as large. It does not, however, insist that all problems require the same technique or degree of fact-finding. It may use the historical, statistical, experimental or other method according to the nature of the problem. In one instance exhaustive experiments may be made and in another a few samples examined, according to the importance and urgency of the problem. Scientific management seeks data for use in planning action; if the action is to extend far into the future and affect many individuals, the search for data will be exhaustive; if the action is transitory and affects few individuals the investigation will be modified accordingly. In this connection it may be said that scientific management insists on three things: always the mental attitude which demands the pertinent facts before making a judgment; as many of the pertinent facts as the nature and duration of the use justifies, when judged by the cost and time required for finding them; and facts of such a nature that their significance can be formulated into understandable specifications of action.

Standardization means simply the publication of the results of research in the form of specifications which serve as a guide to action. Inasmuch as research should be continuous and continuously fruitful of new knowledge, standardization does not imply a static situation but regulated change. The rates, increments and times of change are themselves subject to determination by research involving primarily the balancing of the costs of change—not measured only in money—against the value of change. A close-up cross section of a scientific management situation should disclose an apparent static relationship of co-ordinated "bests in the present state of the art." But a scientific management situation in perspective over a period should disclose predetermined and regulated change in these "bests" and their relationships—a moving equilibrium of internal readjustments like that of a ship at sea.

If there were more of genuine standardization of this sort, including particularly standardization of the methods and rate of standardization, what is called technological unemployment would tend to be reduced to that caused by periodic basic and revolutionary discoveries and inventions, and thus brought to a humanly irreducible minimum. Technological unemployment appears to be caused generally by periodic sudden adaptations and utilizations, stimulated by changes in economic conditions, of well-known rather than new basic discoveries and inventions. Most enterprises follow the line of least resistance and manage to get along with equipment and methods which gradually become too obsolete to be operated in the face of the competition of new progressive plants. This situation forces periodic sudden widespread and radical technical changes. Technologically too many employes are released at one time to be reabsorbed economically. But in a plant in which research, standardization and restandardization are continuous, technological improvement can be introduced by such small increments that employes may be adjusted and reabsorbed. Under such circumstances the older workers, with their accumulated fund of skill and understanding, become an asset instead of a liability.

Control in scientific management means exactly the opposite to what it means under the ordinary form of management. In the latter instance it means arbitrary power over—"authority" and individually determined "orders." In scientific management, to accomplish a given purpose the laws of the situation specified in the standards must be commonly observed; i.e., each co-operator must perform his function in the manner, at the time, to the degree and in the relationship prescribed by the research-discovered best system of joint effort to accomplish the common purpose. "Responsibility" replaces "authority." Executives as well as workers are subject to the laws of their responsibility. Instead of one looking to another for an "order," one looks to another for performing his responsibility.

For an analogy common to the experience of all nations represented in this Congress, perhaps the management of an orchestra will best serve our purpose. The score constitutes the standards. The various choirs of the orchestra correspond to the classes of work in the shop. The conductor and the concert-master are the executives and the individual musicians are the workers. All are bound by the laws written in the score. The leader wields a baton, and each signal of the baton is an "order" in a very special sense. But it is not an order representative of an individual's guess or whim. It is a signal which is determined by a law of the score to which the leader is bound as much as each performer is bound by his particular set of notes. If the leader is incompetent or lawless, confusion results, there is no common achievement and he is separated from his responsibility. Each performer knows in advance what the order is to be. He is competent to judge whether it is properly given. He knows instantly whether an impulse of the leader has violated the written law. All are subjects of a code constructed to accomplish the common purpose smoothly and economically. And yet there is opportunity within the law for a genius like Toscanini to manifest his particular qualities of leadership, and for an individual player to manifest his skill with an instrument. Likewise in scientific management there is within the law opportunity for leadership and individual craftsmanship.

The meaning of co-operation has been indicated by what has been said about standardization and control. If control is not dependent upon authority and force it must be dependent upon co-operation. Control is established by common understanding of purpose and of individual responsibilities and their relations, and by the will to work together. Control in scientific management implies co-operation—and of the individually detonated, enthusiastic type. It is for this reason that the establishment of scientific management is a problem of education, of understanding and practice, for which time is required. It is not a complex group of mechanisms which may be bought or imitated, and installed in a short time.

Insofar as establishment and observance of a code of co-operation constitute mechanization, scientific management is mechanistic. It constitutes mechanization of the same sort as playing a game according to the rules of the game, or in any situation performing complementary functions according to the requirements of the functions. In many discussions of the subject, however, there appears to be the assumption that scientific management is mechanistic by requiring the substitution of mechanical for human energy; that scientific management is achieved to the same degree, and the same degree only, that machine energies are substituted for human energies. No assumption could be more erroneous. Scientific management in any particular situation starts with no preconceptions concerning mechanization. Its research may lead to the substitution of machine for manual labor, improvement of an existing machine, substitution of a new for an obsolete machine, or a larger for a smaller machine, or a smaller for a larger. Its research may in some instances lead to the elimination of a machine as uneconomic, and the substitution therefor of human energy. In other instances it might lead to the elimination of an operation and the purchase of the product of that operation in the open market, in which case mechanization in the industry is reduced by the avoidance of duplication of facilities among plants. Scientific management research includes within its scope, and in fact begins with, inquiry into the economics and sociology of the situation, and does not proceed to mechanical engineering until sociological and economic facts have been determined and mechanical and industrial engineering requirements derived therefrom.

In extreme cases of mechanization, e.g., mass-production plants having continuous processing on automatic and quasi-automatic single-purpose machines, scientific management of the details of processing, so essential in smaller plants utilizing multiple-purpose machines, tends to disappear because management of details itself tends to disappear. In these cases the researches of industrial as well as mechanical engineering are focused on the designing of the equipment. Co-ordination between parts of a machine and between machines is designed into the machines themselves and into the auxiliary conveying apparatus. The human contribution in processing becomes restricted chiefly to maintenance of the equipment and the manipulation of valves and levers. Speaking broadly, machines determine the actions of the men instead of men determining the actions of machines. Therefore there is little need of scientific management of variations in processing. An extreme case is a plant in Milwaukee, Wis., which produces 10,000 automobile chassis frames per day, 3,000,000 per year, with a scant 200 workers of whom only 50 touch the product. There is, however, a supplementary organization of 1,000 research engineers. Such plants as these are called into being by mass markets which make continuous processing economical on costly single-purpose machines; they are not a consequence of scientific management *per se*.

Let us leave this point with the general statement that scientific management does not presume increased mechanization; that in any particular instance it may increase it or reduce it; and that where mechanized mass-production exists, scientific management may or may not be present.

Stabilization of the Human Factor

In marked contrast to the later literature of the subject, the early literature of scientific management did not place strong emphasis on human relations as a factor in management. Yet in practice such relations received significant attention from the beginning.

This absence of emphasis in the early literature was due to the circumstances of the time, general and particular. In particular that literature did not consist of exhaustive treatises for a general public of varied interests, but was the record of occasional addresses to special audiences of engineers and executives. These