued draft standards for state highway safety programs.

The National Commission on Safety Education held a meeting March 8-9 attended by 76 persons from 36 states to review and organize constructive comments on the draft standards. These comments were put in writing and submitted to Dr. Haddon.

On April 1st, the new U. S. Department of Transportation came into being with Alan S. Boyd as the first secretary of this cabinet-level Department. By June 27, the standards for state highway safety programs were issued by the National Highway Safety Bureau of the Department of Transportation. Many of them have either direct or indirect relationships to pupil transportation:

1. Periodic Motor Vehicle Inspection.
2. Motor Vehicle Registration.
3. Motorcycle Safety.
4. Driver Education.
5. Driver Licensing.
6. Codes and Laws.
7. Traffic Courts.
8. Alcohol in Relation to Highway Safety.
9. Identification and Surveillance of Accident Locations.
10. Traffic Records.
11. Emergency Medical Services.
12. Highway Design, Construction, and Maintenance.
13. Traffic Control Devices.

Standards on three additional subjects are yet to come: Law Enforcement, Community Support, and Pedestrian Programs.

Under a contract with the National Highway Safety Bureau, our Commission is currently conducting a nationwide study of school transportation, with emphasis on safety. This entails a critical review of the literature in a search for reliable and valid principles for school bus safety. A representative sample of 100 knowledgeable people in the field were asked to suggest areas of need and steps for program improvement. Four "case-study" states are being visited for on-

location observation of practices and over-all operations. The study is expected to produce criteria for programs of safe operation, and to set forth recommendations for both short-range and long-range projects for program improvement.

We are advised that the National Highway Safety Bureau will soon have a person on its staff to work in this field. It seems reasonable to assume that a full-time staff will step up the Bureau's activities in the field; and likely will produce further guidelines for states and school systems.

The Fair Labor Standards Act of 1938 was amended by Congress in 1966 and for the first time, under the amendments, the Act was extended to apply to elementary and secondary schools and institutions of higher learning. In addition to its basic minimum wage and overtime provisions, the Fair Labor Standards Act contains provisions relating especially to child labor. For example, the Act sets age standards of 16 as the basic minimum age for employment, 18 as the minimum age for employment in occupations declared to be hazardous, and 14 as the minimum age for specific occupations outside school hours. There are seventeen so-called hazardous occupations for which the minimum age is 18 years. One of these is "Motor Vehicle Occupations," meaning driver and helper.

When it was realized that sixteen states that now employ under-18-year-old students as school bus drivers would be drastically affected by the ruling scheduled for February 1, 1967, the Secretary of Labor suspended the ruling until July 1, 1967, and asked for comment from the states concerned as well as from other persons.

The National Commission on Safety Education held a meeting in February, 1967, for representatives of the affected states, and representatives from eight states attended, including Alabama, Florida, North Carolina, South Carolina, and Virginia.

Following the February meeting, the Commission prepared a brief statement listing general principles which the group felt should be brought to the attention of the Labor Department for its consideration in arriving at a final decision on under-18-year-old student school bus drivers. The statement was circulated among the sixteen concerned states for comment, and the slightly revised version was then sent to the

U. S. Department of Labor. Each state submitted additional material of a more specific nature, based on its own experience with student school bus drivers under 18 years of age.

In mid-April it was learned that an extension of the time would be allowed by the Secretary of Labor for public comment on the matter and alerted the sixteen states by a special memo.

In March, Maryland and 25 other states, including all of the states except North Carolina and Nevada where students under 18 may drive school buses, brought suit to restrain the Secretary from enforcing the amended Fair Labor Standards Act. The grounds for this suit were that the Act, as amended to cover employees of schools and other governmental entities, is unconstitutional. A recent court order from a federal court in Baltimore has been issued restraining the Federal Government from enforcing provisions of the wage law (part of the Federal Labor Standards Act) until the matter is decided by the U. S. Supreme Court. The earliest time for the Supreme Court to hear the case would be late 1967, and a final decision is not likely to be made until 1968.)

According to information received by us June 30, 1967, the Secretary of Labor has decided not to enforce Hazardous Occupation Order No. 2 as it may pertain to 16- and 17-year-old school bus drivers until the Supreme Court renders a decision on the constitutionality of extensions of the Fair Labor Standards Act to state and municipal employees.

As to new and amended automotive safety standards expected to appear in the *Federal Register* soon the word from the National Highway Safety Bureau is that the new and amended provisions, as presently written, will allow either the red four-light signals on school buses (as in *Minimum Standards for School Buses*) or the eight-light system (four red and four pre-warning amber) as now used in New Jersey, Florida, and one or two other states. These alternatives will provide for either system, and then the Bureau will be able to make a final decision later, on the basis of widespread use of both systems.

The only other provision has to do with braking systems on station wagons and would affect school transportation programs

only where station wagons may be used as school buses.

The Elementary and Secondary Education Act of 1965—especially Title V also has important implications for pupil transportation.

Dr. John Lumley's testimony before the House Education and Labor Committee urged that disaster aid amendments to H. R. 6230 (ESEA amendments) be included. We have given Dr. Lumley a statement for his use before the Senate Committee on Education urging that disaster aid relief be pro-

vided through amendments to present education legislation.

If provided as NEA's testimony urges, school districts would receive dollars to help replace school buildings, school buses, school bus garages and maintenance facilities, if these properties should be substantially damaged through any type of disaster.

Can the states seize the initiative and assert the forward thrust which our times require? I believe that they can—that they will.

TOTAL FITNESS AND PREVENTION OF ACCIDENTS

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Total fitness has a place in helping to prevent accidents. Accidents don't happen; they are caused, and many of the causative factors of accidents are directly or indirectly related to the fitness of the individual. The degree of fitness many times determines whether or not there will be an accident.

The primary reason for total fitness is centered around the personal benefits derived from it. A man should keep in shape for his own sake so that he can live a better, healthier life. Only those whose level of total fitness is relatively high will be able to cope with the ever increasing number of accident-producing situations in modern living. Total fitness allows the expansion of opportunities for adventure, which is one of the highest goals of safety.

To understand the value of total fitness in preventing accidents, we must first of all understand "what total fitness is." Broadly conceived, total fitness is a thorough development of both the mind and body. Since the days of the ancient Greeks, people have carried the belief that a sound mind and a sound body go hand in hand.

Fitness in today's world is obviously not a matter of mere muscle, nor is it a matter of physical capacity alone. Total fitness of the individual calls for the cultivation of physical, mental, emotional, social, and spiritual qualities that best serve the potentialities of each individual.

When we speak of fitness for life today,

we refer to more than lifting a weight over one's head, running a mile, or touching one's toes. These physical performances demonstrate a degree of physical fitness, but they fail to indicate one's emotional stability, social adaptability, or problem-solving ability—all of which are essential ingredients for total fitness.

This paper is concerned with portraying how accidents can be prevented through possession of the qualities which describe a totally fit individual. The discussion is organized under three broad categories: physical fitness, emotional and mental fitness, and social fitness.

How Physical Fitness Prevents Accidents.

Physical fitness can be defined in either a specific or a general sense. From a specific standpoint an individual who performs a particular task with a reasonable degree of efficiency, without undue fatigue, and with rapid recovery from the effects of the exertion is considered physically fit; but he is fit only for that particular task. From a "general" standpoint, physical fitness refers to the absence of disease and the proper functioning of all body organs and all body parts. Physical fitness connotes especially that the body is able to move in reference to strength, endurance, agility, and coordination.

Many criteria are used to evaluate physical fitness, frequently in combination. How-

ever, speed alone, or muscle strength, flexibility, and elasticity, or even "health" based on normal organic conditions, are by no means true indicators or measures of fitness.

Is there a characteristic feature that might permit a detection of differences in condition among individuals or among groups of individuals? If we imagine a natural catastrophe that could force people to escape certain death only by marching for many days under unfriendly environmental conditions, who would last longest? All other essential conditions being equal, we would give the greatest chances of survival to individuals possessing the greatest physical reserves. It can be postulated, therefore, that the size of the physical reserves and the general adaptability to great physical demands must be determining factors of physical fitness. In other words, physical fitness depends on the individual's biodynamic potential, his functional and metabolic potential. The best test of physical fitness would be man's ability to survive under extraordinary biological demands.¹

Characteristics describing the physically fit individual have been listed as follows:²

1. Strength enough to be ready for tasks encountered in everyday routine and in emergencies.

2. Stamina (endurance) to continue necessary tasks without undue fatigue, and energy enough to participate in recreational activities after a day's work.

3. Cardiorespiratory endurance for sustained effort in activities involving motion of the entire body.

4. Agility to be able to make a wide range of movement easily.

5. Speed to be able to move rapidly when personal safety demands it.

6. Control to coordinate body movements skillfully.

Especially pinpointed in the preceding characteristics is body movement. The human being possesses the capabilities for movement and is essentially an active creature. Movement is more than a basic physiological necessity, however; it is our interpretation of self to ourselves and others. The way we act depicts our personality.

The degree to which an individual may be efficient in his movement is dependent upon a variety of factors: body build, reaction time, strength, power, flexibility, endurance, and acuity of the senses. The quality of

efficient movement is also dependent upon "the ability to judge spatial relations and timing, the ability to solve motor situations and to make adaptive decisions, the ability to remember past movement situations so that they can be applied, and the ability to understand the mechanics of effective movement."³

Since body movement is essential to locomotion and effective performance in any life situation, movement exposes people to accident situations. Many people do not possess the techniques of handling their bodies or protecting themselves from the ordinary hazards of everyday life. We are aware of the incidence of falls as a leading type of home accidents. It is surprising how many people suffer severe injuries and sometimes death from such incidents as stubbing the toe, falling backward from a standing position when thrown out of balance, tipping over backward in a chair, stumbling and falling down a flight of steps, slipping on an icy pavement or a waxed floor, or falling from a ladder. These situations all seem very simple, yet they are everyday occurrences that catch most people unprepared. If the person involved has learned the basic fundamentals of handling the body in a variety of situations, he would be able either to prevent the fall or to minimize the results. Knowledge and application of the basic principles of human movement can prevent accidents. "If the physical laws of force and resistance and the physiological potentialities of the human body are understood, with the limitations that such potentialities imply, the chance for accident resulting in injury is considerably lessened."⁴

Unfit and inadequately trained athletes are often involved in accidents that could have and should have been prevented. Students should not be allowed to participate in any activity until the instructor has made very possible effort to ensure that they are sufficiently skilled and in good enough condition to do so without needlessly endangering themselves. Young people are usually eager to participate in sports and because of this they often grow impatient with the conditioning exercises and practice sessions necessary to develop the strength, agility, and skill required for safety on the playing field. Too many students are satisfied with mediocre performance, failing to realize that lack of skill in sports demands unnecessary effort,

thus: causing awkwardness, a rapid onset of fatigue, and increased vulnerability to accidents. Good physical conditioning is a prerequisite for successful and safe participation in sports.⁶

The need for fitness, conditioning, and training in organized sports and games, both amateur and professional, is evident. There is a great incentive to win, and the value of proper conditioning is readily understood and accepted by the participants. On the other hand, in individual, nonorganized sports and recreational activity, engaged in for personal exercise and social contacts, there is little incentive for conditioning. In many recreational activities, however, such as skiing, skin diving, and mountain climbing, top-notch physical condition is essential for the avoidance of personal injury and general safety.

In skiing, for example, the most important single preventor of injury is proper conditioning, adapting the body to the physical requirements of skiing. While it is difficult to prove to what degree the physical condition of a skier is responsible for accidents, some definite information points to the fact that good physical condition is extremely important. Two instances may serve as illustrations:⁷

1. A Westchester, N.Y., ski club averaged 5,000 skiing days during 11 years. During this time pre-ski conditioning was practiced. No fractures, and only two mild sprains occurred. When the pre-ski conditioning was given up, three fractures occurred during the first year.

2. At the North Country School, Lake Placid, N.Y., 50 children, aged 8 to 14 years, accumulated a total of 5,000 skiing hours. Seven fractures and five sprains occurred. When a pre-ski conditioning program was adopted, none of the children participating in the program suffered accidents in the first year (5,000 skiing hours). Two boys who did not do conditioning work suffered fractures of the leg.

Proper conditioning of the muscles helps to prevent injuries in sports. For example, the most frequently injured joints in sports, particularly football, are the ankle and knee. While ligaments attach from bone to bone to help stabilize joints, they are reinforced by the major stabilizers of the joints, the muscles, which actually span joints via their tendons. Since ligaments have little or no elas-

ticity, their ability to withstand trauma, received when a joint is at an extreme position, can be increased through conditioning exercises which increase the strength of muscles. In other words, if we wish to improve the stability of joints, we must increase the strength of muscles which cross the joints.⁸ Competent athletic trainers and coaches spend a great deal of time in proper conditioning of athletes, for "the most important phase of prevention of injury is conditioning."

One of the most troublesome disturbers of human efficiency is fatigue, which can be both mental and physical. Fatigue is a comprehensive term which, in its widest application, embraces all those immediate and temporary changes, whether of a functional or organic character, which take place within an organism or any of its constituent parts as a direct result of its own exertions and which tend to interfere with or inhibit the organism's further activities.⁹ The principal effect of fatigue is the loss of efficiency in both mental and physical output in an individual. Indirectly, mental fatigue can cause accidents. For example, a mother exhausted by work and noise cannot have the complete awareness of her children's activities that is essential.

A person who is tired or near the end of a long period of exertion is more likely to be involved in an accident than an alert and rested person.⁹ Control in coordinating activities and directing movements is the first function to fall away under the influence of those disorganizing factors which interfere with efficiency. The ability to execute movements will tend to remain after one has lost the power to control and coordinate them.

Muscular endurance is necessary for prolonging the onset of fatigue. For example, a person who is able to perform a given task a greater number of times with proficiency because of lessened energy requirement is less likely to become injured in a situation where injury is imminent. The individual who lacks endurance and becomes fatigued has a tendency to disregard potential accident situations. This person often becomes lax and inattentive and tends to take undue chances, erroneously assuming that he can react as quickly as he did in a nonfatigued state. This person also seems to lose insight into the seriousness of the hazards of potential accidents.

Vision and hearing play vital roles in personal protection. It is obvious that a person with visual or auditory defects would be in great peril when placed in situations where these characteristics are essential. A blind person may be unaware of hazards on a busy street; a deaf person may be in danger when approached from the rear.

A point of considerable argument is that concerning the frequency of accidents involving persons with physical handicaps. Many people believe that the handicapped individual will compensate for his defect by adhering strictly to all rules of safety and by attempting to develop good attitudes toward safety; others feel that no matter how much extra effort such a person gives, his handicap will impede him in his struggle for safe living. A study conducted by M. S. Viteles attempted to determine whether or not people with physical impairments have more accidents than people who are without physical disability. The study followed 57 men without physical handicaps and 49 men with handicaps over a ten-year period. The results showed that the men with handicaps were involved in more accidents by a ratio of 3:1.¹⁰

A study of causation of industrial accidents, revealed that the leading causes of accidents, regardless of sex, were visual and auditory defects, poor motor and reflex coordination, alcoholism, and fatigue. Factors such as menstruation, pregnancy, lactation, and menopause were leading causes of accidents among women.¹¹

Many accidents in industry can be traced to physical reasons or characteristics. Two studies have shown that there is a relationship between illness and accidents. People who have suffered from chronic diseases are more susceptible to accidents. As the number of illnesses from which an individual suffers rises, his rate of susceptibility to accidents goes up.¹²

Obesity can play an important role in the accident record of an individual. A man who allows his weight to increase steadily can be putting himself and his peers in a hazardous position. At a time when quick movement is necessary, he may be too sluggish to avert an accident. If his weight drops below a proper level it can also lead to accident.¹³

Physical fitness or its lack is probably most noticeable in highway and traffic safety records. This area involves the most people

with the most physical defects or physical fitness barriers. It has been the practice to allow almost anyone to operate a car, although several states are at this time instituting programs by which they can check the physical condition of drivers before and after licensing. There is yet no valid proof to show that a high degree of physical well-being will cut down accidents in driving. Physical fitness may thus contribute to reducing accidents on the highway, but by itself it cannot solve the problem. Whether it be on the highway, at work, at home, or at play, other elements of total fitness are needed to provide for safe living. A most important element is emotional and mental fitness.

How Emotional and Mental Fitness Prevents Accidents.

An individual can be an ultimate stage of physical fitness but because of an emotional or mental problem he may be considered an unhealthy person as far as total fitness is concerned.¹⁴ A mentally well person will possess good mental control, poise, and steady nerves. Without these attributes an individual will be more susceptible to accidents.

Symptoms of mental unfitness which could lead to an accident-causing situation are: (1) the individual is indifferent to his environment, (2) the individual does not show any appreciation to and of other people, (3) the individual is unable to face responsibilities, (4) the individual tends to take his troubles out on other people, (5) the individual loses his social and moral inhibitions, and (6) the individual has frequent states of depressions and moodiness.

This is not an all inclusive list, but it can easily be seen that the presence of any of these symptoms could easily lead to an accident. For example, a driver may exhibit disregard for the rights of others by hogging the road, demanding the right of way, and speeding—all of which are accident-producing situations.

Emotions are those inner forces, powerful and primitive, that set the course for all human behavior.¹⁵ If an individual is to be considered totally fit he must have control of his emotions or emotional stability. Control of emotions does not mean that the emotions should remain within the individual; rather, it means that healthy ways should be found to work them out.

Sometimes there are blocks between a need and its satisfaction, a barrier which prevents the individual temporarily or permanently from reaching his need. Frustration results when one is unable to reach a desired goal. When one is frustrated, the type of behavior that he exhibits depends upon his previous experiences and his personality. The two most common types of behavior when one is frustrated are aggression and withdrawal.

The important thing in accident prevention is how much frustration one can take and what type of reaction it will produce. An easily frustrated person may become disturbed and upset and susceptible to accidents.

Individuals exhibit different types of emotional patterns when confronted with frustration. Anxiety is one common pattern. Some characteristics of an anxious person are worry, thinking in circles, fearfulness to such an extent that he is unable to reach his goal. Many people who are in this state of anxious behavior realize it but are unable to correct it themselves.¹⁸

In dealing with frustration, some people become worried, others angry, and some fearful of the problems facing them. Some people seem to thrive on frustration; others feel the frustration and mask it. If the people who are having difficulties could be discovered and helped, many accidents could be prevented.¹⁹

When a person's emotions block his common sense, his reactions often lead to an accident. Not all emotions have a maladjustive aspect, however. Emotions may also have a motivating effect.

Human behavior is affected by attitudes. When attitude changes, behavior will also change. Past experiences of such things as pain, fear, and grief influence a person, and if they cause a negative attitude, safety rules are likely to be disregarded.

To change an attitude is a long and difficult process. A teacher cannot change anyone's attitudes if he does not show the proper attitude himself in his daily behavior. While the importance of attitudes in accident prevention studies is generally conceded, "there is no conclusive experimental evidence of the absolute or related effectiveness of various measures and programs for changing attitudes toward safety."²⁰

Studies in the area of emotional fitness

have listed personality traits which lead to accidents. Some of these traits are aggressiveness, anger, attention getting, being easily offended, bereavement, boredom, competitiveness with inability to lose, excitement, feelings of inferiority, feelings of superiority, frequent conflict with authority, frustration, guilt feelings, and unconscious need for self-punishment.²¹

A person possessing all or some of the foregoing traits is said to be "accident prone" but the list does not define a certain type of person in our society. The bulk of evidence indicates that there is no such thing as a single type of "safe" or "unsafe" individual. "Rather, each individual has a range of behavior, any portion of which may be safe or unsafe, depending upon the environmental hazards to which he is exposed."²²

Many accidents do occur when people are emotionally upset. However, being upset at one time or another is an inevitable consequence of living. Our charge as accident prevention specialists is not to recommend that people stop being upset but to educate people that if they are under unusual stress they should withdraw from potential accident situations until the stress is dissipated.

The emotionally mature person is someone who has learned to cope with problems which may arise. He may accomplish this by talking over his problem with a friend. He may build those qualities for which risky behavior is often substituted, or learn to manage problems through less dangerous methods. He may take up some hobby as a release for frustration. If there is a great need for achievement he may direct his energies toward a sport or take active part in a church, lodge, or civic organization. When emotions are controlled and directed in such a manner, the hazards leading to many accidents are avoided.

From what we know about learning, perceptions, attitudes, and emotions are more important in developing total fitness in the person than indoctrinating him with safety facts or skills. For facts memorized or repeated do not necessarily change behavior. It is the individual's responsible or irresponsible attitude toward a fact that makes him safe or unsafe.

How Social Fitness Prevents Accidents.

Another integral part of total fitness is

good social adjustment. This not only includes making personal adjustments but also making group and social adjustments as well. An individual is socially well adjusted when he is able to meet his social needs. If for some reason these needs are unmet, antisocial behavior may begin to develop. An antisocial person displays characteristics which do not coincide with those of society; he does not keep aggressive tendencies in check and refuses to be aware of other people's property and rights.

Antisocial behavior can easily lead to an accident-causing situation. The presence of social well-being and peace of mind is actually a factor in accident prevention. The critical factor in controlling accidents is the individual's "ability to discipline himself and to respond voluntarily to disciplines imposed by society in order to achieve safety."²

A person who is socially fit is least likely to break any rules of safe living because he has a thorough understanding of the needs for such rules and a genuine concern for his fellow citizens. The socially fit person is not concerned solely with a happy and safe life for himself, but concerns himself with the problems of other and readily lends a helping hand or watchful eye if necessary. In all, the socially fit person attacks his own personal problems and is readily available to give assistance to others.

Associated with social fitness is the element of "sportsmanship." This means that the individual respects the rights of others, works for the best interests of the team or group, is tolerant toward persons of less ability, gives his best to the team or group, and controls his emotions under great stress.³

Another aspect of social fitness involves "courtesy." This means that the individual respects and appreciates the individuality of others, and at the same time shows an interest in other people and behaves in a friendly and kindly manner.

Sportsmanship and courtesy are desirable in any situation where groups of people are to work or play safely together. If a person is to be accepted by society, he must realize that only through self-imposed rules can group cooperation be achieved. He must realize that the importance and welfare of the individual is dependent upon the welfare of society and that the welfare of society depends on the welfare of the individual.

Safety is everyone's job and a safe society,

or in more limited terms a safe community, is dependent upon how safety conscious its individuals are.

The social needs of the child include the ability to assert, defend, and protect himself and the ability to work and play with others. In recreational pursuits, he needs to develop a sense of responsibility for the welfare of the group. The teacher can help by showing the child what his responsibilities concerning safety are to other children. The teachers can help establish an understanding of the necessity for group activity by making plain the need for one individual to bear responsibility for the safety of all. This is the reason why safety education should involve pupil projects in which youth work together on safety rather than in a teacher-dominated, telling situation. It is the reason why safety activity is more likely to flourish if tried in the prestige organizations of the school, including clubs and honor societies.

Today there seems to be a lack of training in responsibility and an overemphasis upon the right of self-expression. We see too many people striving to get all they can for themselves with very little regard for the rights of their fellow citizens. We see a decay in public and private integrity and a declining state of morality. The fact is that too many teenagers have been brought up with a tremendous appetite for their rights and privileges and a very limited realization of their duties and obligations. As a result, they are not grateful for privileges and lack a sense of responsibility. Social fitness means that an individual faces the world willing to give as well as to get.

To develop social fitness an individual needs to be loved, respected, and needed. He should be given responsible, challenging tasks to perform. He should be allowed to make a reasonable percentage of ordinary mistakes to learn from experience. Above all he must be made to realize that privileges, such as driving a car, carry with them the obligation that he must not endanger himself or others.

The individual who has not adjusted socially is apt to be reckless and irresponsible. His actions, selfish and immature, may often create hazardous situations.

In our society we find that conflicting social standards make the formation of proper attitudes difficult. The hot rodder is often idolized by his fellow students. Poor exam-

ples are set by adults when safety violations are ignored if the violator is wealthy and influential. Promoting good safety attitudes is thus a very complicated task.

Reckless conduct in adolescents often stems from their need to rebel against the authority of their parents. They resent adult-imposed restrictions and want to show that they can get along on their own. If they fail to attain status in a socially approved manner, they often assert themselves through destructive behavior. Rebellion against society as well as conflicting social standards often lead to unsafe behavior.

For many children who wonder if they are loved, or how much they are loved, taking chances becomes a way of provoking a caring response. Sometimes the "daredevil" is seeking the affection of his parents, sometimes of his peers, or sometimes both. "When minor risk-taking or minor injury fail to evoke the desired response, stronger measures often ensue. Bandages in the school-room are badges which win attention and admiration."²⁸

A Philosophy for Safety

The spiritual aspect of total fitness mentioned earlier will not be discussed, but in conclusion, let me say this about it. The individual who lives by the "Golden Rule," illustrating high ethical standards, develops his own philosophy of life, the integration of all acquired knowledge which patterns human behavior and is controlled by values, attitudes, ethics, and habits. This philosophy helps man to form his own destiny and become aware of other people, sharing activities which promote the general welfare for all people. In the opinion of the writer, this philosophy, this concern, can be relied on in accident-preventing situations.

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Transit Section

IS TRANSIT MEETING THE CHALLENGE?

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There are many challenges for our industry:

1. Urban Sprawl.
 2. Decentralization of industry.
 3. Traffic congestion.
 4. Restrictive traffic regulations.
 5. Slower schedules.
 6. Equipment damage, and personal injuries.
 7. Complaints.
 8. Few commendations.
 9. Loss of patronage.
 10. More restrictive labor agreements.
- We could go on and on.

But, you say, these problems have been with us throughout all of our transit careers. I agree; they have been with me during my 31 years of association with the industry.

Are they different today? In reply to this question, I ask others. Are new employees today of the same quality as those hired five years ago? Are they adequately meeting job performance standards? Are they creating problems among other employees who are doing satisfactory work?

If your company is at all typical of the trend in most businesses today, you will agree with me that this is a real problem area. You will also agree that we as training, safety, and personnel people must recognize these facts and make appropriate adjustments in our personnel programs.

The challenge is one of maintaining desired performance standards in today's labor market. All across the nation, in all types of businesses, you can hear the same questions raised: "Where is the old time employee? What has happened to pride in work?"

Perhaps it's because we have it too easy these days. Maybe it's too easy to get another job if we don't like the one we have or if the boss doesn't like us. In spite of these conditions, we still have to run our buses and trains with the manpower available to us.

There is a bright side to the picture. In my company, in your company, in any company, we do have some employees who are

doing their jobs in a satisfactory manner—and we also have many more who *can* do the same thing. I believe it to be more of a matter of attitude toward the job. A psychologist would describe the good employee as being properly motivated.

How then can we get properly motivated employees?

There are three steps to having motivated employees:

1. *Hire employees who are motivated or have the potential to become motivated employees.*

2. *Provide good training for the job for which they are hired and keep them at an acceptable level of performance throughout their employment.*

3. *Provide opportunities for an employee to seek greater job responsibilities.*

Hiring, as we all know, consists of two parts: *Recruitment* and *Selection*. In today's labor market, neither of these tasks are easily accomplished and our challenge begins to sub-divide: Are we doing everything we can to recruit suitable applicants? Are we doing a good job of selecting applicants?

Let's first discuss recruitment.

At CTA, we believe that our best source of applicants is from our present employees. In a sense, applicants are pre-screened. The applicant usually has a pretty good understanding of working conditions and feels some obligation to the person who referred him.

We have used just two formal means of urging employees to make referrals: Passout material and articles in the company magazine. We hope that by making CTA a good place to work, present employees will voluntarily make referrals.

A question you might have is: "Do we pay employees who make referrals?" The answer is, "No". We have thought about it but so far have not done it.

Our next best source of applicants are "Help wanted" announcements on car cards in buses and trains and posters in rapid transit stations. Another fairly successful

source is "Help wanted" information on the backs of transfers.

We've had a little success in spot announcements on radio, and our CBS station in Chicago has a weekly telecast titled "Opportunity Line," on which they publicize job vacancies in several industries. The network is picking up the idea for other large metropolitan areas.

Probably least successful—and a source one might think should be most successful—is the "want ad" section of newspapers.

We do get referrals from the Illinois State Employment Service, and we have just embarked on a cooperative venture with the Chicago Commission on Urban Opportunity.

We also participate in community organization "Employment Fairs". These are generally at high schools, and we consider this participation as a kind of long-range recruitment activity. Another source of applicants are the people who merely come in off the street and just figure that maybe CTA has job openings.

In 1968 we had more than 10,000 applicants for all types of jobs. Just about a half of these were for bus operator; the openings we most desperately need to fill. As you can see, we have many sources and not too much trouble in recruitment. We get lots of applicants. But now let's discuss selection—a much bigger challenge so far as having a motivated employee is concerned.

Selection is probably the most difficult phase of the hiring process. Assuming that a group of applicants are equal from the standpoint of age and medical requirements, how can we choose the ones who will become properly motivated employees? Who will do a good job? Who will do a poor job?

Like most companies, we use some tests. For most entrance level jobs, we use simple tests. For bus operators, for example, we use the standard ATA test. Also, we use a range rather than an arbitrary cut-off point. For some jobs, we use other tests such as Wonderlic, the Flanagan Industrial tests, Purdue Mechanical, Purdue Electrical, etc. In some instances we prepare our own work sample tests.

However, we believe that our best selection criteria are what we can learn about an applicant through a personal interview. A person may test well, but through good interviewing we can get a much better insight into a person's attitude, personality, and mo-

tivation. Conversely, a person may not test well but may be a good risk.

Of course, even an experienced, competent interviewer cannot be expected to ferret out everything about an applicant, so we also rely heavily on an investigation. We have a sizeable staff of investigators who check out references and make inquiries in the applicant's neighborhood and at former places of employment. For bus driver and rapid transit applicants we run their fingerprints through local police files and the F.B.I. files.

You may be interested in the number we hire compared to the number of applicants. In 1968 we had just over 10,000 applicants, and in that year, we hired just under 3,000. For every person we hired, we interviewed about four.

Unfortunately, I can't say that every one of the 3,000 we hired turned out to be a competent and well-motivated employee. We still have a long way to go in determining who should and should not be hired. However, we are conducting a study of 500 new bus operators in an attempt to correlate our hiring requirements and the operators' background experience with their performance on the job.

Performance on the job brings up the subject of training, which is the second step toward having properly motivated employees.

Training can motivate. We realize, and even expect, that every person hired is not well adjusted to and motivated in his new job. We also realize that we must instill motivation into the employee. Good training can help immeasurably in this regard. When I say "good" training, I mean training that is permeated with the ingredients that will make the employee want to do an outstanding job.

What are these motivating ingredients? What must instructors emphasize to the new employee?

1. The company he has chosen to work for is a *good company*. It is a company worthy of his talents and abilities. First impressions are important and if the new employee gets the impression that his instructor doesn't think much of the company, that's the impression he's going to get of the company. If we have an instructor who does not believe that his company is a good company, we had better relieve him of instruction duties.

2. The new employee is an *important person*. He must be made to feel that he is wanted and needed, and that the job he is training for is an important job. He must be made to feel that the instructor has a personal interest in seeing that he becomes proficient and skilled in his new job.

3. The *training program* must be well-planned and well-executed. The program must be designed and presented in a way that the new employee will learn quickly and thoroughly. Throughout the program, he must be checked to determine that he is learning.

4. There must be *follow-up* to the training to determine that the employee is performing as set forth in the training.

5. There must be a program of *retraining* to take care of employees who fall below an acceptable level of performance. A program of retraining shows the employee that the company does care about him. Very often, discharging an employee is the only alternative to retraining.

6. There must be what, at CTA, is called *refresher* training. This training is conducted when certain employees, as a group, are having a problem. For example:

a. Drivers on a certain route may be having more than their share of accidents.

b. Rapid Transit conductors may be making poor station announcements.

c. There may be a rash of trip sheet or transfer errors.

d. Mechanics may be weak on a certain phase of trouble shooting.

e. Complaints may be on the rise.

In circumstances like these, we bring the particular group together to discuss the problem and then conduct training to overcome it.

Does this kind of training motivate employees? We think it does, because we believe that most employees want to do a good job even if they are not self-motivated to help themselves.

One type of refresher training that is highly motivational is "brainstorm" sessions. In this kind of training, we state a problem and ask the employees involved how the problem can be solved. We record their answers, and after all the sessions are completed we tabulate the answers, print them, and feed them back to the employees. This training is effective because the training is

based on what the employees said. It's as though they designed it.

7. A few minutes ago I said that to be motivated, employees must feel important—that they are needed and wanted. In our industry, the group that is most needed—and probably the group that feels most neglected—is our operating personnel. This is the group that meets our customers, and I believe that we must do everything we can to motivate them.

This month at CTA we are having a company-wide campaign. A lapel button is a symbol of the campaign; it says "CTA—Teamwork".

The campaign has three objectives:

a. To make "Teamwork" a by-word among employees, but *in actions*, not in words.

b. To have all employees aware that our operating personnel are very important people and should get cooperation from all.

c. To get employees to use "Teamwork" to communicate troubles or problems that they observe on CTA vehicles and property and, where possible, minimize the effects of adverse publicity.

As you can see, the purpose is to show our operating employees that the whole company is working with them. We don't just want to be sympathetic to them—we want to help them in a very positive way.

8. There must be training when there are changes in service, equipment, or procedures. Employees want to learn what is new in the company. At CTA, this kind of training gets excellent response. Some employees attend training two or three times, because they want to be sure that they understand the change. Sometimes employees who are not affected by the change attend—they are just interested.

9. Training can sometimes be conducted off the company premises, or outside instructors will come to your property and conduct training. This training makes the employee feel that his welfare is being considered, and it is highly motivational.

For example, some of our apprentice training is conducted at a trade school on a regular basis. Suppliers of equipment come to our property and conduct specialized training in some aspect of the equipment they sell. When we purchased our new rapid transit cars, certain key personnel went to Erie, Pa. to receive training on the new

electrical equipment. Some also went to the Safety Equipment Co. in New Haven, Conn., to receive training on the air-conditioning system.

10. Training must be *conducive to learning*. The straight lecture type of training is no longer considered good training. Training must be interesting and palatable to the trainees. It must be well-paced, eye-catching, and appeal to more than one of the five senses. Much can be accomplished by means of audio-visual aids such as sound-slide films, motion pictures, flip charts, transparencies on an overhead projector, magnetic boards, black boards, tape recordings, and models and cut-a-ways.

All of these audio-visual devices are fairly inexpensive to purchase and, best of all, many materials for them can be home-made. The advantage of making your own audio-visuals is that they can be designed to meet your own particular needs.

There are other types of teaching aids on the market. The "Edex" system combines sound slide films and motion pictures with electronic equipment for trainees to record their choice of multiple-choice questions. "Intermedia" is another type of response learning system using electronic equipment. One advantage of this type of training is that one person can instruct a large size class.

At CTA we have 70 full-time instructors in the Transportation Department. In the Shops & Equipment Department we have 16 full-time instructors and 10 who instruct on a part-time basis. Live instruction is no problem to us.

Simulators such as the "Altea" driving machine and the one by the Rockwell Manufacturing Company ("Drive-O-Trainer") have met with some favor. However, at CTA, we believe that teaching on the actual vehicle is better than using a simulator.

Video-tapes also have a real place in training programs and may just fit your own particular needs.

There have been many studies made and theories proposed on what motivates employees to do a better job. It is generally agreed that one of the greatest motivating factors is to give an employee opportunities to accept greater responsibilities—motivation by incentive.

We also must recognize that we need po-

tential leaders. As supervisory employees retire, get promoted, or die, we need people to fill their jobs. The best way to fill these jobs is from within the company—to up-grade your present employees. We believe that up-grading must be based on ability. Nothing can be more demoralizing to a group of employees than seeing a man promoted because he's somebody's "fair-haired boy".

At CTA, we believe that there should be a systematic up-grading progression. To illustrate, following is the progression in the surface system of our Transportation Department:

We start with some 6,000 bus drivers. The first step upward is to Line Instructor—the group that gives platform instruction to new bus drivers. There are 350 regular line instructors and another 350 who are in the line instructor "pool". These pool men instruct when needed. Line instructors must apply for the job and are selected by the Station Superintendents on the basis of their past performance. Those selected receive training for the job and additional pay when instructing.

The next step in the progression is to Traffic Supervisor. This is a group of about 200 men. For this up-grading, selection is more formalized. Again, bus operators apply for the job on a posting system. One requirement is that they must be qualified line instructors. Station Superintendents make recommendations as to whom they believe are most acceptable. The men recommended are sent to the general office for tests and interviews. As many as 100 or 200 men may be interviewed and tested, but generally only about 25 or 30 are needed. The ones finally selected are given training for the job, and those who pass the training are placed in the Supervisor "pool" where they fill in when needed and get appointed to full-time supervisor as vacancies occur.

The next step is to Instructor. Although the pay for Supervisor and Instructor is the same, transfer to the Instruction group places a man in line for the job of Station Superintendent. There are 60 men in the Instruction force. Selection is similar to that of supervisor, and a formal training program is also established for this group.

From Instructor the progression is to Supervisory Instructor and then into the ranks of Station Superintendent.

In summary, the progression goes like

this: From a group of 8,000 men (drivers) to a group of 700 men (line instructors).

From a group of 700 men to a group of 200 men (traffic supervisors).

From a group of 200 men to a group of 60 men (regular instructors).

From a group of 60 men to a group of 50 men (station superintendents).

With this system of progression, even the brand new bus driver can see that he has opportunities for advancement. There is an incentive for doing a good job.

A similar system of progression is available to men beginning as Bus Servicemen in the various garages, and in other departments, too.

Another form of motivation by incentive is the "job posting" system. Practically every job vacancy within CTA is subject to posting and bidding by anyone who believes he can fill the job. Thus anyone, even the bus driver, realizes that he is not "nailed down" to his present job. If an employee can demonstrate his abilities, his promotional possibilities are almost unlimited.

Yet another form of incentive is the Suggestion System. Here the employee can demonstrate his creative ability and receive monetary recognition.

Tuition Refund on advanced educational programs is highly motivational. This is tan-

gible evidence of the company's interest in an employee's growth.

There should also be incentives for non-promotable employees. We must realize that many employees, particularly in the large operator group, will not be promoted. It is important that they realize the importance of their job. They must be kept aware that other employees appreciate their contributions to the success of the company.

Of course there are many other forms of incentives that many companies have, and to a greater extent than we have at CTA. For example: Driver of the month; awards for safe driving, such as National Safety Council's Safe Driver Award; dinners for accident-free drivers; cash and/or gifts for satisfactory records; etc.

Our challenge of producing properly motivated employees in today's labor market must be recognized and accepted. The methods we used five years ago are no longer adequate. I urge you to review your areas of responsibility with a view toward strengthening your programs. We must improve our techniques to compensate for what we know to be lacking in our raw material. The time to act is now.

Every inept act, every task slighted, every "I don't care" attitude by an employee hurts your company.