

# ENGINEERING *and* HEALTH

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OUR FRIENDS the doctors belong to an appealing profession. They deal with human suffering and work miracles of relief. The practicing physician touches the lives of his patients and their families in times of minor or major illness, brings calm competence for them to lean on, initiates useful activity when the urge to do something is especially strong, and renews and strengthens the courage of all concerned. The hospital provides, sometimes a little too impersonally, but nevertheless effectively, a kind of care that the average household can but seldom afford. The research worker in medicine wins dramatic victories over one disease after another by methods that the educated layman can comprehend, even if he cannot fully understand the detail of the scientific technique. To the general public it all seems like a personification of science at its best, working untiringly for the benefit of mankind. Perhaps it is for this reason that, at least in reasonably prosperous times, generous-minded men and women are so easily persuaded to make liberal contributions to hospitals, medical schools, and institutes for medical research.

Our own profession commonly makes no such emotional appeal to the lay public. Our achievements are too often thought of as having an industrial rather than a human significance. The man in the street admires and trusts the engineer in a blind and sometimes extravagant fashion, but this admiration tends to be as cold and impersonal as that which he accords to one of his machines. Does not the engineer deserve a warmer and more affectionate appreciation? If only we could make clear to ourselves and to the public some of the things we are doing or trying to do, that touch intimately the personal lives of men, we have not hope that the respect now commonly accorded us will be tinged with more of the emotion-stirring loyalty that can inspire active cooperation?

With this thought in mind that I have chosen to inquire to what extent the engineer can be thought of as rivaling the physician in the promotion of health. In appraising this rivalry, let us not forget that, while the engineer's achievements are never as dramatic, spectacular, or individual as is the saving of a life or the restoration of a sufferer, in vigorous effectiveness, the engineer deals, not with individuals, as do most physicians, but with the great masses of men, women, and children that constitute modern communities. If, then, the intensity factor of his health work is, perhaps, less than that of the physician, its quantity factor is, in general, immeasurably greater. But any appraisal of the effectiveness of any sort of work, in physics or in life, depends on the magnitude of a product containing both an intensity and a quantity factor. If, then, the intensity factors of the various engineering activities that promote health are found to be far greater than that zero which alone could nullify the significant product, it is, perhaps, not unreasonable to suggest that the engineers of today are contributing quite as much to the promotion of health as are the physicians.

The most obvious, because the most direct, contributions of engineers to the promotion of health lie, of course, in the field

of sanitation. By bringing abundant supplies of pure water into towns and cities, a boon that only those who have lived or traveled in arid regions can fully appreciate, by building sewers and sewage-disposal plants, by modern methods of refuse collection and disposal, by the invention and fabrication of modern plumbing fixtures which make cleanliness easy, and by a patient persevering fight against atmospheric and stream pollution, engineers have undoubtedly saved many lives and relieved the world of much suffering. While the medical men have had to lead the way in attacking such diseases as hookworm, malaria, and yellow fever, it has been the sanitary work of engineers that has put this hard-won knowledge into practical effect on a large scale over considerable areas. Indeed in the whole field of public-health work and of preventive medicine in which so many forward-looking physicians are actively engaged, engineers are their indispensable allies. The tremendous influence which these various sanitary and other advances have had on the general health level of the population as compared with that which prevailed in the middle ages is too striking to require further comment.

In the important matter of diet also, the work of the engineer has been of importance. By the development of tin plate and of intricate machines for fashioning it, he has made possible the canning of food on a tremendous scale, thus broadening and enriching the diet of the nation, and making available at all seasons, and in the most out-of-the-way places, foods rich in vitamins and hormones. The development by engineers of refrigeration on ships, on trains, in cold-storage warehouses, and in the home, including the newest methods of quick freezing, has contributed to the same end. Irrigation, often involving engineering projects of enormous magnitude, has helped the farmer to produce food in greater abundance and often of finer quality. Still more fundamentally, the ships, trains, and motor trucks, by means of which most of the food of the nation is brought to those who consume it, were invented and developed, and are fabricated and maintained by engineers. Without them no modern urban population could exist. By these means engineers have profoundly affected the dietary habits of whole nations and have made possible the elimination of deficiency diseases and of the lowered resistance to infection that malnutrition causes.

In the matter of housing, also, engineers have played their part. They have improved the materials and methods of construction, and therefore both the availability and the usefulness of buildings of every sort. They have flooded houses, offices, and workshops with eye-saving light. They have provided the central heating plant that insures a uniform controllable temperature throughout a house. Air conditioning is just around the corner. By developing transportation they have enabled an urban population to find over a far-flung area more healthful living conditions than were available even to the well-to-do, let us say, two centuries ago.

In all these obvious ways engineers have contributed to the maintenance and improvement of the health of vast numbers of people. This is, however, by no means the whole story. There are certain other activities of engineers that have an even more significant effect on the health level of a nation.

Consider first, all that is involved in what is called a national

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standard of living. Technical achievements in sanitation, in the production, transportation, and preservation of food, and in housing may determine what is available to those who can afford to have what they want; but it is the national standard of living that determines what the average man actually gets. If the national standard of living is low, there will be bad housing, bad sanitation, malnutrition, a prevalence of deficiency diseases, and a general lowering of resistance to infection that will be responsible for much sickness and many deaths. By far the most effective way of raising the general health level of any population is to raise its standard of living. This problem is, fundamentally, not medical but economic.

The standard of living of a community is nothing else than its production of goods and services per capita per year. Unfortunately this is not always the same as a community's capacity to produce per capita per year. At the moment, for instance, we apparently do not know how to make our economic system function in such a way as to permit men to produce and consume all they could easily produce and would like to consume.

In the long run the actual production of a community per capita per year will be determined by its capacity to produce, and its capacity to produce will be conditioned largely by the possible production per man-hour of expended labor. In other words, in the long run, the only way to raise the standard of living of any community, and with it the general level of the health of that community, is to increase what a man can do in an hour by giving him more inanimate slaves in the form of horsepower and kilowatts, by giving him more and better tools and machines with which to work, by mechanizing and automatizing more of the routine operations in his productive processes, by working out technological advances and inventions that displace some useful thing that is hard to make by something else equally useful and easier to make, by showing him how to handle things more deftly, and how to postpone or avoid fatigue, and by more effectively organizing the teamwork of the industrial unit in which he works. Only by such means as these can the standard of living of any community be permanently raised, and only engineers can provide these elements in the increased hourly productivity of the workman of today and tomorrow. By raising our scale of living in the future, as they have marvelously raised it in the past, engineers can markedly affect the future health level of the whole population.

Over shorter periods, a high standard of living is characteristic of what we call prosperity. Anyone who ventures to talk about the business cycle is treading on dangerous ground. But it is, I think, generally admitted that a characteristic of most waves of prosperity is the rise of an important new industry. The automobile and the radio are striking examples. What the next new industry will be, no one knows, but it is surely safe to assert that, when it comes, engineers will have been responsible for its genesis and growth. Only industrial activity, energized by the genius of the engineer, can generate good times. If then, it is to engineers that we must look both for the long-term trend, and for the cyclic bulges, in the upward progress of our standard of living, their part in the maintenance and improvement of the health of the nation is great indeed.

All that I have said thus far pertains to the physical health and well-being of mankind. But our friends the physicians know even better than the rest of us the importance of that other aspect of men's lives that may be called mental health. Always important in itself, it often influences, if it does not completely dominate, physical condition. Here too, engineers

have important contributions to make in at least two different ways.

The first depends on the fact that a considerable proportion of men and women spend more than a third of their waking hours on an industrial job of some sort. Someone has said that the chief difference between a professional man and a job holder is that the former lives through his work, the latter by means of it. I see no reason why this cynical characterization of industrial work should be accepted as inescapably true, or why such work cannot be made to afford to the worker an acceptable and satisfying way of living. In fact I believe that many workers do thoroughly enjoy their work. We are all too prone to ignore the nonfinancial incentives and rewards of business and industry.

Enjoying one's work is greatly enhanced by, if it is not actually dependent on, having a job that one can do well. This is where the engineers come in. They are beginning to feel their way into new fields of management which involve both adjusting jobs to their holders and assigning men to the right jobs.

Adjusting a job to its holder may be done by a machine designer or by a motion-study specialist. Many modern machines are already designed with special reference to the convenience and comfort to those who are to operate them; though how much remains to be done is indicated by the saying of one of my friends that there is only one machine in the world that is perfectly adapted to the operator, and it took three thousand years to make it so—the machine in question being the ax handle. And to the extent that motion study is used to make jobs easier and less fatiguing, rather than merely to speed up production, it can confer great benefits on the worker.

Assigning men and women to the right jobs holds even greater promise of materially raising the general level of mental health of the working population. Industrial managers are beginning to make notable progress in studying human beings objectively, in measuring individual differences, in appraising both the strengths and the weaknesses of prospective employees, in cataloging the pattern of strengths and weaknesses most appropriate to each particular job, and in assigning men and women to the right jobs. I could tell you, if time permitted, of men who came into an industrial testing laboratory restless and inefficient, sometimes even morose and uncooperative, because they had strong aptitudes of certain kinds on which their jobs made no demands whatever, and how, in many cases, re-assignment of these men to jobs that called into play all their aptitudes resulted within a year in almost miraculous alterations in personality and outlook on life. I could tell you of women, trained at their own request as comptometer operators, who become nervous wrecks within a year because of the lack of a certain necessary aptitude which could easily have been detected in advance. Nor should we forget the intangible but often important stimulation to personality that comes from the mere fact that one has been studied and measured, that one's abilities have been sought out and recognized, that one's life has been paid attention to and discussed as an individual adventure. Not that the millenium is immediately at hand by any means; the engineer-managers of today have only just begun to scratch the surface of this highly promising field, and he who tries to go too fast in it will come a cropper, and perhaps temporarily discredit the whole field. Nevertheless I am convinced that this kind of activity will produce, in the next twenty-five years, a greater harvest of human satisfaction and mental health than any of us can yet conceive.

Turning now to the second way in which engineers can hope to help bring more abundant mental health to the world, we find ourselves facing a much more difficult problem. Perhaps I

am over optimistic in even mentioning it as one that engineers or anyone else can hope to solve. And yet, in its various ramifications, it is probably the most important problem that civilization faces today. I refer to the problem of industrial instability, the problem of the recurrent recessions and depressions that periodically throw millions out of work, and disrupt, sometimes permanently, the lives of many of them, the problem of social insecurity.

That social insecurity can profoundly affect the mental, and even the physical health of great numbers of people, is undubitable. Worry has wrecked more lives than tuberculosis, and there is no worry so insistent as that which besets a self-respecting industrial worker, and his whole family, if he thinks there is danger of losing his job, except that of a worker who has lost his job. I suspect that this sort of worry is by far the most important single factor in the American health situation today.

What hope is there of lightening this incubus of fear caused by industrial insecurity? What hope is there of steady, perhaps even of guaranteed employment?

Two types of thinking are current with respect to problems of this sort, one political, in the best sense of that word, the other industrial. It is characteristic of the political type of thinking, whenever a social problem can be defined at all, to attempt to solve it by enacting a law. This type of thinking holds, consciously or instinctively, that social progress can best be forced forward by legislation. This dogma, to those who are persuaded of its validity, is comforting. It affords them an opportunity to do something about it, here and now, without waiting for the slow processes of social evolution. In some cases reform by means of legislation is indeed the only practicable procedure, particularly when a recalcitrant fringe of unsocial competitors has to be whipped into line with the standards which a great majority would be glad to maintain if they could. But to coerce a majority to proceed faster along the path of social progress than they are ready to go, is a process both difficult and dangerous even though alluring. In such a case, education is more to the point than legislation.

The political type of approach to the problems of today may, of course, succeed in remaking our world, particularly if it be reinforced by plenty of emotion-stirring propaganda. It may even lead to the most effective forms of government that the world has yet seen. These new forms of government are, however, almost certain to be highly centralized, closely integrated forms of government, exerting over industry, and over the lives of citizens generally, the detailed regulation and control which seem to be essential to making any planned economy work. Personally, even if I were sure that the political approach would lead to highly efficient governmental forms and to really well-ordered lives, I would rather sacrifice some of this efficiency and orderliness to secure more individual initiative and responsibility, more of a chance for each of us to make his own mistakes and enjoy his own triumphs.

The industrial type of thinking about economic and social problems proceeds in quite a different way. Too often in the past, unfortunately, it has tended to ignore such problems as long as possible, and when at last they loomed up inescapably, it has tried to fight them instead of to solve them. The industrial leaders of today, however, are beginning to have an economic and sociological background with which to think through the remoter human implications of the decisions they make and the policies they pursue. They are beginning to work out, step by step, each in his own business unit, some sort of social justice with respect to the conditions and rewards

of industrial work and the effect of it on the whole lives of workers. The industrial type of thinking pins its faith to the hope that all these tiny steps forward, scattered all over the country and through many industries, influencing each the other both by the contagion of example, and by the educational process of thoughtful discussion, will integrate into a march of progress that, however halting and irregular it may at times appear to be, will have firm ground under its feet.

The key to the whole economic and social situation, according to this way of thinking, is the breeding of a sufficient supply of industrial administrators who have not only sound business judgment but also enough social understanding and vision to better adjust the functioning of our present economic and industrial system to the welfare of society at large. Many of us are hoping that such progress will be made rapidly enough to forestall the motivation for, and the possibility of, too much legislative experimentation.

But, you say, where do engineers come into this picture? The answer is that more and more are engineering-trained men finding themselves in positions of executive responsibility in business and industry. There seems to be something about the training and experience of engineers that fits them for such work. Instinctively they deal with facts rather than with traditions and emotional reactions. Their work forces them to see things in the large, to fit details into long-range plans, to see visions and dream dreams, and then to translate them into reality by the careful organization of a multitude of various contributing activities. I believe that engineering-trained men are destined to contribute far more than their proportionate share of the industrial leaders of the next quarter-century. If so, they are facing a great opportunity and a great responsibility. If they can learn to think around their jobs as well as thinking their jobs through, if from their natural vantage point as liaison officers between capital and labor, they can get a comprehensive vision of the aims, aspirations, points of view, and prejudices of both groups, if from their familiarity with the flow of materials through a factory or the flow of energy through a power plant they can derive a vivid picture of the flow of goods and of money through the channels of production and consumption, if their experience in handling men on the job can bring to them some understanding of how men want to live, they can, perhaps, contribute more than any other single group to the solution of those fundamental economic and social problems of which we have been speaking. And if by these means they can, even to a small extent, diminish the worries inherent in industrial insecurity, they will have made the greatest contribution of the century to the promotion of the mental health of vast numbers of people.

May I, then, suggest that he who is profoundly interested in maintaining and improving the health of mankind, and who has enough vision and imagination to sense the long-time trends of life, would do well to devote a considerable part of his energy, or of his beneficence, to fostering engineering education and research. In particular he should be interested, not only in the technical aspects of the profession, but especially in those branches of it which are concerned with industrial management and with the foundations on which sagacious industrial administration must rest. The results will not be so easy to observe, so directly and immediately obvious, as if he had been instrumental in training a succession of wise physicians or skilful surgeons, or in conquering some obscure disease, but in the long run, he will accomplish much improvement in both the physical and the mental health of his fellow men.