possible surplus and as to the necessity of substituting exact scientific knowledge for opinion . . ."[12]

He summarized the duties of the management in his four well-known "Principles": (1) the development of a science, (2) the scientific selection and development of the workmen, (3) the hearty cooperation with the men, and (4) the division of work and of responsibility between the management and the men.[13]

As a result of Mr. Taylor's vision expressed in these excerpts, and in the light of the best development of these principles in practice today, I believe that we can briefly summarize some of the significant viewpoints which distinguish this movement. I believe there is coming to be a better understanding that Scientific Management rests upon the viewpoints:

1. That business is organic, no part of which can function to best advantage until all parts function to good advantage;

2. That thorough standardization and scientific methods throughout the whole business are necessary for organic control, that management must be based so far as possible on facts, and that ignorance leads to more harm than does malice;

3. That the interests of the employer and employee are mutual; that, as Mr. Taylor says, the principal object of management should be to secure the maximum prosperity for employer and employee; that this viewpoint requires a change in mental attitude and a belief that employees cannot be tricked or driven into working efficiently, but that they must be carefully selected, trained in their jobs and fitted to the highest class of work of which they are capable, and that they be promoted on merit;

4. That the management must take the lead in bringing about proper conditions and mutual helpfulness;

5. That lasting development must come from within the organization; that Scientific Management cannot be "installed" from without; that outside assistance is often desirable, but that any outsider can do absolutely nothing unless the heart of the management is in the work, because the success rests absolutely on the management; that Scientific Management cannot remove the need of big men, but can make a little manager bigger and add permanence to the business.

6. That development must be democratic; that the road to opportunity must be kept open; that promotion must rest on proved ability backed by adequate records; and that sound methods will bring pressure to bear upon the management for the proper exercise of its functions;

[12] "Hearings," pages 1387-89: "Now in its essence, Scientific Management involves a complete mental revolution on the part of the workingman engaged in any particular establishment or industry . . . a complete mental revolution on the part of these men as to their duties toward their work, toward their fellow men, and toward their employers. And it involves the equally complete mental revolution on the part of those on the management's side—the foreman, the superintendent, the owner of the business, the board of directors—a complete mental revolution on their part as to their duties toward their fellow workers in the management, toward their workmen and toward all of their daily problems. And without this complete mental revolution on both sides Scientific Management does not exist. That is the essence of Scientific Management, this great mental revolution."

Continuing, he says: "The great revolution that takes place in the mental attitude of the two parties under Scientific Management is that both sides take their eyes off of the division of the surplus as the all-important matter, and together turn their attention toward increasing the size of the surplus . . . They both realize that when they substitute friendly cooperation and mutual helpfulness for antagonism and strife they are together able to make this surplus so enormously greater than it was in the past that there is ample room for a large increase in wages for the workmen and an equally great increase in wages for the manufacturer. . . . . It is along this line . . . . . , of the substitution of peace for war; the substitution of hearty brotherly cooperation for contention and strife; of both pulling hard in the same direction instead of pulling apart; of replacing suspicious watchfulness with mutual confidence; of becoming friends instead of enemies; it is along this line, I say, that Scientific Management must be developed.

"This change in the mental attitude of both sides toward the "surplus" is only a part of the great mental revolution which occurs under Scientific Management. I will later point out other elements of this mental revolution. There is, however, one more change in viewpoint which is absolutely essential to the existence of Scientific Management. Both sides must recognize as essential the substitution of exact investigation and knowledge for the old individual judgment or opinion . . . .

"These are the two absolutely essential elements of Scientific Management."

[13] "Hearings," page 1393: "These new burdens and new duties assumed by those on the management's side are so unusual and so great that they are to the men used to managing under the old school almost inconceivable. These duties and burdens voluntarily assumed under Scientific Management by those on the management's side, have been divided and classified into four different groups and these four types of new duties assumed by the management have (rightly or wrongly) been called the 'Principles of Scientific Management.' "

These principles, or duties, he states as ("Principles of Scientific Management," page 35): *"First;* They develop a science for each element of a man's work, which replaces the old rule-of-thumb method. *Second;* They scientifically select and then train, teach, and develop the workman, whereas in the past he chose his own work and trained himself as best he could. *Third;* They heartily cooperate with the men so as to insure all of the work being done in accordance with the principles of the science which has been developed. *Fourth;* There is an almost equal division of the work and the responsibility between the management and the workmen. The management take over all work for which they are better fitted than the workmen, while in the past almost all of the work and the greater part of the responsibility were thrown upon the men."

7. That development must be based on principles, consciously, continuously and consistently enforced through *sound methods.*

Scientific Management is not "simply common sense"; neither is it simply the scientific method applied to the management of industry. Both of these definitions leave out of account the "mental revolution" and the mutuality of interest so constantly stressed by the founder of the movement. I believe "Scientific Management" at its best comes pretty close to being the golden rule made operative in industry through the scientific method.

II. Positive Contributions of Scientific Management

In setting down as impartially as I can what I believe to be the principal contributions of Scientific Management at the present time, it would, of course, be folly to claim any monopoly of effort along constructive lines for the movement as a whole or for any business operating under its principles. These cases are simply illustrations of what may be accomplished along so many lines, by a policy of conscious and continuous taking thought of the numerous economic and social factors which make for permanent success, and of coordinating these elements into a rounded, balanced management.

A. Original Contributions

The outstanding accomplishments of Mr. Taylor and his associates are well known and require only a reference. His revolutionary invention of high speed steel has had a profound effect on all metal-cutting establishments; as a result of long investigation we have the standard shapes of tools which are in everyday use in all well-run shops today, the marvelous slide rules devised by Mr. Barth, and the modern automatic tool grinder. As part of his early work also came the standardization of belting care and maintenance which constitutes best practice up to the present time. The present sharp line which well-run plants draw between planning and performance is a direct outgrowth of his later work. His instructional or functional form of organization, found in such wide use today, is a direct heritage from his early insistence on making the work of the management more effective. Over thirty years ago he devised a cost system which, with slight modifications, has not suffered in comparison with the best along this line that we have at the present.

Some of the significant contributions, as outlined in a paper by the present writer in 1919,[14] will be briefly summarized, but reference must be made to that paper for a more extended discussion of each of these contributions than is possible here.

1. The Mechanical or Impersonal Aspects

a. Increased Production

By far the most striking single fact as regards the results of Scientific Management is the very considerable increase in production it has effected with the same equipment and personnel. And this result has not been always secured, as might be assumed, from plants that were near the lower level of efficiency before the development took place.[15]

Of the various means by which Scientific Management increases production and decreases cost, some—such as the selection, fitting and training of the workers, the reducing of labor turnover, absences, lates, etc., the determining and securing of a proper day's work and the paying of a correspondingly increased wage—are distinct economic gains in themselves. These will be indicated under the human factors. Others, however, only indirectly related to questions of personnel relationship, merit mention here. Among the most important of these are:

(1). The *more effective utilization of equipment,* a use greatly stimulated by Mr Gantt's admirable idleness charts showing as accurately as may be the cost of each different kind of idleness;

(2) The *more effective use of labor* through scientific man and job analysis and the devising of better methods of work;

(3) The *strict regulation of materials* through simplification and standardization, and through methods of control of material activities;

(4) More accurate *routing,* including both the physical layout and the administrative control of work in process; and finally,

(5) The *regulation of industry.* Perhaps nowhere

[14] *Quarterly Journal of Economics;* May, 1919, reprinted in *Bulletin of Taylor Society,* October, 1919, Vol. 4, No. 5.

[15] Besides the desire for increased production there has also been the determination to establish a more scientific and therefore more lasting basis for the management of industry, and to bring about better industrial relations. When speaking of increases in production, it must be remembered that a simple increase in production with accompanying decrease in a cost which was hitherto higher than it should reasonably have been, is not entirely satisfactory—it is only erasing the negative and getting back to par, as it were, but failing to add a plus. Where the increase in production and the decrease in already reasonable cost go hand in hand, however, as is characteristic of plants run under Taylor principles, the gain is direct and indisputable.