

vail in a manufacturing establishment, and the second has to do with the relations between the management and the workman, and the means of securing the cooperation of the latter in producing an increased output.

The question may naturally be asked, what is new in the first division? We have always endeavored to have order and system in a factory, and since the beginning of industry foremen and superintendents have occupied themselves with the orderly arrangement of the work in their charge; going home at night, and often lying away, thinking of the distribution of the work next day among the different workmen, and the use of the various machines with which the work had to be performed. But Mr. Taylor has shown us that the amount of thought which it is profitable to devote to this subject, and the attention and expense which will give a solid financial return, are so much greater than had been the practice before his time as to be really revolutionary.

For example: He has shown us that it is very well worth while, at the commencement of the execution of a manufacturing order, to make a complete list of all the separate component parts which it is necessary to make for the purpose of filling the order; to make out a time table of the progress of each of these parts through the shops, showing the time when each should have work commenced upon it, the machines which should be used for it, and the date at which it should be finished; so that all the parts shall pass through the shops without at any time producing congestion at any machine which might have more work than it could handle, or at any time leaving any machine without work appropriate to it. These "Route Sheets" as they are called, thus constitute a set of time tables in accordance with which the parts of the order pass through the establishment without collisions, and without lapse of occupation of machines or workmen, and each is finished at the time when it is needed; so that no part of the work is delayed because of waiting for something which should be ready to be assembled in its place, but is not on hand when wanted.

Another example is the preparation of "Progress Reports" showing continuously the state of the work, and exhibiting at once to the manager any point at which there may be failure to meet the prearranged schedule, without the necessity for a time-consuming study upon his part, which naturally he could make only at more or less infrequent intervals. Another ex-

ample is the means of keeping track of the raw materials which should be used in carrying out each order, of estimating initially the amount of each which will be needed, of seeing that it shall be on hand when it is wanted and not much before, and of insuring that when issued to the shops, it shall be used for the purpose intended, instead, as oftentimes is the case, of being picked up by a needy foreman and used for some purpose for which it was not intended and to which its cost is therefore not properly charged. Still another example is the method of accurately determining the cost of each individual order which may be executed in the establishment; an elusive subject which your experience as manufacturers has undoubtedly taught you is often treated with embarrassing inaccuracy. All of this systemization constitutes a task so important as to require a special personnel which has no other duties than to attend to it. The ordinary superintendent or foreman who has been expected to look ahead and map out the course of the work for which he is responsible, has practically always had to do this planning in addition to multitudinous other duties which have taken up substantially all of his time during working hours, so that the looking ahead has had to be done at other times. Scientific management requires that this foreman or superintendent shall have his mind free for his regular and proper duties, and that the systemization and planning shall be done by an individual who has no other task, and who generally has a set of assistants also with nothing else to do. This person should be selected from the staff of the establishment, and should be a man of position and authority, acquainted with the kind of work which is turned out, and generally conversant with all the departments of the factory. He should not take the place of the superintendent, but ought to be the superintendent's most useful assistant. His assistants should be selected from among the employees, and the practice should be avoided, as far as possible, of bringing in new individuals from the outside to perform any of the functions which the new methods prescribe.

The second division of the system relates particularly to the workmen; but it should be borne in mind that the system is not a welfare scheme for the purpose of improving the conditions of labor, but has for its first object the increase of profit by the diminution of the cost of production, and secures the cooperation of the working force in accomplishing this object by incidentally increasing the wages of labor.

It is a fact that very few workmen, even among those of long experience, know the best methods of

performing the work which they are accustomed to do. The machinist very rarely knows the capacity of his machine; that is, he does not know whether the strength of the parts of the machine, or of the belting, is such that it would be dangerous to drive the machine at a higher speed or not; and of the three important elements in the operation of the kind of a machine which I know most about, that is, a machine for metal working—namely the speed, the feed, and the depth of cut—he usually knows only roughly and very inaccurately the best combination. Some of the factors which enter into the determination of these three elements are necessarily unknown to him; he probably does not know the physical qualities of the piece of metal which he is working upon; neither does he know the composition of the cutting in which the cutting tool should be worn out, so as to require re-grinding. It is the part of scientific management to determine, accurately and scientifically, and by means of a specially skilled expert, these elements for the workman, and to give them to him for his guidance. It pays to do so.

It is also almost invariably the case that the order and sequence in which a workman habitually performs a given task are not the best. For example; in the forge shop of one of the arsenals, in the early days of the introduction of scientific management, a very simple instance was one in which the blacksmith, after forging a piece of steel, placed the next piece in his fire and then stood by, with his helper, while it was being heated to the proper temperature. Of course it did not take the specialist long to tell him that the proper way for him to do was to place the new piece of steel in the fire before he took the hot piece out, so that it might be heating up while he was forging the other, and thus diminish the idle time during which he and his helper were uselessly standing around.

In the case of each piece of work a set of instructions are written for the workman upon a card, which is given him for his guidance, and by following which a surprising amount of time can usually be saved. Of course it requires close attention on the part of the workman to observe these instructions, and calls for a greater mental effort upon his part than he is in the habit of exerting in simply carrying out the usual method which has become more or less automatic with him. It therefore follows that some inducement must be offered him to make this effort, and to understand and carry out his instructions. And right here Mr. Taylor has shown us that the ordinary wages which are regularly paid to workmen are not those

which are proper for the workmen's best efforts, but are the ones which have grown up in the neighborhood from being the best of which the workmen are easily capable. The wages therefore should be related to the output, for which purpose there are a number of methods available, the most common of which you are familiar with under the name of "piece-work." Piece-work payment has been practiced in many establishments for a great many years; but in America at least it has always been accompanied with difficulties, and the principal difficulty has been the necessity for changing the rate because of inordinate earnings when the stimulus brought out the real capacity of the workmen. It does not take many such changes to cause the workmen to lose confidence in this method of payment, and to agree among themselves to limit the amount of work which they will do, under the conviction, often only too well founded, that the more they do the more they will be expected to do, without corresponding increase of pay. It has therefore become a principle of the Taylor System that, once a tariff of rates is adopted, it shall not be changed unless the methods or circumstances of performing the work are changed. It is consequently necessary that the proper and reasonable rate shall be accurately determined in the first place, by scientific methods, which it is the business of the expert to know and to apply. With the tariff, or the premium, or the bonus, in accordance with the method of payment for output which may be followed, thus accurately determined, the best experience has shown that the average amount of earnings of a good workman, over and above the ordinary day wages of his class, should be from twenty-five to fifty per cent, and workmen who cannot earn this amount of increase, after a fair trial, are not suited to their jobs. It is found, however, that in winnowing workman out, so as to employ only those well fitted for their occupation, it is necessary to make but very few discharges. In the great majority of cases it is found that workmen are wrongly placed, and that with care other occupation can be found for them better suited to their capabilities, so that readjustment rather than discharge is the process which is indicated as the one to be followed.

Now a few words as to the experience in the arsenals of the American Ordnance Department: We occupied two years' time in the systemization of the first part of the system before doing anything affecting the stimulus or wages of the workmen, or the relations between them and the management; and I may here say that although the second part of the system is the