is not so much a question of whether or not management is interested, but whether or not its interest is in proportion to the existing and potential problem. The problem is part of the new economic fabric of industry and cannot be ignored.

The influence of engineering is to carry industry toward larger and larger investments of capital. Operation is becoming more and more simple and engineering more and more complicated. Some claim that the simplification of operation will be extreme, and this claim is justified in some directions.

There are interesting related sociological aspects of the problem which are to some extent indicated in the order of change. One thing is certain and that is that operators, no matter how many there are, should have a part in both creation and operation. Their interest in processes and products should be sought. Schools should be established, and have been to some extent, to furnish a scientific understanding of production processes. This would mean larger opportunity for creative expression.

A division in responsibility is upon us and we must decide who is to lead, administer, manage and engineer. A more rapid adjustment of the social problems involved is essential if the application of industrial engineering principles is to go forward rapidly. These adjustments should make up a larger and larger part of the industrial engineer's task.

Engineering as a Process

In order to bring about improved engineering practice, and its more extensive rise, it is essential that engineering be seen as a process as well as a technical science. It should be accepted as a life process and not merely as a tool. The industrial engineer should desert traditional approaches and unite his efforts with those of the technical engineer, since he is concerned with the whole organization. As he has been able to do away with unnecessary operations, so he should attempt to eliminate organization problems. The technician should also recognize the psychological problems with which the industrial engineer has long contended. He should work for a wider appreciation of the work of time study. If the technician realizes his work is with both men and materials, he will have a broader understanding of processes and be able to improve his designs. Machinery and processes are fairly regulated by men, and their mental processes have to be taken into consideration.

By a better understanding of engineering philosophy the engineer will see more clearly final results and values, as contrasted with immediate ones, and will be better prepared for comprehensive accomplishment. It would seem that the engineer has yet to see himself in relation to the influences he has created.

The scientist knows that his professional ethics are tied up with the application of his science. In applying science to industry, the engineering scientist has learned that scientific and moral truths go hand in hand, when the effects of science are understood. This understanding makes more certain the adjustment of internal and external social problems.

The practice of establishing research and engineering departments and then ignoring them is hard to understand. This new member of organization is still a bit strange, and we often hear that a research or engineering department has been reorganized so as to co-ordinate more closely with production. There is an old and inborn fear of this new monster, science. Managers and workers like its immediate results but at times dislike the necessary concomitant changes.

The confusing thing is that engineering, once an auxiliary tool, has now become a function. We must think of engineering as a process.

J. A. Willard.[2] The outline of this paper received before the meeting states that it "treats with the position of engineering in the economic structure of business."

This paper is a further able defense of the engineering profession in industry, and it does not appear necessary or desirable to add, in this discussion, to this defense. If in the past it has been necessary, it is believed most earnestly that the fault lies with the engineer himself. By and large, he has been too much concerned with his position in industry and too little concerned with rendering a broad gauge service to mankind.

Progress has been relatively slower because engineers did not use common sense in selling their ideas and methods to the more practically minded manager and banker. An earnest effort on the

[2]Treasurer, Bigelow, Kent, Willard & Co., Inc., Boston, Mass.

engineer's part to think in terms of the other man's point of view will almost always find him eager and ready to adopt the program, when presented in the language of dollars and cents and from the operating viewpoint.

But, even if the engineer has "made his bed," he does not have to lie in it. He can trade it in for a new model and look at his problems from a broad human point of view, based on a deep spiritual feeling of service.

The statement of the author that he does not believe that industry is over mechanized is ably supported by the paper presented to the American Society of Mechanical Engineers this morning by Messrs. Alford and Hanna. They present a picture of a very low average of machine efficiency throughout industry. This condition has been verified by my own experience. It is firmly believed that progress ten years hence will show even greater advances than the last decade, and, in all probability, we shall find about the same percentage of managers who are loath to keep step with this progress. Declining profits will eventually force them into improvement or bankruptcy.

Personally we are much more concerned with the over-merging of industries than we are with over-mechanization; this, not at all because of the building of unwieldy organizations, but on account of the weakening of the effective man power of these organizations. I have recently witnessed two mergers from a professional viewpoint, and in both cases remarkably fine organizations have been broken up and scattered. The loss of this high grade executive man power cannot help but be reflected in subsequent loss of profits. It is not good for business as a whole to scrap men, who from long experience in the manufacturing or merchandising fields of a specific business are good profit makers in that business and practically useless out of it.

Again it is a case of neglecting the importance of the human factor in business.

To revert to the title of the paper, we believe a theorem can be stated to cover the relation of engineering to the various types of manufacturing plants as follows: Control methods in an industry increase as the human factor increases.

This has been clearly indicated in the paper under discussion.

A paper mill and the average cotton goods mill are good examples of continuous process plants which need a minimum of engineering control for their successful operation. Nevertheless what control is necessary must be good or the business will fail.

You can build standard speeds and feeds into a lathe or a rip saw, but that does not mean that someone who doesn't know any better will not try to run it at half its normal capacity. Effective management and control are vitally necessary even with highly engineered equipment.

I had an experience with a plant in the Mid-west about a year ago which produced a line of goods susceptible of being made by automobile manufacturing methods; in fact, they were tooled up and conveyor equipped for such methods; but, because of a breakdown in management control they were being run largely as a huge job shop with almost 15,000 employes.

The author has pointed out clearly in his chart the elements of control needed in different type plants, but each plant must be treated as an individual case and ultimate success is dependent on the accurate adaptation of control to the human factors in the particular business.

Henry Post Dutton.[3] Mr. Schulz has brought out very clearly the differences in control between the continuous or flow industry and the variety or jobbing business. If we analyze the various production steps such as plant layout, routing, supply of materials, scheduling, dispatching progress records, and follow-up, as Mr. Schulz has done, it becomes possible to indicate, as he has done in his chart, how each of these is simplified or embodied in the plant, in continuous production. It is also possible to separate these elements into two distinct classes, corresponding closely to the classification of fixed costs and costs proportionate to volume, used by Mr. Williams. Instruction of the workman, routing, layout, scheduling of the lot, are in the nature of proportionate costs done only once for an order, with little correspondence to the size of the order. Dispatching, progress records and follow-ups, tend to be more closely proportional to volume as, of course, does the actual work of operation. As the size of the lot increases and the number of lots decreases the incidence of these costs per unit becomes less.

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