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COMPUTERS CAN HELP PLAN A SAFETY PROGRAM

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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.

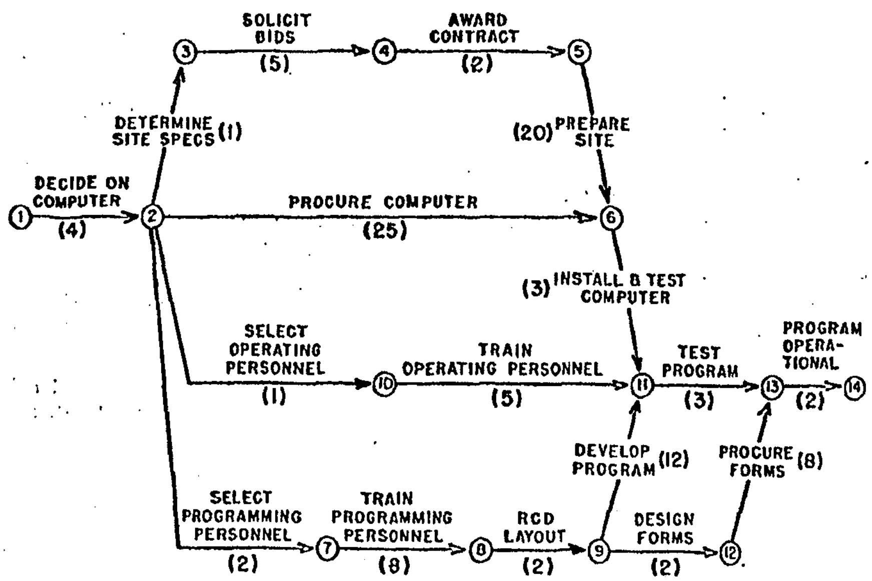
The *planning* phase of a project consists of determining a proposed method of action or procedure. In this technique, planning must be separated from scheduling; therefore, it is independent of timing. Planning involves making an analysis to determine what specific jobs are to be done, the sequence 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 active 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 organization believes is desirable and it may not necessarily be appropriate for other activities. Information available through the computer outputs include milestone 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 246, 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 primarly 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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