exist: (1) physical organization, (2) research, including time study, (3) systems, (4) methods and materials, (5) plans and policies, (6) product, (7) performance records, (8) training and promotion of personnel, (9) supervision and leadership, and (10) morale.

In the continuous process plant the machine and its supporting devices solve some of these problems and, as has been pointed out, simplify or partially absorb others. Training may even be taken over but it is believed that scientific training for operation is highly desirable. Closer co-ordination of the operating and engineering ends of industry is necessary to accomplish this purpose.

The element of cost is included among other elements represented in the chart. The proportions to which this has grown call for managerial understanding and direction, for improved internal engineering and improved organization, including simplification and standardization. It requires that more thought be given the economic aspects of engineering because the costs of engineering make up a considerable part of production costs.

Three stages of organization are indicated on the chart—variable, intermittent and continuous processing—but no indication is made as to which of these stages is good and which bad. As a matter of fact any of them could be either good or bad. There may be reasons why an industry is in one of these particular stages. No matter what the stage, there is room for mechanization, and it is one of the objects of this paper to show the desirability of approaching mechanization regardless of the stage.

If some plants that are classified under variable or intermittent processing were to use the engineering skill and equipment available they would rapidly progress toward continuous processing and receive some of the economic benefits. The managers of these plants would probably argue that it is not equipment but product that puts them in the variable or intermittent class. This may be partially true. If products are variable, however, it is primarily processes in which they are interested, and an analysis of operations and elements of operations would show that both are repetitive. A plant may be highly variable as far as its product is concerned and still be highly repetitive as far as its work is concerned. A careful classification of the products, common operations (machine and hand) and operation elements of most factories will show a great deal of repetition. This should encourage mechanization and influence the selection of machinery.

Traditions and Practices of Industrial Engineers

The industrial engineer has often been forced to build on a traditional understanding of product. He has not been able to start with the fundamental problems of organization construction—sometimes because immediate surface improvements have been demanded. Results are bound to be disappointing, however, unless organization construction is built on strong foundations of engineering rather than on traditional grounds.

This paper can only indicate the possibilities of work classification as a controlling feature in mechanization. There are all the questions, which can only be touched upon here, of standardization and simplification of the product itself. Simplification does not necessarily mean elimination. It may be brought about in design and in co-ordination of methods. It seems that the engineer has too often failed to realize that the product is an important consideration in reorganization plans.

A considerable amount of mechanization has taken place in the design of single unit machines used in variable and intermittent processing. Manufacturers have suggested that engineers consider in their designs the time involved in forming materials, manipulating the machine, and in handling tools and materials. Two advertising cuts of a manufacturer of machinery furnish an illustration. The one shows an old style machine, with the operator walking back and forth and around, in order to prepare for even a small cutting job. The other shows a new style machine which permits the operator to stay in one place while he adjusts and operates it. Movable parts which were formerly moved by hand are moved by power traverse. Does not this newer type of machinery simplify employe relations and change the human problems involved? I question whether any of us would wish to go back to hand starters and the old style tires on automobiles, and yet we still get a great kick out of driving cars, at least on the open road. As engineers designing machines, we should consider our operators in the same light that the producer of automobiles considers his customers.

Managers and engineers in the machine tool industry deserve high credit for their work in the automobile industry. Their excellent and comprehensive work, stimulated by keen competition, has undoubtedly done much to make cheaper automobiles possible. The machine tool industry has been a leader in designing improvements and the automotive industry and the public were fortunate in being able to draw upon this engineering skill. Other industries with large problems in engineering would be fortunate if they could profit also by such applications of engineering skill to the fields in which they operate.

Examples of Problems Absorbed by Mechanization

Some may question the claim that mechanization has absorbed problems of accounting, control and supervision. Let us take two extremes of supervisory practices. Under the old conditions, where little or no machinery existed, a gang boss set the production pace and attempted to keep work moving. It was his influence that determined how many units were produced in a man hour. Under the new system of continuous processing the machine controls the number of units produced per machine hour and also the number of men necessary to supplement the work of the machine. It sets the tempo. There are numerous modifications of these two extremes at the present time. For purposes of discussion they fall into two groups: (1) industries where tasks are set largely by foremen and workmen from tradition, and (2) industries where tasks of some form are set as a result of time study and other data. In either case supervision is concerned with the accomplishment of tasks. It is a constructive influence which has to do with the preparation and flow of materials and with the production of quantity and quality of goods.

Supervisory work is a combination of physical and psychological acts performed in relation to men, materials, equipment and processes. It involves also reciprocal acts of co-ordination and co-operation with other departments and functions of the business.

Let us assume that there are four operations to be performed on a number of pieces of work in a variable or intermittent plant, where machines are separate production units. If it is a well ordered plant of any considerable size the order of work will be planned and the materials, special devices and instructions for doing the work will be on hand before work is started. If we assume this situation, the following things will happen: The foreman receives instructions concerning a job; he sees that the necessary materials and devices are on hand and in good condition and investigates the job so as to obtain a clear picture, if the job has not been handled before, of what it requires; he advises the operator of the order in which the operation is to be performed and gives the operator his concept of what it requires; he is responsible for the operator's checking in on each operation, so that accurate time and cost records may be kept and the progress of work through the shop, and its co-ordination with the other work, controlled; he approves work before the operator checks out and is responsible for the return of instruction sheets and devices, and for the care of materials and their delivery to the person that moves them to the next job.

The procedures described would be modified on different jobs but these will suffice for illustrative purposes. They would be repeated for each of the four operations. This would mean direct supervisory work before each operation, reciprocal relations with the planning or shop management department, and cost records for each operation. If a continuous process machine were developed to do all four operations, the reciprocal acts of control, the intermediate acts of physical and mental supervision and the physical acts of moving materials would be absorbed and therefore would no longer be necessary. Cost records would no longer be necessary for four operations because the four would have become one. Management problems are greatly simplified under conditions such as these.

Supervision could often be improved in variable and intermittent industries if they would copy more accurately the principles applied in continuous processing. In the continuous process, operation is practically impossible unless all the preparatory activities have been carried out precisely and in order. Plans, instructions, tools, materials, are all prepared in advance. It is not possible for one operation to depend upon another for service. Continuous processing encourages and forces good management. The trouble with non-continuous processing is that it permits any kind of management.