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WORK, WAGES, AND PROFITS

SECOND EDITION
REVISED AND ENLARGED

BY

H. L. GANTT

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INTRODUCTION TO SECOND EDITION

The first edition of Mr. Gantt's book appeared in 1910 as a volume of 194 pages, with seven charts, the graphic illustrations and most of the specific examples being drawn from results secured in the textile industries. Since that date a rapid rise has taken place in public attention to the methods used and the results secured, and in the active effort (evidenced by inquiry and undertaking) to obtain advantages corresponding to those so substantially realized in the cases cited.

This interest and inquiry have been the principal influence inspiring the enlargement of this book, not only by inclusion of additional instances, but by more detailed development of some features of the work, and the summation of the argument into a comprehensive and entire (even if broadly sketched) outline of a plan of systematic management, based on the policies and methods defined by Mr. Gantt. His experience in the field of labor management covers a quarter-century of close practical application. His special methods, which even yet are but partially and imperfectly understood by many, have been identified with his name for at least half this period. These methods are sometimes incorrectly supposed to be summed up in the bonus system of wage payment; but the inducement of increased earnings is only one factor, and almost the last factor, in the complete statement of Mr. Gantt's methods. His whole concept of scientific investigation, careful standardization, individual instruction, and interconnected reward to both instructor or supervisor and workman, must be clearly grasped before any adequate idea of task work with bonus can be obtained.

This full concept is set forth in the present volume, multiplied by ample exhibition of practical results. The added material is drawn from the mechanical industries, from machine-shop, metal-working and locomotive-building plants. The colored charts, which have been received with so much interest, are increased in number from six to twelve, the whole number of illustrations being brought up to twenty-seven, and the original nine chapters being enlarged by expansion and supplement to twelve.

The larger portion of the first edition was gathered by compilation of a series of articles published in *The Engineering Magazine* from February to June, 1910, with incorporation of three of Mr. Gantt's important earlier contributions on the same subject. To this are now added a new chapter on "The Task Idea," adapted from Mr. Gantt's paper before the Tuck School Conference; an enlargement of the discussion on "Fixing Habits of Industry," based upon results observed since the former volume was issued; a new chapter on "Results," inspired by comment and inquiry addressed to the author during the last three years; and a concluding chapter, condensed from an article on "A Practical Example of Scientific Management," published in *The Engineering Magazine* for April, 1911.

It is natural, and indeed inevitable, in the present active development of the philosophy of efficiency and the practice of scientific management, that such revisions should be made. The underlying ideas are vital; and, like all live things, they are still growing, and will continue to grow. Growth means expansion, if not change of form, and this makes final definition impossible, because definition means limitation. In the following pages, however, Mr. Gantt gives the fullest exposition ever put forth of his mature thought and work. He gives to the world here the latest word (though happily far from the last word) on his principles and practice. His grasp of fundamentals is scientific. His association of effects with their causes is philosophic. In its entirety the work offers an interpretation of industrial conditions and a promise for betterment that make it a classic—a classic of optimism—in the literature of industry.

CHARLES BUXTON GOING.

PREFACE TO SECOND EDITION

The law of development is evolution. Revolution is justified only when evolution is impossible.

If the most complete system of scientific management which has ever been devised could be installed in a manufacturing plant over night, it would probably be impossible to operate that plant at all the next day, and for weeks, perhaps months, it would be operated in such an inefficient manner as undoubtedly to cause very serious losses.

A system of management especially designed for economical production is a mechanism which is successful only when all parts work in harmony. The men who form a part of this mechanism must be trained individually and collectively.

At the battle of Santiago, individually capable men, serving good guns, under high-class officers, made an average of three per cent in their hits, at an average distance of not over two miles. These same men, under the same officers, properly trained to use the best scientific knowledge and methods of today, would easily score in hits eighty per cent of the shots at the same range, at the same time firing five times as rapidly.

To attempt to operate a new system of gun-fire control from rules and instructions, without training the men, would result in the loss of even the three per cent efficiency which existed before the introduction of the new system.

While I do not believe that, in an ordinary manufacturing establishment, a sudden change of management would be quite as disastrous as such a change would have been in the navy, yet it would unquestionably be very detrimental to the business, perhaps for a long time.

The principles of modern industrial organization, popularly known as "Scientific Management," are getting to be pretty well understood by those who have studied the subject thoroughly. Even the methods of operating the various mechanisms used for this purpose are becoming more clear to people who are in the habit of investigating new methods and ideas. These methods, however, can never be utilized properly until the rank and file have been trained to operate under them. This training necessarily takes time; but, if it is properly done, I have yet to find anybody more enthusiastic than the workmen themselves operating under it. They have the same kind of enthusiasm that the gunner in the navy has acquired since he learned that shooting is no longer guess-work.

The man who undertakes to introduce scientific management and pins his faith to rules, and the use of forms and blanks, without thoroughly comprehending the principles upon which it is based, will fail. Forms and blanks are simply the means to an end. If the end is not kept clearly in mind, the use of these forms and blanks is apt to be detrimental rather than beneficial.

This book is an effort to explain the principles of "Modern Industrial Organization," and to give some idea of how to utilize the methods of evolution in the introduction of a system of management based on these principles.

A system of management is an asset, and a good system is a valuable asset.

The cost of acquiring such an asset cannot be legitimately charged to operating expenses.

H. L. Gantt.

April, 1913.

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THE APPLICATION OF SCIENTIFIC METHODS TO THE LABOR PROBLEM

THE greatest problem before engineers and managers today is the economical utilization of labor. The limiting of output by the workman, and the limiting by the employer of the amount a workman is allowed to earn, are both factors which militate against that harmonious co-operation of employer and employee which is essential to their highest common good.

Scientific investigation is rapidly putting at our disposal vast amounts of knowledge concerning materials and forces, which it is the business of the engineer to utilize for the benefit of the community. Well-designed plants and efficient labor-saving devices, to be seen on every hand, bear testimony that he is doing at least a portion of his work well. When, however, it comes to the operation of these plants and the utilization of these labor-saving devices, the lack of co-operation between employer and employee, and the inefficient utilization of labor, very much impair their efficiency.

The increase of this efficiency is essentially the problem of the manager, and the amount to which it can be increased by proper study is, in most cases, so great as to be almost incredible.

In considering the subject of management we must recognize the fact that in this country, so long as a man conforms to the laws of the State, he has a right to govern his own conduct, and to act in such a manner as his interests seem to dictate. Granting this, it follows that any scheme of management to be permanently successful must be beneficial alike to employer and employee, and neither labor unions that regard their interests as essentially antagonistic to that of employers, nor employers' associations whose only effort is to oppose force with force, can ever effect a permanent solution of the problem of the proper relations between employers and employees.

Boards of arbitration are temporary expedients, and the results of their work are seldom better than a sort of Missouri compromise, to be fought out later; for although they be composed of men of the highest intelligence, and of the greatest integrity, the conditions under which they are organized and the means at their disposal never enable them to get more than a superficial knowledge of the subject. The information such a board gets is all in the form of testimony, which, although it may be honestly given, can never produce a complete understanding of the subject; for, as a rule, neither employer nor employee knows exactly in detail the best way of doing a piece of work, and, as far as my own experience goes, they *never know exactly how long it should take a good man fitted for the work, and provided with proper implements.* Before intelligent action can be taken in any case these facts must be known.

In order to get a general idea of the conditions that exist in the mass of our manufacturing industries it is necessary to review briefly the manner of their development.

The expert mechanic, who, with a business growing to larger proportions than he could take care of, hired a few men to help him, and directed them all by his personal example and skill, first gave place to the small factory, which he could run on the same lines.

Today, however, even the smaller factories have grown beyond the point where they can be directed or controlled by one man, and methods which were successful on the smaller scale fail now to apply on the larger. The factory is divided into departments, each directed by a foreman, who, in many cases, has had no training in management, and often has no capacity for it. He is invariably overworked if he attempts to do his duty, and the manager seldom has time to inquire into his troubles, but frequently tries to remedy matters by appointing another foreman, often making matters worse.

Again, if expenses are too great, and it seems impossible to meet competition, there is seldom any serious effort made to find out why expenses are too high, but it is assumed that the way out of the difficulty is to reduce wages. It never appears to occur to a manager that perhaps the cause of the excessive expense may not lie with the workman, but with the management. Managers rarely seem to suspect that, if the workmen were more intelligently directed, the output per man might be largely increased without a corresponding increase in expense.

Those who have given even superficial study to the subject are beginning to realize the enormous gain that can be made in the efficiency of workmen, if they are properly directed and provided with proper appliances. Few, however, have realized another fact of equal importance, namely, that to maintain *permanently* this increase of efficiency, the workman must be allowed a portion of the benefit derived from it.

To obtain this high degree of efficiency successfully, however, the same careful scientific analysis and investigation must be applied to every labor detail as the chemist or biologist applies to his work. Wherever this has been done, it has been found possible to reduce expenses, and, at the same time, to increase wages, producing a condition satisfactory to both employer and employee.

The great difficulty in instituting this method of dealing with labor questions is that usually neither employer nor employee has sufficient knowledge of the scientific method to realize either the amount of detail work necessary, or the extent of the benefits to be derived from it. In general, their inclination is to adhere to the methods with which they are familiar, and to distrust all others, even though their methods have failed to bring them appreciably nearer the solution of their problems, and the newer methods have produced results far more satisfactory than they even hoped for. A scientific investigation into the details of a condition that has grown up unassisted by science has never yet failed to show that economies and improvements are feasible that benefit both parties to an extent unsuspected by either.

The scientific laboratory for the study of materials and forces, originally considered as belonging only to educational institutions, has recently become a recognized necessity in all our large industries, and to it principally the great advance of recent years has been due. As yet, however, in but few cases has any definite attempt been made to study in a scientific manner the most efficient way of utilizing the human labor. Of how much work of various kinds the ordinary man has done, we have many records; but of how much a man specially suited to any class of work can do, we have almost no knowledge.

Enough study has been spent on the subject, however, to determine that men specially suited to any particular kind of labor, if supplied with proper implements and intelligently directed, can do on the average at least three times as much as the average workman does, if the limiting factor is physical exertion; and, if assured sufficient compensation, the average workman will do this increased task, day after day.

The ratio of what can be done to what is done is even greater than three to one in work requiring skill and planning. Well thought out plans alone, if accompanied by complete instructions for doing work, often produce an increase of more than 100 per cent. over what is usually done. This is particularly true in complicated work, which should be planned most carefully, but which is often not planned at all. It is usually left to the judgment of a busy foreman, whose first knowledge of what is to be done reaches him with the order to do it. In such a case, it is the exception when the work does not cost in wages several times what it should, and this with no fault of the foreman or workman.

These facts have been established in numerous cases of ordinary labor, in doing machine-shop work, in building engines, and in the erection of structures of various kinds. Similar possibilities have been indicated wherever the slightest effort has been made to study or to plan, showing that in many instances a condition of affairs exists which is not only wasteful to the owners, but discouraging and unjust to the workmen, most of whom would be willing to do more work to earn increased pay if only the opportunity to do so were offered, and they were guaranteed that they would not ultimately lose by doing so.

Mr. E. F. Du Brul, formerly the Commissioner of the National Metal Trades Association, an organization of employers formed to protect themselves from the unjust demands of the labor unions, stated some time ago that a large majority of strikes were produced by mismanagement. Mr. Du Brul has perhaps had more general experience with striking employees than any other man in this country, and his conclusion is that the best insurance against strikes is good management. He, therefore, strongly advises managers to study the subject. The necessity for this advice will become evident when we realize that hardly any two managers, unless they have been trained under the same influence, agree as to the proper way of dealing with any of the intricate questions that are constantly arising between employer and employee; much less will they agree on any general principles of management.

There have been in the past and are today great managers. Are there not some general principles by which they either consciously or unconsciously are governed? In other words, are there not some general principles, applicable, at least to a large number of cases, according to which substantial equity can be insured between employer and employee, and a higher degree of efficiency realized from their harmonious co-operation?

The only successful method of determining general laws has been that of *scientific investigation,* and, in the study of questions involving human labor, enough has been done to show that the same method is applicable to at least a large number of individual cases, and there is good reason to believe that it is universally applicable.

Labor unions demanding all they can get, and employers' associations organized simply to oppose the demands of the unions, can never evolve a satisfactory system of management; for, although each, in its way, may be (and undoubtedly is) often beneficial to its members, both are formed with the idea of using force only, which can never be a substitute for knowledge.

Although a board of arbitration may be useful in averting a crisis, the decision of such a board founded on such facts as are available should be professedly only temporary in character, to be revised later according to the results of a scientific investigation of the matter in dispute, to be undertaken at the earliest possible date.

This problem consists of three parts:

First.—To find out the proper day's task for a man suited to the work.

Second.—To find out the compensation needed to induce such men to do a full day's work.

Third.—To plan so that the workman may work continuously and efficiently.

The problem is difficult, for a man suited to the work must be found and induced to work at his full capacity. The details of the work must be arranged so that he can work most efficiently, and the time to do each detail must be carefully studied with a stop watch. From such detail observations it is possible to determine what a good man can do, day after day, and there is but little difficulty in finding out what men have to be paid to make them do all they can; for, although men prefer, as a rule, to sell their time, and themselves determine the amount of work they will do in that time, a large proportion of them are willing to do any reasonable amount of work the employer may specify in that time, provided only they are shown how it can be done, trained to do it, and guaranteed substantial additional amounts of money for doing it. The additional amount needed to make men do as much as they can depends upon how hard or disagreeable the work is, and varies from 20 to 100 per cent. of what they can earn when working by the day, according to their own methods and at their preferred speed.

The cost of these initial investigations is necessarily large, for they can be made only by capable men who have had the special training necessary, and hence the expense must be borne by the employer; but the returns, when the results of these investigations begin to be applied, are so great as to pay in a short time for the investigations, to allow a substantial increase of wages to the employee, and to leave a good margin of profit to the employer.

The benefits which have been derived from such investigations are:

An increase of output.

A decrease in cost of product.

Better workmen attracted by higher wages.

Improvement of quality of product due to better workmen and more careful supervision.

These results are well worth striving for, and the fact that they have been obtained by the application of the scientific method to the ordinary problems indicates strongly that progress is to be made in such matters by the scientific method, which has been responsible for other kinds of progress in the past.

EFFICIENT UTILIZATION OF LABOR

CHAPTER II

EFFICIENT UTILIZATION OF LABOR

IT has become an axiom in the commercial world that in the long run those transactions most promote prosperity which are advantageous alike to buyer and seller. It is coming to be realized in the industrial world that the same thing is true regarding the arrangements between employers and employees, and that no arrangement is permanent that is not regarded by both as being beneficial. In other words, the only healthy industrial condition is that in which the employer has the best men obtainable for his work, and the workman feels that his labor is being sold at the highest market price.

The employer who insists on more service than he pays for, and the employee who demands excessive wages for his work, both lose in the long run. The former worries continually about how to manage dissatisfied workmen, who are continually on the verge of a strike, and in dull times the latter lives in constant dread that his employer may no longer be able to continue business, and he may be out of work. In other words, unless efficient work goes with high wages, the result is apt to be disastrous to both employer and employee, and if we would have satisfactory workmen we must learn how to make their labor efficient, for it is to efficient labor only that high wages can be uniformly paid.

Again, if a plant is badly laid out, if it contains inferior or antiquated machinery, or if the management is inefficient, it may be impossible for the best workman to do an amount of work really entitling him to good wages. Any one of these causes and others may explain why a plant, whose name for years has been a synonym for prosperity, has gradually become less prosperous, until finally it scarcely holds its own by decreasing the wages of its employees. The final stage of such a plant is to close down indefinitely, and to remain for years a monument to the short-sighted policy of its owners and the misfortune of its employees.

The time to make provision against such a fate is not when sharp competition begins to show the need of it, but when prosperous times produce a large surplus of earnings.

Out of such earnings ample provision should be made to take full advantage of all improvements in apparatus or management that are available.

Improving a plant does not necessarily mean enlarging it, but equipping it with the best and most efficient apparatus scientific investigation can suggest and ingenuity can devise.

Improving the system of management means the elimination of elements of chance or accident, and the accomplishment of all the ends desired in accordance with knowledge derived from a scientific investigation of everything down to the smallest detail of labor, for *all misdirected effort is simply loss, and must be borne either by the employer or employee.*

In a proper system of management practically all loss of this character is eliminated, and the saving effected by this alone will usually pay all the expenses of the system and leave a handsome profit.

Wherever any attempt is made to do work economically the compensation of the workman is based more or less accurately on the efficiency of his labor. Very fair success in doing this has been accomplished in day work by keeping an exact record of the work done each day by every man, and by fixing his compensation accordingly. This method, however, falls very far short of securing the highest efficiency, for very few workmen know the best way of doing a piece of work, and almost none have the time or ability to investigate different methods and select the best. It often happens then that a man working as hard as he can falls far short of what can be done on account of employing inferior methods, inferior tools, or both.

We can never be certain that we have devised the best and most efficient method of doing any piece of work until we have subjected our methods to the criticism of a complete scientific investigation. Many people who have been accustomed to seeing an operation performed in a certain way, or to performing it in that way for a number of years, imagine they know all about it, and resent the intimation that there may be some better way of doing it. Anybody, however, who carefully analyzes the sources of his methods will find that the mass of them are either inherited, so to speak, from his predecessor, or copied from his contemporaries. He will find that he knows but little of their real origin, and consequently has no ground on which to base an opinion of their efficiency.

Even such a simple operation as shoveling is done very uneconomically in many places. I have seen the same shovel used for coal, ashes, and shavings, and this when coke forks were available for the shavings. The foreman had apparently given the subject no study, and was content if the men were at work. The idea of working efficiently had never occurred to him. This is, of course, an extreme case, but it is a real one, and all degrees of efficiency exist between this and the case where each workman is provided with the proper implement and given a specific task, for the accomplishment of which he is awarded extra compensation.

The knowledge needed to set a task, even in such a simple case as shoveling, is much greater than is at first realized, for hardly any two substances can be treated exactly alike, and the same substance is often much harder to shovel from the top of a pile than from the bottom, which rests on a smooth, hard surface. In studying shoveling the first thing to be determined is the size of shovel, which must be gauged to hold the weight which it is most economical to handle. The second step is to find how long it takes to fill the shovel. For sand, fine coal, ashes, etc., it makes no difference in loading the shovel whether the material is taken from the top or the bottom of the pile; but in egg coal, broken stone, or lump ore, the difference is very great; for, while it is quite easy to get a full shovel from the bottom of the pile which rests on a smooth, hard surface, it is, in some such cases, practically impossible to fill a shovel from the top of the pile without actually raking the material onto the shovel. Again, the distance or height to which the material is thrown is a factor in all cases, not only because the higher or longer throw takes slightly more time, but because it takes more energy.

This analysis shows that each such operation is composed of a number of elements, which may be studied separately. Having determined each element, they may be combined in a number of ways to show the time needed to fill and empty a shovel, with any material, under a variety of conditions. Knowing the time needed for an operation, we can add to it the percentage of time needed for rest, etc., which has been determined by a long series of tests, and calculate just how many shovelfulls a good man can average per minute without over-exerting himself. Having determined thus the amount of work that a man can do, we can usually get it done if we offer the proper wages for doing it, and furnish an instructor who will teach the workman how to do it.

Having determined the best method and taught it to a capable workman, to whom good wages are paid for its successful operation, would seem to be enough to assure that the work should be done that way permanently. Such, however, is not the fact, for while these conditions will usually produce the desired result, they will not always maintain it, but must be supplemented by another condition, namely, *no increase in wages over day rate on the part of the workman unless a certain degree of efficiency is maintained.*

The importance of maintaining a definite degree of efficiency is readily understood when we consider that a properly equipped plant has only its proper complement of each kind of machine, and if the output of any one falls below a certain amount the output of the whole plant is diminished in proportion and the profits fall off in a much greater ratio. This fact does not appeal to the workman who has made good wages for several days and concludes to *take it easy* for a while, unless he also feels the loss his *easy going* causes his employer.

In order to get the best results these four conditions are necessary:

First—Complete and exact knowledge of the best way of doing the work, proper appliances and materials. This is obtainable only as the result of a complete scientific investigation of the problem.

Second—An instructor competent and willing to teach the workman how to make use of this information.

Third—Wages for efficient work high enough to make a competent man feel that they are worth striving for.

Fourth—No increase of wages over day rate unless a certain degree of efficiency is maintained.

When these four conditions for efficient work are appreciated their truth seems almost axiomatic. They are worthy of a very careful consideration.

SCIENTIFIC INVESTIGATION.

The first condition is an investigation of how to do the work and how long it should take. The fact that any operation, no matter how complicated, can be resolved into a series of simple operations, is the key to the solution of many problems. Study leads us to the conclusion that complicated operations are always composed of a number of simple operations, and that the number of elementary operations is often smaller than the number of complicated operations of which they form the parts. The natural method, then, of studying a complex operation is to study its component elementary operations. Such an investigation divides itself into three parts, as follows: An analysis of the operation into its elements; a study of these elements separately; a synthesis, or putting together the results of our study.

This is recognized at once as simply the ordinary scientific method of procedure when it is desired to make any kind of an investigation, and it is well known that until this method was adopted science made practically no progress. The ordinary man, whether mechanic or laborer, if left to himself seldom performs any operation in the manner most economical either of time or labor, and it has been conclusively proven that even on ordinary day work a decided advantage can be gained by giving men instructions as to how to perform the work they are set to do. It is perfectly well known that nearly every operation can be, and in actual work is, performed in a number of different ways, and it is self-evident that all of these ways are not equally efficient. As a rule, some of the methods employed are so obviously inefficient that they may be discarded at once, but it is often a problem of considerable difficulty to find out the very best method.

To analyze every job and make out instructions as to how to perform each of the elementary operations requires a great deal of knowledge, much of which is very difficult to acquire, but the results obtained by this method are so great that the expenditure to acquire the knowledge is comparatively insignificant.

INSTRUCTIONS.

As a result of our scientific investigation, we find in general that it is possible to do about three times as much as is being done; the next problem is how to get it done. No matter how thoroughly convinced we may be of the proper method of doing a piece of work and of the time it should take, we cannot make a man do it unless he is convinced that in the long run it will be to his advantage. In other words, we must go about the work in such a manner that the workman will feel that the compensation offered will be permanent.

When we have established this condition of affairs, we are ready to start a workman on the task, which, when properly set according to our investigation, can be done only by a skilled workman working at his best normal speed. The average workman will seldom be able, at first, to do more than two-thirds of the task, and, as a rule, not more than one out of five will be able to perform the task at first. By constant effort, however, the best workmen soon become efficient, and even the slower ones often learn to perform tasks which for months seemed entirely beyond them. If our people have confidence in us and are willing to do as we ask, the problem of getting our task work started is easy. This, however, is frequently not the case, and a long course of training is necessary before we can teach even one workman to perform his task regularly, for workmen are very reluctant to go through a course of training to get a reward, especially when they fear that the high price will be cut when they can earn it easily.

BUYING LABOR.

Buying labor is one of the most important operations in modern manufacturing, yet it is one that is given the least amount of study. Most shops have expert financiers, expert designers, expert salesmen, and expert purchasing agents for everything except labor. The buying of labor is usually left to people whose special work is something else, with the result that it is usually done in a manner that is very unsatisfactory to buyer and seller. It is admitted to be the hardest problem we have to face in manufacturing to-day, and yet it is only considered when the manager "has time," or has "to take time," on account of "labor trouble." The time to study this subject is not when labor trouble is brewing, but when employer and employee have confidence in each other.

Men, as a whole (not mechanics only), prefer to sell their time rather than their labor, and to perform in that time the amount of labor they consider proper for the pay received. In other words, they prefer to work by the day and be themselves the judges of the amount of work they shall do in that day, thus fixing absolutely the price of labor without regard to the wishes of the employer who pays the bill. While men prefer as a rule to sell their time, and themselves determine the amount of work they will do in that time, a very large number of them are willing to do any reasonable amount of work the employer may specify in that time, provided only they are shown how it can be done, and paid substantial additional amounts of money for doing it. The additional amount needed to make men do as much work as they can depends upon how hard or disagreeable the work is and varies (as previously stated) from 20 to 100 per cent. of their day rate.

If the work is light and the workman is not physically tired at the end of the day he will follow instructions and do all the work called for if he can earn from 20 to 30 per cent. in addition to his usual day's wages. If the work is severe and he is physically tired at the end of the day he requires from 40 to 60 per cent. additional to make him do his work. If in addition to being physically tired he has been obliged to work under disagreeable conditions or in intense heat, he may require 70 per cent. or even 100 per cent. additional. These facts are derived from experience and give us a key to the intelligent purchase of labor. If we wish to buy the amount of labor needed to accomplish a certain task, we must find out exactly, and in detail, the best method of doing the work, and then how many hours' labor will be needed by a man suited to the task working at his best normal rate. This is simply getting up a set of specifications for the labor we wish to buy, and is directly comparable to a set of specifications for a machine or a machine tool. The man who buys the latter without specifications is often disappointed even though the manufacturer may have tried earnestly to anticipate his wishes; and the man who buys the former under the same conditions has in the past almost universally found that a revision of his contract price was necessary in a short time. The relative importance of buying labor and machinery according to the best knowledge we can get, and the best specifications we can devise, is best illustrated by the fact that while the purchase price of a machine may be changed whenever a new one is bought, that of the labor needed to do a piece of work should be permanent when it is once fixed.

As was said before, few men can work up to these specifications at first, if they are properly drawn, but many men will try if they are properly instructed and assured of the ultimate permanent reward. Most men will not sacrifice their present wages to earn a higher reward in the future, and even if they were willing few men could afford to. Therefore, while they are learning to perform the task, they must be able to earn their usual daily wages, and the reward for the accomplishment of the task must come in the form of a bonus above their daily wage.

Increase in efficiency makes the payment of high wages possible, and it may be added that without efficient labor, high wages cannot be paid indefinitely, *for every wasteful operation, every mistake, every useless move has to be paid for by somebody, and in the long run the workman has to bear his share.* Good management, in which the number of mistakes is reduced to a minimum, and useless, or wasteful operations are eliminated, is so different from poor management, in which no systematic attempt is made to do away with these troubles, that a man who has always worked under the latter finds it extremely difficult to form a conception of the former. The best type of management is that in which all the available knowledge is utilized to plan all work, and when the work is done strictly in accordance with the plans made. The best mechanical equipment of a plant that money can buy avails but little if labor is not properly utilized. On the other hand, the efficient utilization of labor will often overcome the handicap of a very poor equipment, and an engineer can have no greater asset than the ability to handle labor efficiently.

The subject of wages is then inextricably bound up with that of management. Poor management usually means poor wages. Good management means good wages, for the high efficiency demanded by good management can only be maintained by such wages as will attract good men and induce them to work at their highest efficiency.

The manager who boasts of the low wages he is paying for his work would generally find, if he had a reliable cost system, that his costs were greater than those of his competitor who paid better wages.

THE COMPENSATION OF WORKMEN

Chapter III

THE COMPENSATION OF WORKMEN

WE all like to feel that we are passing away from the age of violence, and approaching an age when justice and equity will have more influence in the world than brute force. If we rely too much upon the progress already made, however, we are bound to get into trouble. Kipling sounded a world note in his lines:

> "An' what 'e thought 'e might require,
> 'E went and took, the same as me."

As far then, as acquiring property was concerned, he put the ancient Greek and the modern Briton in the same class. The Japanese-Russian war was caused by the fact that each of two powerful nations wanted the property of a third weak one. Neither had any right to it, but the fact that each wanted it was enough to set aside all questions of right. Recently the seizure of the provinces of Bosnia and Herzegovina by Austria was another example of an act done because the aggressor had the power to do it. The present alarm in Great Britain over Germany's armaments is not due to the fact that England thinks there is any real cause for a war, but the fear that if Germany has the power it will be used to the detriment of Britain. In other words, it is still accepted as common practice that "they should take who have the power and they should keep who can."

To come a little nearer home, we find that large corporations are not very much more squeamish, or particular, than large nations. The Standard Oil Company, the Beef Trust, the Sugar Trust, and any number of others, have absolutely no regard, apparently, for right or wrong. They get what they can by any means available. The difference between the savage and civilized communities is largely that the civilized communities have enacted laws which tend to restrain individual greed. Inasmuch, however, as it is impossible to foretell all the forms individual greed may take, it is impossible to enact in advance laws to cover all possible cases, and the best that can often be done is to make new laws to restrain new forms of greed as fast as they develop. Laws were made long ago that restrained robbers, sneak thieves, and even the "robber barons," but none have so far been framed that restrain the "high financier," who, without giving anything in return, taxes the community for his own benefit to an extent that makes all other forms of acquiring without giving an equitable return seem utterly insignificant. One of the foremost American patent lawyers not long ago stated that the tremendous industrial success of the United States had been largely brought about by its beneficent patent laws, and yet the greatest part of the legal talent among the patent lawyers is engaged in evading those very patent laws, which are so beneficent to the community. These statements only go to show that in general it is only in so far as the laws restrain, that men fail to take advantage of each other. Certainly there are many honorable exceptions. There are many people who are actuated by higher motives, and who are doing a great deal to advance the cause of equity and justice, and to establish proper relations between human beings, and we give them all credit. But if we consider their methods the rule, and base our plans on them, we shall find that others, not quite so scrupulous as we are, will get the better of us. Therefore in discussing the relations between employer and employed, we must recognize the fact that in the majority of cases, men still act on the principle that "they should take who have the power and they should keep who can."

This is true whether you are speaking of employer, or employed. Labor unions are just as insistent in their demands for things that do not belong to them, as the Sugar Trust is in its efforts to evade duties that it ought to pay. One of the best illustrations of this spirit of which I ever heard, was incident to the ending of a strike in a Western State, where the labor union had won. Soon after the men had gone back to work, one of the employers said to a workman, "I hope you are satisfied now." "No!" said he, "we are not satisfied, and we never shall be, until we come to the works in our carriages, and you walk!"

As long as the interests of the employer and employee seem antagonistic there will be conflict, and in any discussion of the subject, we must recognize that antagonism means conflict. Until we can find some means of doing away with the antagonism, the conflict will continue. Our search, then, must be for such means.

If the amount of wealth in the world were fixed, the struggle for the possession of that wealth would necessarily cause antagonism; but, inasmuch as the amount of wealth is not fixed, but constantly increasing, the fact that one man has become wealthy does not necessarily mean that someone else has become poorer, but may mean quite the reverse, especially if the first is a producer of wealth. The production of wealth can be so greatly facilitated by the co-operation of employer and employed that it would seem that if the new wealth were distributed in a manner that had in it even the elements of equity, neither party could afford to have the working arrangement disturbed.

As long, however, as one party—no matter which—tries to get all it can of the new wealth, regardless of the rights of the other, conflicts will continue.

On account of the disregard of law and order that unions so frequently show in their strikes, it is the fashion in many places to condemn them as utterly bad, when they are only human. As a matter of fact, they are not all bad by any means. They have done a great deal for the cause of workmen. If it had not been for them, the working people of today would probably be in the same condition as were those of England sixty or a hundred years ago. The average workman is a good citizen, just as loyal to his country as the capitalist, and just as proud of its position in the world. He is even more interested in its prosperity, for in times of depression, when the capitalist loses his surplus, the workman loses his means of living. It is a realization, perhaps, of the small margin that they have above their absolute needs, that makes workmen so liberal to each other, for it is a well-known fact that the wage earner is far more liberal than the capitalist. He will go much further out of his way to help a friend than the rich man will, although it is much harder for him to do so.

Our method of studying labor problems in detail, and studying the individual workmen, has taught us much about them and given us a high opinion of them as men. The proportion of high-minded and honest men is just as great among them as among any other class, and far greater than among those people we continually hear complaining of them. Of course there are worthless and dishonest men among them, but the proportion is no greater than among those who have better opportunities. There are many individuals who do what they can to help their less fortunate friends, and there may be unions formed to help the poor workman; but as a business proposition, such a union cannot long be successful. Unions are formed, as a rule, by men of energy to help each other, and the poor workman is taken in, not for the good he does in the union, but the harm he does if not in. The poor workman is thus advanced with the good, and the employer pays the bill.

It is undeniable that unions have advanced the cause of workmen in general, and we must not blame them for using force to accomplish their ends. It was the only means they had. If we wish them to use any other means we must provide them with a means that they will consider more desirable, and that will give better results, for in this country, so long as a man conforms to the laws of the State, he has a right to govern his actions in such a manner as his interests seem to dictate. Men join the union because they think they will be better off in the long run for being in the union. The idea of the union is to get a higher rate of wages for the whole class, because in general nobody in that class can get a substantially higher rate unless the whole class gets a higher rate.

The employer usually pays but one rate of wages to one class of workmen, because, as a rule, he has no means of gauging the amount of work each man does. It is exceedingly difficult to keep an exact record of what each of a number of men does each day; and even if he had such records, the difficulty of comparing them would be very great, unless the work done by each man was of the same nature, and done under the same conditions. The result is that he keeps no individual records, but usually treats all workmen of a class as equals, and pays them the same wage. There may be 20 per cent. who are very much more efficient than the rest, but he has no way of distinguishing them from the others with any degree of certainty; hence he declines to increase any wages, or makes the difference in wages insignificant as compared to the difference in efficiency.

In hiring men he offers the wages he can get the cheapest man for, and if the good man stood out for higher wages, he would not get any wages at all. Hence if the good man is to get high wages, the whole of his class must get high wages. This is the strongest argument for the formation of labor unions, and when they are successful in raising the class wage, as they have repeatedly been, the employer is forced to pay the poor man more than he is worth.

The desire of the union to take in all the members of its class is not philanthropic. Self-preservation is the first law of nature. Under ordinary conditions a man will advance himself first, and his neighbor next. He will join the union to advance his own interests, and it is only right and natural that he should advance his own interests. Any community made up of people who did not advance their own interests would very soon go to pieces. If a workman thinks it is to his interest to join a union, he has a legal right to do so. If we wish to prevent him, we must make it to his interest not to do so. In other words, we must provide him with means of advancing his interest that is superior to what the union offers. If any such scheme is to be permanently successful, it must be beneficial to the employer also.

Under ordinary conditions where there is no union, the class wage is practically gauged by the wages the poor workman will accept, and the good workman soon becomes discouraged and sets his pace by that of his less efficient neighbor, with the result that the general tone of the shop is lowered.

On the other hand, when the union has had the class wage raised, the inefficient workman is demoralized by getting more than he is worth, while the efficient man still does less than he could, for it is not absolute wages that stimulate exertion, but difference in wages.

Thus under both non-union and union conditions, where no individual records are kept, the employer fails to get the efficiency he should, and the general tone of the shop runs down. This is very marked in many old shops which have been successful in the past.

If shops are to be continually successful the efficiency of the workmen must not only not be allowed to decrease, but must be systematically increased. Increase of efficiency is essentially a problem of the manager, and the amount to which efficiency can be increased by proper management is in most cases so great as to be almost incredible. Decrease in efficiency is not, as a rule, the fault of the workmen, but of the management, and the manager who continually complains of the decreasing efficiency of labor is simply advertising his own incompetence.

There are only two methods of paying for work; one is for the time the man spends on the work, and the other is for the amount of work he does. The first is day work. The second is piece work. All other systems, whatever may be their name, are combinations of these two elementary methods in different proportions. It is natural that the employer should wish to get all the work he can for the money he spends. It is also natural that the workman should wish to get all the money he can for the time he spends. Any other condition would be wrong, would be almost suicidal. These two conditions seem to be so antagonistic that most people give up any attempt to harmonize them, and adopt a scheme of bargaining. Bargains, as a rule, are made for a definite length of time, at the end of which they are revised. Under such a system the most aggressive group, or the one that has the most favorable conditions, wins in the long run.

DAY WORK

Chapter IV

DAY WORK

DAY WORK, or that in which men are paid for the time they spend, may be divided into two classes; first, ordinary day work in which there is no attempt made to keep individual records, and every man of a class receives the same wages regardless of the amount of work he does; second, that in which the work is carefully planned beforhand so that each man can have continuous work, and so that an exact record can be kept of what he does, and his rate of pay adjusted accordingly.

The day rate of any class of men, such as laborers, weavers, machinists, moulders, etc., is regulated by supply and demand, except where it is regulated by the union; and in times of extreme depression even the unions are unable to keep up the rate. The rate may be, and usually is, different in different localities. Under the condition where no individual records are kept, it does not make much difference whether one man is more efficient than another or not; it is almost impossible for him to get a higher rate of wages than the rest of them. If the pay of one is raised, others are apt to claim that they also are entitled to an increase, and in the absence of records it is impossible often to disprove their claim. To save discussion, then, and possible trouble, the employer declines to sanction any increase of pay. The industrious and efficient man naturally becomes dissatisfied and gradually slackens his pace to that of the poorer workman. Thus the employer, who pays only the rate the poorer man can earn, gets only the efficiency he pays for, even from his capable man, who thus works far below his capacity.

This method of buying labor is similar to buying all materials sold under the same name at the same price, without regard to quality; but it is much more wasteful, as the difference in the quality of materials is seldom as great as the range of efficiency in workmen.

The result of this policy—and it is the logical result—is that the efficient man, the man with boundless energy to spare, says: "I can't get any more money by doing more work. I am going to see if I can get it some other way.'' Then he organizes all his fellows into a union, and they all say, ''We want more money!'' and they get it, and no man cares whether he does more work or not. The moral tone of the shop and the community is lowered, as is always the case when there is a resort to force.

In the second class of day work some intelligent man studies the work to be done, lays it out carefully, perhaps several days ahead, provides the proper appliances, divides it up in such a manner that it can be done by individuals or by men in small gangs, so an exact record can be kept of what each individual or gang does, and compensation be made accordingly. Such a method of handling workmen has exactly the reverse effect, and their efficiency begins to increase at once. When we increase one man's wages because his record shows he deserves it, it not only does not cause trouble with the other workmen, but it acts as a stimulus to them, and we are glad to have each workman know what the others are making.

It is difficult and often impossible, especially at first, to plan all the work of a plant and to keep a record of each workman, but some planning can be done, and some rec-

MACHINE RECORD

Month of ____________ 190 Machine No.____________ Man's Name____________

	Day	Order No	Description of Work	Card Drawing No.	Inst. Card No.	Time Allowed	Time Taken	No. Pieces Finish'd				Remarks

The Engineering Magazine

FIG. 1. MAN-RECORD SHEET AS INTRODUCED AT THE AMERICAN LOCOMOTIVE WORKS IN 1902. These cards must be modified to suit conditions, but this form carries practically all that is ever needed on a time card. Much less will sometimes suffice.

ords kept in almost every case; and if a few steps in this direction are taken, the advantage of taking more will soon become evident.

Some years ago it became necessary to lay off about ten moulders in a foundry working on day work with the record system. The superintendent sent for the records, and having inspected them, he sent the foreman a list of the men to be laid off. There was a great complaint, in which the foreman joined, that the wrong men had been selected, and that some of these men were the best in the shop. The superintendent invited an inspection of the records, which the foreman had never been willing to pay any attention to before, with the result that everybody was satisfied, and the efficiency of those remaining soon showed a very marked improvement.

If the conditions are such that we can plan out the work ahead of time, we will get a fair degree of efficiency by keeping individual records of the workmen, and raising their day rate accordingly. As a matter of fact, a better efficiency can be obtained by this method than by the ordinary system of piece work, where the rates are set by past records or the estimates of the foreman; and the tone of the shop is far better.

We began the use of individual records in a steel foundry in 1888, and have since always tried to plan our work so that records could be kept. With the introduction of our task and bonus system in the Bethlehem Steel Works, in 1901, the method of keeping these records became standardized. Page 68 shows a sample of the man-record sheet introduced in the works of the American Locomotive Co. in 1902.

Not long ago a large contractor in New York, who had been studying methods of handling his workmen efficiently, spent some time on one of his large excavating jobs. He provided a sufficient number of buckets, so that each man was always shoveling into a bucket by himself, and kept track of the buckets filled by each man. At once the number of buckets that came out of the hole was doubled.

No record can, as a rule, be kept of men doing miscellaneous work unless it is properly planned ahead of time with that object in view. If it is intelligently planned and an increased compensation given for increased efficiency, an improvement will result which will far more than pay for the expense of planning and record-keeping.

If, then, you train a man to be efficient and adopt a system of management which enables him to utilize all of his energies in productive work, you can afford to pay him far higher wages than he can get where the workmen are not trained and where the system of management is not such as will enable him to work continuously and efficiently.

A weaver in a cotton mill accustomed to having his warp ready and filling properly supplied, complains very bitterly if anything goes wrong. A man accustomed to having materials and appliances provided, objects strongly to being obliged to hunt up his own materials or appliances, even if he is required to get a correspondingly smaller amount of output. We have had many examples of workmen trained to work under an efficient system of management, who objected to working under an inefficient system.

One of the best examples of this occurred at the Bethlehem Steel Works, where men were unloading coal from cars at a rate of four cents per ton. They heard that men were getting six cents a ton in Pittsburgh for this work, and six of them left and went to

Pittsburgh. At Bethlehem they were working two men on a car. At Pittsburgh six or seven men were put on a car, and these Bethlehem men were spread around, so that there were always strangers on the car with them. They started to work just as hard as at Bethlehem, but the other fellows didn't. The harder these trained men worked, the less the others did. The faster workers very soon slowed up, and in about two months the whole gang came back, and said they could not make as much money at Pittsburgh in the large gangs at higher wages as they did at Bethlehem at lower wages. It is a well-known fact that men in large gangs do not work as efficiently as men do individually, or in small gangs, but the man in charge of the work in Pittsburgh apparently did not know it.

To summarize: If you keep an exact record of what each worker does, surround the men with conditions under which they can work at high efficiency, and compensate the efficient ones liberally, no man will spend his spare time trying to find out how to raise the wages of the other fellow. Workmen, as a rule, will do more work if their earnings are increased by so doing, and you will find great difficulty in getting the efficient ones into labor unions if they are not benefited by joining.

The point that seems very clear is that the employer is quite as much responsible for the labor unions as the men are themselves, and that he can never expect to adjust his difficulties with the employees until he furnishes them with a means of accomplishing their ends (namely, bettering their condition and getting more money) which will appeal to them as being better than the means that they are now using; for as was said before, so long as he conforms to the laws of the State the workman has a right to govern his actions in the manner that will best subserve his own interests. As we cannot make him do anything, we must accomplish our object by convincing him that what we offer is better than what he already has. When he is convinced, the problem is solved.

PIECE WORK

CHAPTER V

PIECE WORK

THE one fact underlying the philosophy of labor management developed in the preceding chapters, is that it is not the workmen who are chiefly at fault for the inconsistency and inefficiency of most payroll disbursements, but the system generally used in handling the workmen. Under the system that oftenest exists we cannot expect the workman to be much different from what he is. If we were in his place, we should probably do as he does. We should want to make the best living we could for our families, and if by working honestly and conscientiously we could not make any more money, and if we had tried it over and over again, and still could not get any more, even though we did twice or three times as much as the poorer worker beside us, we should do the same thing the average worker now does; namely, come to the conclusion that the system under which we were working had no provision for compensating the individual according to his deserts, and that the only way we could get more money for our services was to get the wage rate of our class raised, and take steps to this end.

This is exactly what the men do. The employer has forced them into a class by keeping their wages uniform, and it is but a short step from such a class to a union. With the union comes first collective bargaining, then demands, then strikes. This is a logical series, for a successful bargainer always wants a better bargain next time, and the demand that is successful is very apt to be followed later by one that will yield more still, even if it takes force to sustain it.

As was said in a previous chapter, most workmen are good citizens, and if we can show them peaceful means by which they can get equitable compensation, they will have but little desire to resort to force. As has been said before, we recognize that our method of keeping individual records and compensating the individual accordingly is not easy, and in many cases may be impossible, but we have found that an honest effort to do it has always produced a feeling of confidence and loyalty among the workmen, which added much to their efficiency.

So far our discussion of the subject has related only to day work. An investigation of the subject of piece work also reveals inconsistencies similar to those already considered. In the term piece work we include all the various schemes for compensating men for *what they do,* instead of for *the amount of time they work.* It may be divided into two general classes.

The first is that in which a price for a job is set from previous records or from the estimate of a foreman, who generally considers his duty done when he has set the price.

This method is the one in general use and until recently it has been almost exclusively employed. In recent years, however, it has been very generally modified in order to avoid the troubles that have so frequently followed such piece work in the past. The following reasons seem to be amply sufficient to account for the labor troubles that have been caused by this kind of piece work.

Records of what has been done are only a very poor indication of what can be done by a capable and industrious workman, and still may be far beyond the possibilities of an ordinary workman who has not had special training in the work.

Estimates of a busy foreman as to how long it should take to do a new job must necessarily be inaccurate, and rates set by his estimates are practically guesses. After the workmen have become skilled, their earnings will increase greatly and will often be out of all proportion to the exertion put forth.

Under these conditions an adjustment of the prices based on the new records is made; and, as the workmen become more skillful, it is done again. Thus the more skilled the workman becomes, and the more progress he makes, the greater the penalty he has to suffer, for his prices are being continually reduced so that he earns but little more than the incompetent man, who has never been able to do his work in such a manner as to exceed greatly the old records.

The effect of this method of *penalizing the good workman* in proportion to his increased effort is to discourage him so that he learns ultimately to limit his output by that of the poor workman. This result is so natural that we should not be surprised at it, nor should we condemn it, unless we make it to the interest of the workman to do otherwise. His desire for more money continues, however, and when he finds his piece rate reduced whenever he earns much more than the average workman, he comes to the conclusion that as his employer seems determined to keep him in his class so far as compensation is concerned, he will see what he can do to better the financial condition of the class.

The fact that he has had to suffer a penalty for trying to advance himself by legitimate methods, however, has caused him to feel that *might* is more powerful in the world than *right*. No better way could possibly be taken to teach him the value of force in accomplishing his ends.

We cannot blame him if he now spends his extra energy in forming his union, for in the past unions have done more for the workman than he could do for himself. If we wish him to abandon the use of force, we must assure him of an equitable return for his efforts without it. Inasmuch as in the union, as was previously shown, the good man seldom gets all he is worth, we can get the good men on our side, if we can convince them that their efforts will be adequately rewarded.

This brings us to the second system of

piece work, which when properly operated provides a complete system of instruction for the workman, equitable compensation for his efforts, and opportunity for advancement on his own merits, and not through "pull" or friendship. So far this system has never failed to create a strong spirit of harmony and co-operation.

The essentials of this system are:

First, to have the best expert available investigate in detail every piece of work, and find out the best method and the shortest time for doing it with the appliances to be had.

Second, to develop a standard method for doing the work, and to set a maximum time which a good workman should need to accomplish it.

Third, to find capable workmen, who can do the work in the time and manner set, or to teach an ordinary workman to do it.

Fourth, whenever the high efficiency is obtained, to compensate liberally not only the workman actually doing the work, but also those who supply him with materials and appliances to enable him to maintain the efficiency specified.

Fifth, to find among the workmen who

have learned the best ways of doing work, some that can investigate and teach, and thus gradually to get recruits for the corps of experts, so that the system may be self-perpetuating.

Sixth. The ordinary foreman of the shop *must not* be called upon to do the work of the expert. His business under the usual conditions of management is that of an executive, and he is invariably so busy attending to his routine duties that he has but little time to make investigations into the best method of doing work. He can only give instructions according to the experience he has had in the past, or according to the knowledge he may pick up at odd times. Again, he frequently feels compelled to allow work to be done inefficiently because he has no man that can do it better, and no time to train a new man. For these reasons it is desirable that the development of improved methods, the setting of tasks in accordance with these methods, and the training of workmen to perform these tasks, should be in the hands of some one other than the foreman.

For this purpose the best expert mechanic available should be selected. Such a man may not have qualities at all fitting him to be a foreman—in fact, the best expert usually makes but a poor foreman. He is generally so absorbed in the mechanical operations themselves that the improvement of them becomes a passion with him, and nothing pleases him more than to see numbers of machines operating at their highest efficiency, the result of his work. On the other hand, the foreman with this kind of a mind often sacrifices other sources of efficiency for this object. The expert must be a good mechanic, with fair education. He must have industry, originality, persistence, and an ability to remove obstacles, not once, but repeatedly.

Such an expert in a shop will study the machines individually and teach workmen to bring each up to its highest efficiency.

While the policy advocated in the above paragraphs cannot be called a system of management, the elements described must be parts of any good system. Each individual problem of manufacture must be studied in such a manner as to determine how the work can be done in the most efficient way.

There is no use in attempting to increase efficiency, however, unless it is done in a systematic manner. Managers will often tell you that you cannot put into their shops methods of this character, and, under the conditions that exist, they are right. In many places you cannot at once better the evident inefficiencies that exist, for the machinery is often so arranged that it is extremely difficult to do anything different from what is already being done.

Most plants have grown from small beginnings, and have been added to without any definite plan, or any real idea of the system to be used in operating them. In many cases the character of the work has changed, and a plant well adapted for one class of work may be so arranged as to make it impossible to do another class of work efficiently. Then there are plants in which the machinery has been arranged without considering the subject of efficient management. In most plants, at least one of the above conditions exists to such an extent that much of the machinery must be rearranged to make any great improvement.

Then there are some people who have no idea of doing anything in a systematic manner. They cannot do anything twice the same way. They may be very good people, with an artistic temperament, perhaps, or they may be chronic inventors. They like to change things. If you have a man like that at the head, and succeed once in getting the plant organized for efficient work, he will want to change things again to-morrow. Such a man is not a manufacturer, and will make a much greater success at something else. To attempt to make permanent under such a man an efficient arrangement of machinery, or system of management, is futile.

On the other hand, if the man at the head is systematic, and while capable of recognizing an improvement, is slow at making changes unless he can see distinct benefit from them, the conditions for instituting such reforms as will permanently add to the efficiency of the plant are ideal.

When we have once established our system of management by which the work is done economically, and the workmen get higher pay, they themselves offer the strongest opposition to change, for they will stand by a good system under which they are benefited quite as staunchly as they did by the forty-year-old method it replaced, the only virtue of which, perhaps, was its age.

Before beginning to introduce the methods described we must study the conditions under which the work is to be done. The machinery must be so arranged that the work can be done economically, and provision must be made to have the proper materials and appliances always available for the workmen. This is a question of management, and may have quite as much effect on the proper operation of a plant as anything the workmen can do.*

Having placed our machinery so that it can be operated efficiently and arranged for a proper provision of materials and appliances, the first problem is to determine the best way of doing a piece of work. Usually there are in every shop some workmen who are much more capable than the others. If the best of these can be interested in our work, the problem of studying the work in detail is much simplified. In connection with such workmen, our observer, or "time study" man, can make a detailed scientific study of all the elements of a piece of work and determine the best method for doing it and the shortest time in which it can be properly done by an experienced man working at his best normal speed. Having determined such

*A paper presented before the American Society of Mechanical Engineers, July, 1903, and entitled "A Graphical Daily Balance in Manufacture," goes into this subject somewhat.

a time and method, they are adopted as standards, and the workmen should be awarded liberal compensation for doing the work by the method and in the time set.

As a rule it is best to study, if possible, the work as done by several good workmen. If it is understood that the most efficient will be given the work at a fair rate, we are usually able to secure their co-operation in fixing that rate.

If it is necessary to train several workmen, the very best man should be made an instructor and compensated liberally for teaching the others his knowledge and skill.

In machine shops, or other places where many tasks are to be set, the investigator or task setter should be the most expert workman available, and his compensation should be such as to make him jealous of his job. If any workman often succeeds in doing the work in less than the time set, we mark him —not to have his rate cut—but as a promising candidate for an instructor's, or task-setter's, job. As a matter of fact, our trained workers often yield a good supply of instructors and occasionally a task-setter.

We thus provide means for the workman to learn the best practice we can devise, and not only compensate him liberally for following it, but give him a chance to advance himself still further if he has the ability to do so.

When it is clearly understood that we mean to do this, we have no difficulty in securing the hearty co-operation of the workmen.

After a proper study we should know the time needed by a good man to do the work with the same certainty that we know it is possible for a good healthy man to walk four miles per hour for several hours. We know, however, that if we go out into the street, and ask a dozen men at random to walk to a place four miles off in an hour, they will all probably have great difficulty in doing it. If we ask them to go eight miles in two hours, the great majority of them will fail. If we extend the walk to twelve miles in three hours, almost none of them will accomplish it. Suppose, however, we know a man who can walk four miles per hour readily, and get him to teach others to do it. If we make it to the interest of the others to do as they are taught, our expert can soon teach them by walking them, perhaps, the first day, only one mile in a quarter of an hour; the second day, two miles in half an hour; in a day or two four miles in an hour, then six miles in an hour and a half. He soon gets them so they can walk day after day at that rate without any difficulty. We have the same problem in doing any kind of work. If a man is trained to do a certain kind of work at a certain speed, he will do it at that speed, even though it may have been absolutely impossible for him to do it at that rate before he was trained.

Training takes time, and training a man to work rapidly and well is a much more difficult job than training a man to walk fast. Therefore, after our expert has found the best way and the best speed for doing certain work, his job is still often only half done. He must find somebody who can be trained to do it in that way at that speed. Frequently we know it should be done at that speed, but cannot find anybody to do it. Our investigation may show that a job can be done in an hour, and yet the best result we can get may be an hour and a quarter, or an hour and a half. Every worker in the place may say he cannot do it, and nobody may be willing to try. But if our studies are correct, and if we patiently train people, experience proves that we can eventually get some one to do it.

If the man who is doing the work is successful in performing his task in the time and manner specified, he, of course, gets extra compensation; but this is not enough. The men who supply him with the means of doing the work must also get extra compensation, for unless you can make it to their financial interest to co-operate, the worker may fail for want of their co-operation. On the other hand, if they do get extra compensation when the individual is successful, there will be a complaint from some one if he is not successful. If his failure is due to the man supplying the materials this man will be criticised, not so much by the superintendent as by the workman himself. If the workman often fails from his own inefficiency, the helper, who also loses, will complain. Not long ago an illustration of this occurred in a cotton mill. A slow-moving fellow you would hardly think could do a full day's work, finally woke up, and became a good weaver, earning his extra compensation nearly every day. One day the proper "filling" was not ready for him in time. The foreman heard a great row in the weave room, and, looking around, found this fellow about ready to take off the head of the man whose duty it was to supply the filling. That man had energy enough, but he had only recently learned to use it, and the object lesson he gave helped the whole room.

After we have studied a job and set the task, it should be our invariable rule never to change it unless we change the method of doing it. If, in spite of careful study, we find we have made a mistake, we must simply accept the consequences of that mistake. We may some day find a better way of doing the job. In this case we may change the task by adopting that as our method, and teaching it to the workmen. As long as the work is done by the same method, however, we should seriously impair the efficiency of the whole place if we attempted to increase the difficulty of the task. Suppose we have decided, after careful study, that 10 pieces is a day's work. If our people become exceptionally skillful and do 12 or 14, it is well worth our while to have them do so.

On the other hand, if an attempt is made to increase the task as the workers become more skillful, the workmen will logically decline to do the increased task, if the original task is a fair oue. Suppose the employer insists on his point, and lets his trained workers go.

If his task is a proper one, his new gang will be unable, as a rule, to do more than half as much as his trained gang, aud hence he will need twice as many people and twice as much space to get out the same product. Twice as many people require at least twice as much supervision, and if they are untrained and new in the shop, more than twice as much. In addition, the product of the untrained workers is sure to be decidedly inferior to that of the good workers, and altogether the loss to the employer is likely to be many times the possible gain by the saving in wages.

When, therefore, we have a lot of efficient men, working harmoniously, we can afford to pay them big wages rather than try to change things at all. A certain mill formerly had the reputation of paying poor wages, and, of course, had difficulty in getting good help. Now, under this system, it pays the best wages and draws the cream of the help from all around. Every man in that mill knows he has the best job he can get, and he comes every day to take care of it.

If the men know that the employer will stand by his word, and not change the time for performing a task when it has been once set, they soon get confidence in him, and the problem of increasing the efficiency of the plant becomes easy.

In attempting to increase the efficiency of a plant, then, the first problem is to convince the workmen of our good faith and that they will be treated fairly. When this has been done, we always have their co-operation to a degree entirely unsuspected by those who have never tried that method.

We must remember, however, that proper piece rates and loyal workmen are only elements in producing efficiency. They have but little effect unless there is system of management that tends to harmonize all the various elements upon which efficiency depends.

In fact, a broad-minded manager who understands the relative importance of the various operations carried on in the plant, and who adopts a policy which has a tendency to harmonize these various operations, can accomplish more with individual records and day work than can be accomplished by the best possible piece rates without a harmonizing system of management.

In any attempt to increase efficiency, therefore, the first problem is to harmonize the various operations. In most plants, especially those that have grown gradually from small beginnings, it is usually possible for a capable man to do this in a manner that will increase efficiency, diminish the amount of supervision needed, and secure the co-operation of the best men, if he makes a careful study of the work with that object in view.

To do this it is often necessary to rearrange machinery in order to minimize transportation and bring together similar and allied operations. This should be done before a study is made of the detail operations, which, if possible, should be studied under the conditions that are to be permanent.

In other words, the general problem of manufacture must first be divided into its grand divisions; these grand divisions must then be divided and subdivided until the individual operations may be further subdivided into details which can be studied separately.

Analyzing a piece of work into its proper elements and determining the minimum time for each element is not work that can be done by an inexperienced clerk with a stop watch, but requires a man with a trained analytical mind who can concentrate his attention on a problem and learn all there is to be known about it. Having determined the minimum time in which the work can be done, the problem of setting a reasonable task is still to be solved. If the work is simple and is to be repeated many times per day, and day after day, the task should be a difficult one for even the good workers at first, for with repetition they will acquire skill, and in a short time it will become easy. In such work it will often pay to spend quite a long time training workers to do it efficiently.

If, on the other hand, the operation is but seldom done, it may not pay to spend much time training workmen to do it with great efficiency. In this case we should not make the task too severe, but such as a good workman can do without the preparation of special training.

This studying of the elements of a piece of work and setting proper tasks or piece rates, though an important part of any proper system of management, is only a part. The broad problem which includes all others is to develop a system that encourages the study of all operations and adequately rewards all who co-operate for their continued efficient performance.

As was said before, it is not the workman to whom we must look for increase in efficiency, but the manager. The policy of compensating the individual for efficiency is bound to cause increase of efficiency, and that of fixing compensation regardless of efficiency is just as sure to reduce it. The manager, and not the workman, is responsible for the policy.

It is a well-recognized fact that the efficient man at high wages is much more profitable to his employer than the inefficient man at low wages, yet how many managers give any consideration to the subject of increasing efficiency? Under the system of management in most general use the manager puts the solution of all problems concerning workmen on his superintendents, who in turn pass them on to their foremen.

Is such a policy a system of management, or is it a system of shirking the responsibilities of management? Of course the manager cannot personally study all the operations, and solve all the labor problems that may come up; but if he has the knowledge and ability he can gradually build up an organization that will successfully study and solve them.

The demand for trained workmen is very extensive, but it too often spends itself in schemes for schools to carry out at their own expense, and the question immediately arises as to whether the schools, or, in other words, the State, should bear the expense of training workmen. Under the old apprentice system each trade trained its own workmen. Under our factory system this method has been largely abandoned, and nothing has been developed to take its place. Is it not the duty of the factory to develop a substitute for a system its methods have made obsolete? Is not the system of having a first-class workman study mechanical operations in detail and teach the younger man to perform them in the best manner he can devise, and at the best speed he can show, far superior to the old method where the apprentice might have an efficient teacher, but more often did not?

Surely nobody will deny that such a system is to be preferred to the old apprentice system, and, if so, the only question that arises is, will it pay the manufacturer?

Inasmuch as the efficient workman often does two or three times as much as the poor workman, and always does it better, and inasmuch as the workman who does twice as much work cuts the general expensės per unit of output in half, there would seem to be no question that such a system of training would pay handsomely. This will be discussed in detail in the subsequent chapters.

TASK WORK WITH A BONUS

CHAPTER VI

TASK WORK WITH A BONUS

IN the preceding chapters an attempt has been made to show that present labor conditions—that is, labor unions and employers' associations—are a natural and almost a necessary result of the present methods of handling workmen. The horizontal wage, under which men in a certain class get a certain wage and under which it is practically impossible for any individual to get much more than the average day, or piecework, wage of the class, has its effect in causing the workmen of that class to combine to get the average wage of the class increased.

It was also explained that as long as we classified workmen and paid those of one class substantially one wage, without greatly varying that wage according to efficiency, the efficient men, realizing that they could not get any more money than was paid to the average of their class, would continue to combine with the others in that class to have the class wage raised. This is what they have done in the past; and, if we read human nature aright, this is what they will do in the future, until some means has been devised by which the efficient man can get proper compensation for his work. When his compensation is independent of what the inefficient man gets, he will not worry himself greatly about combining with the inefficient man. The employer recognizes that the efficient man is worth more to him than the inefficient man, but most employers do not know any scheme by which they can compensate the efficient man according to his deserts, and avoid trouble with the inefficient man.

The object of this chapter is to show what we have accomplished both in the way of rewarding the efficient man, and of making the inefficient man efficient.

In March, 1899, I became associated with the Bethlehem Steel Company to assist in putting into operation methods for increasing the efficiency of their labor. This work was being done by Mr. F. W. Taylor, with whom I had been associated twelve years previously in the Midvale Steel Company, where the methods underlying Mr. Taylor's work originated, and where they are still in operation.

One object that Mr. Taylor had in mind was to establish throughout the plant a system of piece work based on a scientific study of what could be done, and to make piece rates that should be permanent. The portion of the works that seemed to offer the greatest field was the main machine shop; but before setting these piece rates it was necessary to make a great many changes. Machines in this shop had been located, not with reference to any particular system of management (because nobody had given the system of management any particular thought) but promiscuously, throughout the shop.

In order to do work economically it was desirable to rearrange the machine tools in such a manner that a foreman, expert on one class of work, should be able to supervise that work. Accordingly the location of the machines was so changed as to place the large lathes in one group, the small lathes in another, the planers in another, etc. While the machines were being moved they were respeeded to enable them to utilize to advantage the improvements that had been made in tool steel, Mr. Taylor at the same time making a large number of experiments* to determine the best shapes of tools and the best tool steel with which to do the work, which in this shop was very miscellaneous in character. Even when we got the shop rearranged, much study still had to be done before we could know enough about the conditions to make permanent piece rates.

The high degree of perfection demanded by Mr. Taylor took much time; and the consequence was, that although slide rules for determining how to do machine work and instruction cards for directing the workmen had been in use since 1899, the monthly output of the shop during the year from March 1, 1900, to March 1, 1901, had been but little more than the monthly average for the five years preceding.

Up to this time we had devoted ourselves to the study of what could be done, and had done but little to cause the workmen to cooperate with us. This record shows that we had not in any measurable degree secured their co-operation. In other words, we had much knowledge, but were unable to get any substantial benefit from it because the men

*The result of these experiments was the development of the Taylor-White method of treating tool steel.

would not help. Not being ready to introduce the differential piece-rate system, which was regarded as the ideal one for obtaining a maximum output, I felt that we should not wait for perfection, but should offer the workmen additional pay in some manner that would not interfere with the ultimate adoption of the differential* piece-rate system. Accordingly on March 11, 1901, I suggested that we pay a bonus of 50 cents to each workman who did in any day all the work called for on his instruction card. This was adopted at once, and Mr. E. P. Earle, the superintendent of the machine shop, suggested that we should also pay the gang boss (the man who supplied the work) or speed boss (foreman) a bonus each day for each of his men that earned his bonus. This was also approved, and both plans were ordered to be put into execution as promptly as possible.

This bonus payment was begun at once, and on May 13 the assistant superintendent

*The differential piece rate was devised by Mr. F. W. Taylor while with the Midvale Steel Co., to stimulate maximum production. It consisted of a high rate per piece if a definite large product per day was attained, and a lower piece price if the output was less than the amount set. The effect of the system was to cause a big increase in wages for attaining a definite degree of efficiency.

of the machine shop, Mr. R. J. Snyder, made the following report:

Mr. E. P. Earle.
Supt. of Machine Shop No. 2.
Dear Sir:

I hand you herewith some notes on the results obtained by the introduction of the "bonus" plan for remunerating labor in No. 2 machine shop. (Here follow machine numbers and dates when they were started on this plan.)

One of the best results after a short trial has been the moral effect upon the men. They have had it placed in their power to earn a very substantial increase in wages by a corresponding increase in their productive capacity, and this has given them the feeling that the company is quite willing to reward the increased effort. They display a willingness to work right up to their capacity, with the knowledge that they are not given impossibilities to perform. This effect has been brought about by the good use of our excellent slide rules in the hands of a number of the most thoroughly practical men, who, when the results which they demand have been declared impossible to obtain, have repeatedly gone out into the shop and themselves demonstrated that the time was ample, by doing the work well within the limits set. All this has inspired the confidence of the shop hands, and the excellent instruction cards sent out are gradually evolving from laborers a most efficient lot of machine hands. . . . The percentage of errors in machining has been very materially reduced, which is unquestionably due to the fact that in order to earn his bonus a man must utilize his brains and faculties to the fullest extent, and so has his attention closely fixed on the work before him, as every move must be made to count. He thus has no time for dreaming, which was, no doubt, the cause of many errors.

The condition of the machines is vastly improved. Most care has been taken to point out to the men that the best results can be obtained only by keeping their machines in good running condition, well-lubricated and cleaned. They have not been slow to realize this, and cases of journals cutting fast are very rare, while before the introduction of the "bonus" plan this was a very common occurrence. Breakdowns are also of a less frequent occurrence.

The crane service lately has given us little trouble, and lack of crane service was formerly a constant excuse of the bosses and men for not being able to keep machines filled with work. The improvement in this case arose from the rule laid down that no exceptions or allowances would be made for delays due to this cause.

It is only by the introduction of this "bonus" plan that we have had furnished the automatic incentive for men to work up to their capacity and to obtain from the machines the product which they are capable of turning out. It has lifted the hands of the speed bosses (foremen) and enabled them to act in the capacity for which those positions were created —that of instructors.

These are some of the direct results obtained. Indirectly it has eliminated the constant necessity for driving the men, and has enabled the shop management to divert some of its energy into perfecting the organization, which only will enable us to give a good account of the shop equipment. Much good has also resulted from putting the work through in lots, and keeping each machine as nearly as possible on the same kind of work.

It is also a pleasure to note in this connection the deep interest taken in the work by the men connected with it, and the fine co-operative spirit which prevails among all hands.

This report was made only two months after the bonus system was started, now nearly nine years ago, and is particularly valuable as it emphasizes some of the fundamental principles on which successful work of this character must be founded. We must secure the confidence and co-operation of the workman by assuring him equitable compensation. If we fail to do this, any results we may get will be of short duration and our work will finally come to naught. Many of the failures to get continuously the high efficiency which seemed easily possible, have been due to a disregard of the fact that the workman is entitled to a share in the benefits of increased efficiency, and in the long run will not co-operate unless he gets it.

The attempt to drive the workman to increased efforts which benefit the employer alone, necessarily creates a force of opposition which grows greater as it is carried farther. Finally, the force of opposition becomes so great that further progress is impossible and the system of management based on *force* breaks down. This is as it should be, if we are to progress from an era of force to one of equity, and to make obsolete the doctrine that "they should take who have the power and they should keep who can."

Continual failure to obtain our ends permanently by the use of force, and success in obtaining them by co-operation, will ultimately show that the selfishness that prompts the use of force is unintelligent, and that the most intelligent selfishness is that which shares the benefits equitably among those helping to obtain them.

In closing the discussion on a paper on training workmen, read before the American Society of Mechanical Engineers, December, 1908, I made the following statement:

> A system of management may be defined as a means of causing men to co-operate with each other for a common end. If this co-operation is maintained by force, the system is in a state of unstable equilibrium, and will go to pieces if the strong hand is removed. Co-operation in which the bond is mutual interest in the success of work done by intelligent and honest methods produces a state of equilibrium which is stable and needs no outside support.

In the paper itself the following statements are found:

> The general policy of the past has been to drive, but the era of force must give way to that of knowledge, and the policy of the future will be to teach and to lead, to the advantage of all concerned.
>
> It is too much to hope, however, that the methods about to be described will be adopted extensively in the near future; for the great majority of managers, whose success is based mainly on their personal ability, will hesitate before adopting what seems to them the slower and less forceful policy of studying problems and training workmen; but should they do so, they will have absolutely no desire to return to their former methods.

In some quarters I have been regarded as not making the most of opportunities because of adherence to this policy, but results in the long run have been so much greater and more stable than those obtained by the driving method, that even the strongest advocates of force are beginning to recognize that in their desire *to get great results quickly they may fail to get them permanently.*

To go back, however, to the Bethlehem Steel Works, we note that the average monthly output of the shop from March 1, 1900, to March 1, 1901, was 1,173,000 pounds; and from March 1, 1901, to August 1, 1901, it was 2,069,000 pounds. The shop had 700 men in it and we were paying on the bonus plan only about 80 workmen out of that entire 700.

In September, 1901, the ownership of the works passed into the hands of Mr. Charles M. Schwab, and with this change came a change in management. Mr. Schwab had been brought up in a school where the *drive method* only was used, and he did not believe in any other. Mr. Taylor had already left the works, and the services of the writer and all others that had been prominent in installing the new methods were shortly dispensed with.

An unintelligent selfishness on the part of the management soon caused them to cease paying any bonus to the foreman. Other changes gradually followed, and, although attempts were made to retain some of the mechanical features of our methods, in a few years the *essential principles* of this work were practically eliminated and the efficiency of the shop ran down to such an extent as to become notorious. A complete return to the *drive method* after repudiating these principles, has produced a series of labor troubles, which, at this writing, have culminated in closing down the whole plant.

Contrast this with over thirty years' freedom from labor troubles enjoyed by the Midvale Steel Company, where long ago these methods had their beginning.

The plan as started at Bethlehem of paying a fixed bonus for performing the task had one element of weakness, namely, that after the men had earned their bonus there was no further incentive to them. It was some time before I devised a satisfactory method for adding such an incentive, which was finally accomplished by paying the workman for the time allowed *plus a percentage of that time.*

For instance, if the time allowed for a task is three hours, the workman who performs it in three hours or less is given four hours' pay. He thus has an incentive to do as much work as possible. If the workman fails to perform the task within the time limit he gets his day rate. The time allowed plus the bonus is the equivalent of a piece-rate; hence we have piece work for the skilled and day work for the unskilled.

One other feature of this work at Bethlehem had a most important effect on the result—namely, that in addition to the bonus paid the foreman for each man under him who made bonus, a further bonus was paid if *all* made bonus. For instance, a foreman having ten men under him would get 10 cents each, or 90 cents total, if nine of his men made bonus; but 15 cents each, or $1.50 total, if all ten made bonus. The additional 60 cents for bringing the inferior workmen up to the standard made him devote his energies to those men who most needed them.

This is the first recorded attempt to make it to the financial interest of the foreman to teach the individual worker, and the importance of it cannot be over-estimated, for it changes the foreman from a driver of his men to their friend and helper.

Under former conditions, the foreman hesitated to teach the workman for fear the latter might learn as much as he knew and possibly get his job. Under the new conditions, the man who knows is paid for teaching others as much as he knows, and the others are paid a bonus for learning and doing what they are taught. It is this feature of the task and bonus system that has enabled us not only to obtain, but to maintain permanently, such satisfactory results. The expert workman who becomes a good teacher soon makes his services valuable, for, by his assistance, *we can often make the average efficiency of the shop even greater than his best efficiency was before we began to study the question of efficiency. He learns to remove obstacles which stood in his way when he was a simple workman, and often becomes an expert also not only at removing these obstacles, but at developing better methods to avoid them.*

Such, in brief, is the history of the development of the task and bonus system, which, starting as a substitute for differential piece work, gradually supplanted it, differing only by the fact that the worker who failed to earn the high rate got his day's pay instead of a lower piece rate, thus allowing the inefficient workman a chance to earn a living while learning to become efficient. This effort to help the poor workman by giving him a living wage and an instructor, enables us to utilize many bright young men who either did not have a chance to learn a trade, or did not appreciate it when they had it. This is an exceedingly large class, and one that we find everywhere.

To review again the elements on which this system is founded, we note:

1.—A scientific investigation in detail of each piece of work, and the determination of the best method and the shortest time in which the work can be done.

2.—A teacher capable of teaching the best method and shortest time.

3.—Reward for both teacher and pupil when the latter is successful.

Are not these elements sure to make for success? The fact that we have been able to develop promptly workmen who could satisfactorily perform any ordinary task is the best answer. This method of providing workers for the semi-skilled jobs of a factory has been so successful that we are led to ask whether our method is not the basis on which to found a system of instruction and training for apprentices and workmen in general.

In a following chapter we shall show in detail what has been accomplished, and give data which prove that money invested in establishing a scheme of management and training on these lines yields a very large return. One of the best results of this work is that the trained workmen almost always hold on to their jobs, and the few that leave soon come back. Under our methods workmen take pride in being efficient.

THE TASK IDEA

Chapter VII

THE TASK IDEA

UNDERLYING the theory and practice of "Task Work with a Bonus" is an important principle—a concept altogether different in kind from that which actuates the "drive" method, or the policy of urging men to mere strenuous toil, without any well-measured standard of how much work a man should reasonably do under the conditions of the case. This principle is the Task Idea. What are its elements and influences?

In studying a problem it is best to consider first the simplest form in which that problem presents itself, and one if possible in which the issues are perfectly clear to all. A good example for our purpose is to study the methods by which a child is taught to perform a simple operation. The invariable method is to explain to the child as clearly as possible what is wanted, and then to set a task for it to accomplish. It may be noted that the accomplishment of the task is rendered much easier for both the child and the parent, if a suitable reward is offered for the proper performance. As a matter of fact, setting tasks and rewarding performance is the standard method of teaching and training children. The schoolmaster invariably sets tasks, and, while they are not always performed as well as he wishes, he gets far more done than if he had not set them. The college professor finds the task his most effective instrument in getting work out of his students, and when we in our personal work have something strenuous or disagreeable to accomplish, it is not infrequently that we utilize the same idea to help ourselves, and it does help us.

The inducement to perform the task is always some benefit or reward. It may not always be so immediate as the lump of sugar the child gets, but the work is still done for some reward, immediate or prospective. Further, it is a well-acknowledged fact that to work at a task which we recognize as being within our power to accomplish without overexerting ourselves, is less tiring and far more pleasant than to work along at the same rate with no special goal ahead.

It is simply the difference between working with an object, and without one. The hunter who enjoys following the trail of the moose, day after day, through snow and bitter cold weather, would find the same traveling very disagreeable except for the task he has set himself. To the uninitiated, golf seems a very inane sort of game, but its devotees work at it with tremendous energy just for the satisfaction of reducing their score a few strokes. As they become more proficient, they become more enthusiastic; for, having performed one task, there is always one just a little harder to work at. A consideration of this subject will convince us that in the vast majority of people there readily springs up the desire to do something specific if the opportunity offers, and if an adequate reward can be obtained for doing it.

A NATURAL METHOD

The idea of setting for each worker *a task with a bonus* for its accomplishment seems thus to be in accord with human nature, and hence the proper foundation of a system of management. Our problem, then, is to find out how to set a proper task and what the reward should be for its accomplishment.

The ideal industrial community would be

one in which every member has his proper daily task and receives a corresponding reward. Such a community would represent the condition of which Kipling says:

> "They shall work for an age at a sitting and never be tired at all."

This is what Scientific Management in its best development aims to accomplish, for it aims to assign to each, from the highest to the lowest, a definite task each day, and to secure to every individual such a reward as will make his task not only acceptable, but agreeable and pleasant. Whatever we do must be in accord with human nature. We cannot drive people; we must direct their development.

The greatest obstacles to the introduction of this method in the past have not been the workmen, but the foremen and others in authority. Those offering most objection have, as a rule, either not understood what was being done, or have felt their inability to hold their jobs if they were asked to perform them in accordance with the high standards set. Frequently, the higher they are in authority the less they can see that they should have a task set for them. Such a system bears hardest on those who hold their jobs by *pull* or *bluff*, and it is from them that we should expect the greatest opposition. In this we are not disappointed. In fact, there is only one class that opposes us more strongly, and that is the class which is using official position for private gain. Such people will often commit serious crimes in an attempt to prevent the exposure of their irregularities, and no concern, therefore, should undertake the installation of these methods, unless with the avowed purpose of eliminating all kinds of graft and special privileges.

SCHEDULES AS TASKS

The task idea is really so common that we do not recognize it. Every railroad schedule consists of a series of tasks, and in the manufacture of such articles as sewing machines, typewriters, and locomotives, the task idea is illustrated by the schedules according to which the various parts are started on their way through the different departments, and day by day make such progress as will bring them to the erecting shop at the proper time to be incorporated into the finished machine without delay.

In the case of locomotives, in particular, the task idea is specifically illustrated by the dates of shipment set, often months ahead, which are lived up to in a very remarkable manner. When the shipping date of a locomotive has been set, there has also been set the time when every piece must start on its course through the shops to arrive at the appointed time in the erecting shop. Inasmuch as this work has been done over and over again, all the principal men in the works know by heart the schedules of all the parts they are concerned with, and what their tasks are.

Wherever the work is of one general character, this condition exists, for each foreman, and in many cases the various workmen, soon learn the proper routes and time-schedules of the parts they are concerned with.

The grand task of shipping at a predetermined date, then, consists of the sum of those detail tasks, each of which must be performed properly and in the proper sequence if the shipping date is to be lived up to.

SCHEDULING MISCELLANEOUS WORK

Where the work is miscellaneous in character, however, the task of having each part go through the proper sequence of operations and arrive at the erecting shop in the order wanted is not so easy. As a matter of fact, it is my feeling that the inability to get miscellaneous work through a shop on time because of lack of proper schedules, and the delays caused thereby, are often the source of as much expense as inefficient work on the part of the operative.

In a small shop one capable man can often so plan miscellaneous work, and keep account of it in his head, that but little expense is incurred from delays or interferences; but in the large shops of today, and especially in plants consisting of several shops, such a thing is quite impossible; and the larger the shop or plant the greater the expense that arises from this source. This, then, is the greatest and most important task to be performed in any works, and it is one for which the management is solely responsible. To go into details of how such a task is performed would be impossible in the short time at my disposal. Suffice it to say, however, that, when a start has been made and each foreman receives each day a list of jobs to be done that day, the general efficiency of the works is much increased, though nothing whatever has been done to increase the efficiency of the individual workman. Although such an *order of work* is of great assistance to the foreman, its usefulness increases rapidly as the work is so planned as to avoid interferences and to have all materials and appliances ready for the workman in advance. With this result the efficiency of the individual increases, and, unless his inefficiency is very flagrant, it is far better to solve this general problem first and to take up the efficiency of the workman later, except to the extent of keeping a *daily record* of his work; for when the large problem is solved, every advance made by the individual counts for all it is worth, which is not always the case when work is done in the wrong sequence or by an inferior method.

What I have said has often proved itself of value. Anybody who gives the subject thought will readily recognize the importance of it. I had a case a few years ago where there was a very good foreman of a certain shop—I say he was good because he intended to do the right thing and he was bright and he knew how to do the work—who nevertheless had one failing, a very bad memory. He would promise anything and never perform it. It was not because he did not want to do it; he would always forget. He honestly forgot. And when we gave him a list of the work in the order in which it was wanted, and presented him each day a list of the work he was to do next, he was perfectly delighted.

I have had many similar cases and have always been able in this way to increase the efficiency of the foreman and of the workmen. In one case I was told that certain foremen in a large shop were useless; there was one in particular whom they would have to get rid of. Well, we did not discuss that question. We found that he was always behind in his work because he was always doing the wrong thing first. We went to work to straighten out what he should do and gave him each day a list of the work he was to do that day. In a short time he caught up with his work, and some months later he came to the superintendent of the shop and said, "There is something wrong in this shop." The superintendent asked, "What is the matter?" "I don't know," said the foreman; "but there is something wrong in this shop." "Well, what is it, if it is wrong?" "Well," the foreman replied, "nobody has been chasing me about my work for three days.'' That happened several years ago, and the man is still there as foreman.

Having solved our large problem of scheduling each part through the works, and having devised means for knowing each day whether our schedules are lived up to or not, we come to what most people consider the real problem, that of setting a task for the workman.

Many shops have a very nice schedule system; they plan their work beautifully—at least, it looks very pretty on paper; but they have no means of finding out whether those schedules are lived up to or not. Usually they are not. I have been through shops where the superintendent or manager told me he had a fine system of management, and, having described his whole system to me, turned me over to a subordinate to take me around and see how it was working. It has been very seldom that I have found the system working the way the superintendent said it was. He had planned it and had given his orders, but when I got out into the shop and asked questions, I found that the foreman and the people charged with carrying out this system said, ''We found we couldn't do it just that way and we have done it this way." One dear old man whom I knew very well was very proud of his shop system. He spent quite a time one day showing it to me, and then turned me over to one of his subordinates to be shown the details of anything I wanted to see. There was absolutely nothing going as he said it was going. The force had not argued with him; they had just gone on and done things in their own way. He had this beautiful system all on paper. It looked to me pretty complicated, but he thought it was fine. Everybody was going on just the same as before, and he was ignorant of the fact. They never brought it up to him; they got things out the best way they could, made whatever excuses were necessary, and got through.

With regard to the subject of tasks it may be said that it is only in those cases where the number of routes is small and the sequence of operations fixed, that proper tasks can be set for the workman before the solution of the general problem. I have been working at one plant for a year and a half where they had a pretty good system of management, and we have not set a task yet. We have been straightening out their routes.

We have been fixing it so that the work should go through the shop in the order wanted and not by the snap judgment of some individual. As soon as we have got into the various rooms—in many cases rooms which were crowded and where work was stacked all round the room—and begun to plan the work so as to have it done in proper sequence and without delay, congestion has disappeared. That has happened in so many cases that it cannot be attributed to accident. In one case the shop was filled with small boxes of little pieces that were in process. There were a great many of those boxes. I said, "The first thing, gentlemen, is to get some racks made and classify these boxes according to the operation which is next to be performed on the pieces." They saw they had a great many boxes there and they built a corresponding number of racks. When they got this work classified and began to lay it out, they found they had many more racks than they needed. The work kept moving instead of standing there.

In many factories the amount of work in process, moving in a desultory way through the factory, is two or three times as great as there is any necessity for, if its course were properly planned. It not only takes up factory space, but it ties up a large amount of capital where work is not properly planned. The ordinary stock-keeper or foreman always wants to give himself about two or three times as much time as is needed to get the work done. He always expects that when a man promises to give him something next Monday, it will be Monday week or Monday two weeks before he will get it. And that is true if the planning of that work is left to a series of foremen. There are many reasons why that has to be so. It is impracticable to do it in any other way. If, however, all that planning is done from one central headquarters, and each man knows how much he has to accomplish, and it is put up to him in such a way that he can accomplish it, it gets through pretty regularly.

To send a clerk into a shop to time workmen with a stop-watch and set rates, or tasks, naturally arouses the opposition of the workmen; and while no doubt it has been possible in many cases to get more work by so doing, no doubt, also, its effect on the industrial conditions of the country at large has been decidedly detrimental. It creates opposition, and justly.

Working at tasks is not a hardship, but a pleasure, if they are properly set and adequately rewarded. Before task-setting can be carried on satisfactorily, the workmen must be convinced that we are not approaching them with a scheme for driving, but with one by which they will be benefited. They must be satisfied, too, that the man who is going to study their work knows what he is doing. He should not be a clerk picked up at random and given a stop-watch; he should be a man who knows what the problem is and how to solve it.

PREPARATION FOR TASK-SETTING

Among the steps to be taken before setting a task are: to get all machines and appliances in proper order, to establish a proper tool-room where suitable tools can be obtained for work, to arrange to supply the workmen with material in the order wanted, to plan work so that it is very seldom that one job shall be stopped to make way for another. In other words, before we begin the problem of task-setting for the individual, we should arrange conditions so that he can work to the best advantage, with proper ventilation and a comfortable temperature. These conditions alone will materially increase output, for petty annoyance of any kind reduces efficiency. If the work requires mechanical skill or ability, the problem should be studied by the most capable mechanic available, and specific instructions given as to the best way to do the work and the time required to do it. If necessary (and it usually is) the investigator and task-setter should now turn instructor and show the workmen how to do the work, and the task should be such that a good workman can readily learn to perform it. If the task is set in this manner by a man in whose ability and honesty the workman has confidence, I have but little difficulty getting the task-work started, provided a proper bonus is offered.

This leads to the question, What is a proper bonus? The reply is that it is such a bonus as will make the workman feel that he is fully compensated for any extra exertion he puts forth.

Judging from this point of view, it is evident that the bonus depends upon the severity of the work. It varies, as a rule, from 20 per cent to 50 per cent of the day rate. Task work does not necessarily mean more severe work, but it does mean more continuous work, and work under more favorable conditions, which always produces greater efficiency.

The attempt to set a task so severe that very few people can be taught to perform it is of no advantage from any standpoint, for few will continue to strive for a reward which they cannot reach. I have seen employers who were much surprised that they did not get an increased output where they had set a reward for it—surprised that the reward was being earned by one or two only out of fifty or sixty. When a workman has made up his mind that the reward is beyond him, it has no effect.

PERFORMING THE TASKS

Having set a task, the responsibility for the performance does not rest upon the workman alone, but must be shared by the instructor, who must see that the conditions under which the task was set are maintained. That is an essential difference between task work with bonus and the ordinary form of piece work. The ordinary form of piece work is to fix a piece rate, and then let anybody do it, if he can; if he cannot, he gets out. We believe that it is our duty to show the man how to do it, and to do whatever we can to help him perform his task. To complete the scheme, therefore, every case of lost bonus must be investigated and the reason determined. Such investigations, when the case is that of a man who has learned the work, usually lead to the discovery of slightly defective material, imperfect tools, machine out of order, or any one of a large number of things that might hamper the output considerably, but which would not be noticed unless a special search was made for them. Thus, *the setting of a proper task for a workman also imposes obligations on, or sets tasks for, the management,* with the invariable result of a better and cheaper product.

TASK WORK IN A MACHINE SHOP

The setting of machine-shop tasks is today quite different from what it was ten years ago. At that time machine operations took a relatively long time, and the time between operations was of much less importance. Today, when machine operations are, as a rule, three times as fast, the time of changing jobs has become three times as important, and to plan our work so that there will be no time lost in going from one job to another has become a far greater factor. For each machine-tool operative today, there has to be planned nearly three times as much work as formerly, and necessarily the supervising force must be much greater. It is this increase in machine-tool capacity which has induced me to lay emphasis on the general scheduling of work, so that no more time than necessary shall be taken in changing jobs.

The ratio between the number of men actually engaged on mechanical work and those engaged in supervising or preparing work must necessarily be quite different from what it was before the advent of high-speed steel and methods of instruction and task setting.

Task setting in every kind of shop is similar, and although we do not have high-speed steel to reduce time in non-metal-working shops, we have, in many cases, something similar, the benefit of which is never fully realized until a proper and detailed study is made of the possibilities.

I could give numerous illustrations of this. For instance, in the bleaching of cloth there are several processes, one of which is to subject the cloth to the action of an acid. I found a variety of opinion in the plant in which I first worked as to how long the cloth should be subjected to this treatment. They told me that they thought an hour was necessary. By watching their performances, I found that, while the man who told me that an hour was necessary usually subjected his cloth to the action of the acid for an hour, he sometimes allowed it to stay in the acid for several hours and sometimes only five minutes. That, of course, opened a field for investigation. He also told me how strong the acid should be, and insisted that he always kept it at that strength. We secured samples of his solution at different times and found that the strength varied from about 1 per cent to 7 per cent. That also opened up a line of study. We found but little difference between cloth which had been acted upon five minutes and that which had been acted upon for an hour. As a result of our studies, we found the strength of acid needed and the time the cloth should remain subjected to it. It had been the practice to pile the cloth in a series of piles, and when it had remained long enough in these piles, to sew the ends together again and to pull it through the subsequent solutions. This method necessitated the sewing of the top of the second pile to the bottom of the first. As this process was usually repeated several times in the bleaching, it is easily seen that the pieces of cloth naturally became pretty thoroughly "shuffled" by the time the bleaching was completed. If the rope contained several kinds of goods, as was usually the case, the kinds were often so thoroughly mixed that they could not be gathered together again, except with much care and labor. The result was that people frequently did not get all of the goods that they sent to the bleachery, but they got somebody's else, which were sometimes as good, and sometimes not.

The discovery that those goods could be treated in a few minutes enabled us to make a remarkable change in the work and eliminate a great deal of labor, besides keeping all the goods in exactly the order they went in. We devised a machine which automatically turns upward the leading end of a pile of goods formed in it. From this leading end the goods are pulled off at exactly the same speed as that at which they are added to the pile. Thus all goods remain in the pile exactly the same length of time and are treated exactly alike, with the result of a uniformity of bleach before unattainable.

The length of time the goods remain in the pile is governed by the judgment of the bleacher and is limited by the size of the machine. Several machines may be placed in series if it is desired to have the time very long.

By means of this machine it has been possible to bleach a number of small lots of different kinds of cloth together, yet to keep each lot intact, and to deliver to the finisher goods so uniform that he can feel sure that like treatment will produce like results. He is thus able to mix his starch according to his formula and be sure of his result.

This one thing has had as much influence on the cotton-finishing industry as improved tool steel has had on the machine-shop industry. I say it has had—it will have, when it is extended to the degree to which it will ultimately be extended. The development is proceeding and it is being gradually extended throughout the country.

This suggests that, in a non-metal-working industry, there is nearly always something in which improvement can be made, just as improvement has been made in the metal-working industry by high-speed tool steel.

We have found that if work is properly planned, so that unnecessary delays do not occur and the workmen are provided with proper implements to enable them to perform their tasks in the best manner we can devise, they can, as a rule, wherever the amount of work done depends upon physical exertion, do an average of three times as much as they did on day work, before planning and task setting were begun, and feel no more tired at night.

MAINTAINING PROPER CONDITIONS

While the setting of tasks under the proper conditions and in the proper spirit, accompanied by a suitable reward for accomplishment, is of great advantage, it is essential that the conditions under which the tasks have been set should be maintained permanently. Failure to maintain these conditions will work hardship on the workman and will make it impossible many times for him to perform his task. No one, therefore, should undertake the introduction of task work, unless he is prepared to maintain the conditions of his shop at a high standard; otherwise dissatisfaction is sure to spring up.

The sum of the tasks which can be performed by the individuals of the shop is the shop task, and the sum of the tasks of the shops is the factory task. Every foreman who can succeed in the accomplishment of his shop task should be properly rewarded. In such a scheme as this the foreman and the workmen are brought together by mutual interest, and there develops a spirit of cooperation. Under this scheme also it is perfectly evident that there will be a decided increase in profits.

SUMMARY

A task has a psychological effect which is very striking. Railroad schedules are tasks. Miscellaneous work is done badly and uneconomically because it is usually done without scheduling or task-setting. Tasks should not be set until we have arranged to maintain permanently the conditions necessary for the performance of the task. The setting of a proper task for workmen necessarily sets a task for and imposes obligations upon the management. The setting of proper tasks in a machine shop today imposes upon the management more strenuous tasks than it did before the advent of high-speed tool steel.

TRAINING WORKMEN IN HABITS OF INDUSTRY AND CO-OPERATION

Chapter VIII

TRAINING WORKMEN IN HABITS OF INDUSTRY AND CO-OPERATION

THE widespread interest in the training of workmen which has been so marked for several years is due to the evident need for better methods of training than those now generally in vogue. The one point in which these methods as a class seem to be lacking is that they do not lay enough stress on the fact that workmen must have industry as well as knowledge and skill.

Habits of industry are far more valuable than any kind of knowledge or skill, for with such habits as a basis, the problem of acquiring knowledge and skill is much simplified. Without industry, knowledge and skill are of little value, and sometimes a great detriment. If workmen are systematically trained in habits of industry, it has been found possible not only to train many of them to be efficient in whatever capacity they are needed, but to develop an effective system of co-operation between workmen and foremen. This is not a theory, but the record of a fact.

It is too much to hope, however, that the methods here described will be adopted extensively in the near future, for the great majority of managers, whose success is based mainly on their personal ability, will hesitate before adopting what seems to them the slower and less forceful policy of studying problems and training workmen; but should they do so they will have absolutely no desire to return to their former methods.

The general policy of the past has been to drive; but the era of force must give way to that of knowledge, and the policy of the future will be to teach and to lead, to the advantage of all concerned. The vision of workmen, in general, eager to co-operate in carrying out the results of scientific investigations must be dismissed as a dream of the millennium, but results so far accomplished indicate that nothing will do more to bring about that millennium than training workmen in habits of industry and co-operation. A study of the principles on which such training has been successfully established will convince the most skeptical that if they are carried out the results must follow. An outline of these principles was originally submitted to the American Society of Mechanical Engineers in a paper entitled "A Bonus System of Rewarding Labor."

Under this system* each man has his work assigned to him in the form of a task to be done by a prescribed method with definite appliances and to be completed within a certain time. The task is based on a detailed investigation by a trained expert of the best methods of doing the work, and the task setter, or his assistant, acts as an instructor to teach the workmen to do the work in the manner and time specified. If the work is done within the time allowed by the expert, and is up to the standard for quality, the workman receives extra compensation in addition to his day's pay. If it is not done in the time set, or is not up to the standard for quality, the workman receives his day's pay only.

This system, in connection with the other work of Mr. F. W. Taylor, greatly increased the output and reduced the cost of the work

*A Bonus System of Rewarding Labor, December, 1901, a system of task work with a bonus which had recently been introduced by the writer into the large machine shop of the Bethlehem Steel Company, as a part of the system of management, being introduced into their works by Mr. F. W. Taylor.

in the large machine shop of the Bethlehem Steel Company.

In the closing remarks on the above paper, I emphasized the value of the system as a means of training workmen, and the late Dr. Robert H. Thurston, in his discussion of it, was so optimistic as to the results it would produce on "workmen and foremen and employer alike" that I felt that my enthusiasm over a new and promising method had carried me, perhaps, a little too far. Results have fully justified Dr. Thurston's predictions, however, for today the method has been developed as a practical system of education and training for all, from the highest to the lowest. The fact, so repeatedly emphasized by Mr. Taylor, *that tasks should be set only as the result of a scientific investigation,* has proven of an educational value hardly to be over-estimated, for the scientific investigation of a process that has been developed without the assistance of science almost always reveals inconsistencies which it is possible to eliminate, thus perfecting the process, and, at the same time, reducing its cost.

It is this scientific investigation that points to improvement in methods and educates owners and managers, but the average workman is interested only in his daily wage and has no special desire to learn improved methods. The results of our investigations are of little practical value, therefore, unless we can first teach our workmen how to use them, and then can induce them to do as they are taught.

PRACTICAL APPLICATION.

For this purpose *an instructor, a task, and a bonus* have been found most useful. People as a rule prefer to work at the speed and in the manner to which they have been accustomed, but are usually willing to work at any reasonable speed and in any reasonable manner, if sufficient inducement is offered for so doing, and if they are so trained as to be able to earn the reward. In carrying out this plan we try to find men who are already skilled and able to perform the task set. It frequently happens, however, that the number of such men is insufficient and it takes time to train the unskilled to a proper degree of efficiency; but with a bonus as an incentive, and a proper instructor, a very fair proportion of the unskilled finally succeed in performing a task that was at first entirely beyond them.

Unskilled workmen, who under these conditions have become skilled in one kind of work, readily learn another, and soon begin to realize that they can, in a measure, at least, make up for their loss in not having learned a trade. As they become more skilled, they form better habits of work, lose less time and become more reliable. Their health improves, and the improvement in their general appearance is very marked. This improvement in health seems to be due to a more regular and active life, combined with a greater interest in their work; for it is a well-known fact that *work in which we are interested and which holds our attention without any effort on our part, tires us much less than that we have to force ourselves to do.* The task with a reward for its accomplishment produces this interest and holds the attention, with the invariable results of more work, better work, and better satisfied workers.

The "Task and Bonus" method of training not only furnishes the workmen with the required knowledge, but by offering an inducement to utilize that knowledge properly, trains him in proper habits of work.

HABITS OF WORK.

In all work both *quantity* and *quality* must be considered, and our task method demands a maximum quantity, all of which must be up to the standard for quality. Workmen trained under this method acquire the habit of doing a large amount of work well, and disprove the oft-repeated fallacy that good work must be done slowly. As a matter of fact, our quickest workers almost always do the best work when following instructions. We set great store by the habit of working quickly, for no matter how much skill a workman may have, he will not attain the best success without quickness.

Habits of work in a mechanic are comparable with *habits of thought* in an engineer, and our industrial schools should make proper habits of work the basis on which to build their training in manual dexterity. The engineering school does not make engineers, but tries to furnish its graduates with an equipment that will enable them to utilize readily and rapidly their own experience and that of others. In the same manner, industrial training schools should equip their graduates with habits of industry that will make them, as mechanics, capable and willing to do a large amount of good work. As I see it, one of the most valuable assets that the graduate of a technical college or an industrial school can have *is the habit of doing promptly and to the best of his ability the work set before him.* With this habit and reasonable intelligence he can make good progress. This habit is one of the first results of the "Task and Bonus" system, for it is a noticeable fact that task workers form habits of industry which they maintain even when on day's work with no bonus in sight.

In all schemes for technical or industrial education or training that I have seen, emphasis has been laid on the importance of knowing how. I wish to add that ability and willingness to do are of at least equal importance. Many skilled workmen make their skill an excuse for slow work, and unless when they are taught *how to do* they are also taught *to do efficiently,* they never attain the success that should be theirs.

Under our task system the workman is *taught how* and *trained to do* at the same time. *Knowing* and *doing* are thus closely associated in his mind, and it is our experience that the habit of doing efficiently what is laid out for him becomes so fixed that he performs without hesitation tasks at which a man not trained to follow instructions would absolutely fail. This is exactly what should be expected, and means nothing more than that in our industrial army the workman who has gained confidence in his superior follows his orders without hesitation, just as the private soldier follows the orders of his officer, even though he does not see where they lead. This is not a fanciful comparison, for I have known more than one case in which a workman expressed his doubts as to the possibility of doing a task, and on getting the reply that the task was all right, said, "If you say it can be done, I will do it." Workers who have been unable to perform their tasks in the time set have frequently asked to have an instructor stand by them with a stop-watch to time the detail operations and show them just wherein they failed, with the result that they soon learned to earn their bonus regularly.

The first essential for a workman to become successful under our task system is to *obey orders,* and having acquired this habit he soon finds out that a skilled investigator can learn more about doing a piece of work than he knows "off-hand." Having satisfied himself on this point, he goes to work at the tasks set him with the determination to earn his bonus, with the result, if he has the natural ability, that he soon becomes a rapid and skillful workman.

Learning to obey orders is often the hardest part of the workman's task, for a large percentage of men seem so constituted as to be apparently unable to do as they are told. As a rule, however, this is a feature of a certain stage of their development only, which, under proper conditions, they overcome at a later date. For instance, many very capable men who were impatient of restraint when they should have learned a trade, find themselves at the age of twenty-five, or less, in the class of unskilled workmen, although their ability would have enabled them to do well at almost any trade. It is this class of men, when they have come to realize the difference between a skilled workman and one not skilled, that furnishes us with many of our best task workers. Such men often see in our *instructor, task, bonus,* a chance to redeem some of their earlier errors, and by learning thoroughly how to do, and doing one thing after another, in the best way that can be devised, get in a short time a training that does much to make up for the previous neglect of their opportunities.

BOSSES AS SERVANTS AND TEACHERS.

In a shop operated on this system, where each workman has his task, one man whom we term a *gang boss* usually tends a group of workmen, supplying them with work and appliances and removing the work when finished. Such a man is paid a bonus for each workman who earns a bonus, and an extra bonus if all of his group earn their bonuses. The result is that so long as the workmen perform their tasks, though nominally their boss, he is really their servant, and becomes the boss only when a workman fails to perform his task. The loss of money to the gang boss in case a workman fails to earn his bonus is such that he constantly has his eye on the poor workman and helps him all he can. If, however, he finds that the workman is incapable of being taught, he uses his influence to have a better man put in his place.

In starting a shop on task work, an instructor who is capable of teaching each workman how to perform his task must be constantly on hand, and must, as a rule, teach one workman at a time. This instructor may be the man who has investigated the work and set the task, or he may simply be an instructor capable of following out the work of such an investigator, but he must be readily available as long as any of the workmen need his services, for we make it a rule not to ask a man to do anything in a certain manner and time unless we are prepared to show him how to do it as we specify.

TASK SETTING.

A task must always be set for performing a definite operation in a specific manner, a standard time being set for its accomplishment. As compensation, the workman is paid for the time set plus a percentage (usually 20 to 50) of that time, provided the work is done in the time allowed or less. If the time taken is more than the time allowed, the workman gets his day's pay only. The fact that in setting the task the manner of performing the operation is specified enables us to set another task for the same operation if we develop a better or quicker method.

If after having performed his task a workman wishes to suggest a quicker or better method for doing the same work, he is given an opportunity if possible to demonstrate his method. If the suggested method really proves to be quicker or better, it is adopted as the standard, and the workman is given a suitable reward. *No workman, however, is allowed to make suggestions until he has first done the work in the manner and time specified.*

It is the duty of the investigator to develop methods and set tasks, and unless the methods developed by him are pretty generally a great deal better than those suggested by the workmen, he is not retained in the position. Working at tasks is pretty good training for task setting, and I have gotten more than one task setter from the ranks of task doers.

Inasmuch as, after a satisfactory method has been established, a large proportion of the work of the task setter is the study of the time in which operations can be performed, he is popularly known as the "Time Study" man. This term has led to a misconception of his duties and has caused many honest people to claim that they were putting in our methods when they have put a stop watch in the hands of a bright clerk and told him to find out how quickly the best men were doing certain work. Unquestionably they have in many cases been able to set more accurate piece rates by this method than they had been able to set by the older methods, but they are still far from our ideal, in which the best expert available investigates the work, standardizes the appliances and methods, and sets a task that involves utilizing them to their very best efficiency. While the stop watch is often used to establish a method, it is used to determine the time needed to do the work only when the standard methods and appliances are used efficiently. Stop-watch observations on work done inefficiently, or with ill-adapted appliances, or by poor methods, are absurd and serve only to bring into disrepute all work in which the stop watch is used. Moreover, such use of the stop watch justly excites the contempt and opposition of the workman.

To make real and permanent progress, the expert must be able to standardize appliances and methods and write up such instructions as will enable an intelligent workman to follow them. Such standards become permanent, and if the workman is paid a proper bonus for doing the work in the manner and time set, he not only helps maintain the standards, but soon begins to exert his influence to help the progress of standardization.

STANDARDIZATION.

All work, and all knowledge, for that matter, may be divided into two classes: *Expert* and *Standard.* Expert knowledge may be described as that which has not been reduced to writing in such a manner as to be generally available, or exists only in the minds of a few. By analogy, expert work is work the methods of doing which either are known only to a few or have not been so clearly described as to enable a man familiar with that class of work to understand them. On the other hand, standard methods are those that are generally used, or have been so clearly described and proved that a man familiar with that class of work can understand them and safely employ them.

The largest problem of our expert is to standardize expert methods and knowledge. When a method has been standardized, a task may be set, and by means of *an instructor and a bonus* a method of maintaining that standard permanently may be established. With increasing efficiency on the part of the workman the standard always has a tendency to become higher. We have here the workman and the foreman using their efforts to maintain standards, for both fail to obtain a bonus if the standard is not maintained. This is so different from the case in which the standard is maintained only by the man in authority with a club, that there can be no comparison. From workmen trained under these methods, we get a good supply of instructors and foremen, and occasionally an investigator. From our investigators, who standardize our methods and appliances, we get our superintendents, and our system of management thus becomes self-perpetuating. The superintendent who believes that the sovereign cure for all troubles is to go into the shop and raise a row, has no place under our methods; for when the task and bonus has been established, errors are far more frequent in the office than in the shop, and the man who is given to bluffing soon finds that his methods produce no effect on men who are following written instructions.

OBSTACLES.

Among the obstacles to the introduction of this system is the fact that it forces everybody to do his duty. Many a man in authority wants a system that will force everybody else to do his duty, but will allow him to do as he pleases. The "Task and Bonus" system when carried out properly is no respecter of persons, and the man who wishes to force the workman to do his task properly must see that the task is properly set and that proper means are available for doing it. It is not only the workman's privilege, but his duty, to report whatever interferes with his earning his bonus, and the loss of bonus soon educates him to perform this duty no matter how disagreeable it is at first. We investigate every loss of bonus, and place the blame where it belongs. Sometimes we find it belongs pretty high up, for the man who has neglected his duty under one system of management is pretty apt to neglect it at first under another. He must either learn to perform his duty or yield his place, for the pressure from those who lose by his neglect or incompetence is continuous and insistent. This becomes evident as soon as the task and bonus gets fairly started and the effect is that opposition to its extension develops on the part of all who are not sure of making good under it, or whose expert knowledge is such that they fear it will all soon be standardized. The opposition of such people, however, is bound to give way sooner or later, for the really capable man and the true expert welcome these methods as soon as they understand them.

HELPS.

The fact that the task and the bonus enable us to utilize our knowledge and maintain our standards, and that the setting of tasks after a scientific investigation must necessarily not only increase our knowledge but standardize it, brings to our assistance the clearest thinkers and hardest workers in any organization. Our greatest help, however, comes from the workmen themselves. The most intelligent soon realize that we really mean to help them advance themselves, and the ambitious ones welcome the aid of our instructor to remove obstacles that have been in their way for perhaps years. As soon as one such man has earned his bonus for several days, there is usually another man ready to try the task, and unless there is a great lack of confidence on the part of the men in the management, the sentiment rapidly grows in favor of our task work.

DAY WORK AND PIECE WORK.

As used by me, the "Task and Bonus" system of pay is really a combination of the best features of both day and piece work. The workman is assured his day rate while being taught to perform his task, and as the bonus for its accomplishment is a percentage of the time allowed, the compensation when the task has been performed is a fixed quantity, and is thus really the equivalent of a piece rate. Our method of payment then is piece work for the skilled, and day work for the unskilled, it being remembered that if there is only work enough for a few, it will always be given to the skilled. This acts as a powerful stimulus to the unskilled, and all who have any ambition try to get into the bonus class. This cannot be too clearly borne in mind, *for we have here all the advantages of day work combined with those of piece work without the disadvantage of either,* for the day worker who has no ambition to become a bonus worker usually of his own accord seeks work elsewhere, and our working force soon becomes composed of bonus workers, and day workers who are trying to become bonus workers.

CO-OPERATION.

When 25 per cent. of the workers in a plant are bonus workers, they, with those who are striving to get into their class, control the sentiment, and a strong spirit of co-operation develops. This spirit of co-operation in living up to the standards set by the experts, which is the only way a bonus can be earned, benefits the employer by the production of

More work.
Better work.
Cheaper work.

It benefits the workmen by giving them

Better wages.
Increased skill.
Better habits of work.
More pleasure and pride in their work.

Not the least important of these results is the fact that the workmen take more pride in their work, for this of itself insures good work. As an instance of this pride, I have known girls working under the task system to form a society, admission to which was confined to those that could earn bonus on their work; the workers themselves thus putting a premium on industry and efficiency.

The fact that we get better work, as well as quicker work, seems inconceivable to some. The reasons are:

1.—Careful inspection, for no bonus is paid unless the work is up to the standard.

2.—Work done by a prescribed method, and always in the same way.

3.—Attention needed to do high-speed work, which keeps the mind of the worker on what he is doing and soon results in exceptional skill.

The development of skilled workmen by this method is sure and rapid, and wherever the method has been properly established, *the problem of securing satisfactory help has been solved.* During the past few years while there has been so much talk about the "growing inefficiency of labor," I have repeatedly proved the value of this method in increasing its efficiency, and the fact that the system works automatically, when once thoroughly established, *puts the possibility of training their own workmen within the reach of all manufacturers.*

TRAINING HELP A FUNCTION OF MANAGEMENT.

Any system of management that did not make provision for obtaining proper materials to work with would be thought very lax. The day is not far distant when any management that does not make provision for training the workmen it needs, will not be regarded as much better, for it is by this means only that a system of management can be made permanent. To be satisfied to draw skilled workmen from the surplus of other plants means, as a rule, that second-rate men only are wanted, and indicates a lack of appreciation of the value of well-trained, capable men. The fact that few plants only have established methods of training workmen does not necessarily mean that the managers are satisfied with that condition, but rather that they know of no training system that can be satisfactorily operated in their plants, and as questions are sure to be asked about the method of introducing this system, a few words on that subject may not be amiss, it being borne in mind that *the changing of a system of management is a very serious matter, and cannot be done by a busy superintendent in his spare time.*

METHOD OF INTRODUCTION.

In order to set tasks, we must know beforehand what work is to be done, and who is to do it. In order to pay a bonus, we must know after the work is done whether it was done exactly as specified. Hence our first care in starting to introduce this method is to provide means for assigning tasks to the workmen, and means for obtaining such a complete set of returns as will show just what each man has done. When this much has been introduced, the output of a plant is always increased and the cost of manufacture reduced.

The next step is to separate such of the work as is standard, or can be readily made standard, from the more miscellaneous work, and to set tasks for the standard work. Then we begin to standardize, and as fast as possible reduce the expert and increase the routine work. The effort to classify and standardize expert knowledge is most helpful to the experts themselves, and in a short time they begin to realize that they can use their knowledge far more efficiently than they ever dreamed.

As soon as work has been standardized, it can be intelligently planned and scheduled, each workman being given his specific task, for which he is paid a bonus when it is done in the manner and time specified. As bonus is paid only on the written statement of the inspector that the whole task has been properly done, failure to earn a bonus indicates that our plans have not been carried out.

An investigation of every case of lost bonus keeps the management closely in touch with the progress of the work, and as the workmen are ever ready to help disclose and remove the obstacles that prevent their earning their bonus, the managing problem is greatly simplified; for, as one of my co-workers has very aptly put it, "*the frictional lag due to the inertia of the workman is changed by the bonus into an acceleration.*"

With increase in the number of bonus workers, this force of acceleration increases, and not only does the careless worker, who by his bad work prevents some other from earning his bonus, fall into disfavor, but the foreman or superintendent who is lax in his duty finds his short-comings constantly brought before him by the man whose duty it is to investigate all cases of lost bonus.

MORAL TRAINING.

The fact that under this system, everybody, high and low, is forced by his co-workers to do his duty (for some one else always suffers when he fails) acts as a strong moral tonic to the community, and many whose ideas of truth and honesty are vague find habits of truth and honesty forced upon them. This is the case with those in high authority, as well as those in humble positions, and the man highest in authority finds that he also must conform to laws, if he wishes the proper co-operation of those under him.

FIXING HABITS OF INDUSTRY

CHAPTER IX

FIXING HABITS OF INDUSTRY

I HAVE done much to train and educate workmen, and consequently have seen the far-reaching results that would follow if manufacturers in general would adopt a policy of educating and training the workmen they need. The preceding chapter on "Training Workmen in Habits of Industry and Co-operation" defines the general advantages of such a policy. In this chapter I shall give specific examples of what has been done.

In 1905 I was engaged by a cotton mill to take up the question of making their labor more efficient, but as they were very conservative people we proceeded slowly. The superintendent and foremen were most of them English or Scotch, who were satisfied that the way they had done things in the old country was all right, and they objected to any change. The work proceeded very slowly indeed, but we gradually succeeded in getting our time and record system established and then a reliable cost system soon followed. We were, however, unable to do anything for a long time that had any great effect on the work itself, and after we had succeeded in getting the cost system in operation I told the treasurer that we had done about all that was possible under the conditions existing. The little that had been done, however, was so beneficial that in April, 1908, the treasurer asked me to come and finish up the job, saying that he now had a new superintendent who was in sympathy with the work, and that the worst foremen were gone.

During the year or more within which I had not visited the mill, attempts had been made to extend the work already started, but, from lack of experience on the part of those engaged in it, practically no progress had been made.

When I took it up again my instructions were carried out conscientiously, and men detailed for the work were kept on it continuously.

Twelve new looms had recently been installed in the weave room, and as soon as a competent man could be got we began to study how to run these looms most efficiently.

A pick counter was put on each loom, and the best weaver in the room (a Pole named Samtak) was given four of them to run.

A trained observer with a stop-watch stood by the weaver and studied all his motions in detail. He learned how this skilful weaver stopped and started his loom, how he removed the empty bobbin from the shuttle and put a new one in, how he tied the knot. From these observations he found out how much time it was necessary for the loom to be stopped in a day, and consequently what proportion of the time it should be actually weaving. No time was allowed for "loom out of order," or "no filling," or any other cause that might be eliminated. Steps were taken to be sure that the loom was in good order and that proper filling should always be on hand, and a task was set on the supposition that all removable obstacles would be removed. This task was fixed as the number of picks the loom should throw provided these unnecessary delays were eliminated, and a substantial bonus was offered for its accomplishment. It was expressed as a percentage of the total number of picks the loom would throw if it ran constantly all day without any stop. It is interesting to note that the task was greater than the best weaver had been able to accomplish regularly before we had made special provision to remove the obstacles. Having decided upon the task, three of the next best weavers in the room were chosen to do it and Samtak was the instructor to teach them how.

The three men chosen are those whose names are at the top of Chart II (facing page 182). They were all Greeks, speaking almost no English. The instructor, Samtak, is a Pole, whose English is not very good, and who could make himself intelligible to the Greeks only by signs. The first man, Papadimitri,* declined to work under instructions and on task work. He was not discharged but allowed to work his own way until he should see where his interest lay. We therefore had Samtak give all of his attention to the other two, our observer, who had studied Samtak's work, being constantly on hand keeping a record of the number of picks each loom threw per hour, and removing the obstacles to the men's performing the task. Both men failed to earn a bonus on the first day—this is shown by the red mark—but on the next two days they came so near it that

* Papadimitri is now (April, 1913) conducting a training school for weavers in the same mill.

it was allowed them, and they got a black mark.

Our observer, however, satisfied himself that failure to perform the task was due to the fact that the warps and filling were not coming in a satisfactory manner, and that some of the looms were not just right. He accordingly ceased for a time to urge the men to perform the task, and devoted his attention to getting things in such a condition that these obstacles would be removed. The black cross shows that the men were on day work and were making no special effort to perform a task. At the end of eleven days our observer felt that conditions were all right and he started the men again. Papadimitri by this time had concluded that we were going to "play fair" and wanted to start too. The black lines on the chart show how soon all began to make their bonus pretty regularly.

It was necessary, however, for our observer to be constantly on hand and to keep a record of their work hour by hour, for he would frequently find some loom falling behind, which, if not looked after, would cause the weaver to lose his bonus. Whenever he found a loom not doing all it should he called

Samtak's attention to it, with the result that the cause was soon discovered and removed; but Samtak seldom at first noticed a lagging loom. Again, Samtak was at first very slow at making any complaint if anything was wrong, but the example of our instructor and the incentive of a bonus of 6 cents for each weaver who made his bonus, and 10 cents each if *all* made bonus, gradually taught him to look out for their interests and his own. It took the entire time of our observer for several weeks to get the conditions such that no obstacle would arise which Samtak could not remove. It must be remembered that while Samtak was a good weaver, he was not a teacher. He had in the past been trained not to object when things went wrong, but to do the best he could without complaining. Even with the example of the instructor and the incentive of a bonus, it was some time before he realized that we really intended that he should assert himself.

We began to study the looms about the first of June, and started the first task workers early in July, but it was nearly the middle of August before we were ready to start others on task work. By this time other weavers were willing to try, but it required the attention of both Samtak and our observer to get these men going right. It took the first two of these men about three weeks to become skilful enough to do the task, but the third, fourth and fifth did it from the start. During September and October several more gradually became proficient.

By this time we had gotten all of the best weavers on task work, and henceforth we had to train the poorer ones, which partially accounts for the sudden increase of red marks. Another cause for this increase was the fact that several trained weavers left. They had not yet become convinced that we were going to treat them fairly, and left for some insignificant cause. The dropping out of these men shows the importance of time in doing this work. Until the workmen become thoroughly satisfied through their own experience that the job they have is the best one they can get, they may be stampeded by a very slight cause.

Our gang had now become too large for Samtak, whose allotment was twelve weavers; and we started another gang, placing in charge of it the weaver Shea, whose name indicates his nationality. He was the only bonus weaver who could speak English.

While there are some exceptions the chart has a tendency to become blacker slowly as time progresses.

Chart III* shows the record of Samtak's gang from March 1 to October 9, 1909. This chart distinctly blackens as time progresses. This means more than that the men have acquired the skill to do the work. They have acquired the habit of working steadily and keeping their attention on their work. The red crosses signifying absence are notably lessened. These men have not only improved in skill, but in habits of industry; and the gang boss Samtak is not their driver, but their helper and friend. The blackening of the chart signifies not only that more work is done, but that it is done better, for *black* means that both quantity and quality are up to the standard. There is one man in the group whose history is worth studying, namely the weaver Samtak, brother of the gang boss. Note that he began on this work on September 21, 1908. He was a good weaver who had been working in the mill off and on for several years. His temper is such that he was liable to leave on the slightest pretext, but in a few weeks or months he

* Chart III is placed below Chart II, on the same sheet, facing this page.

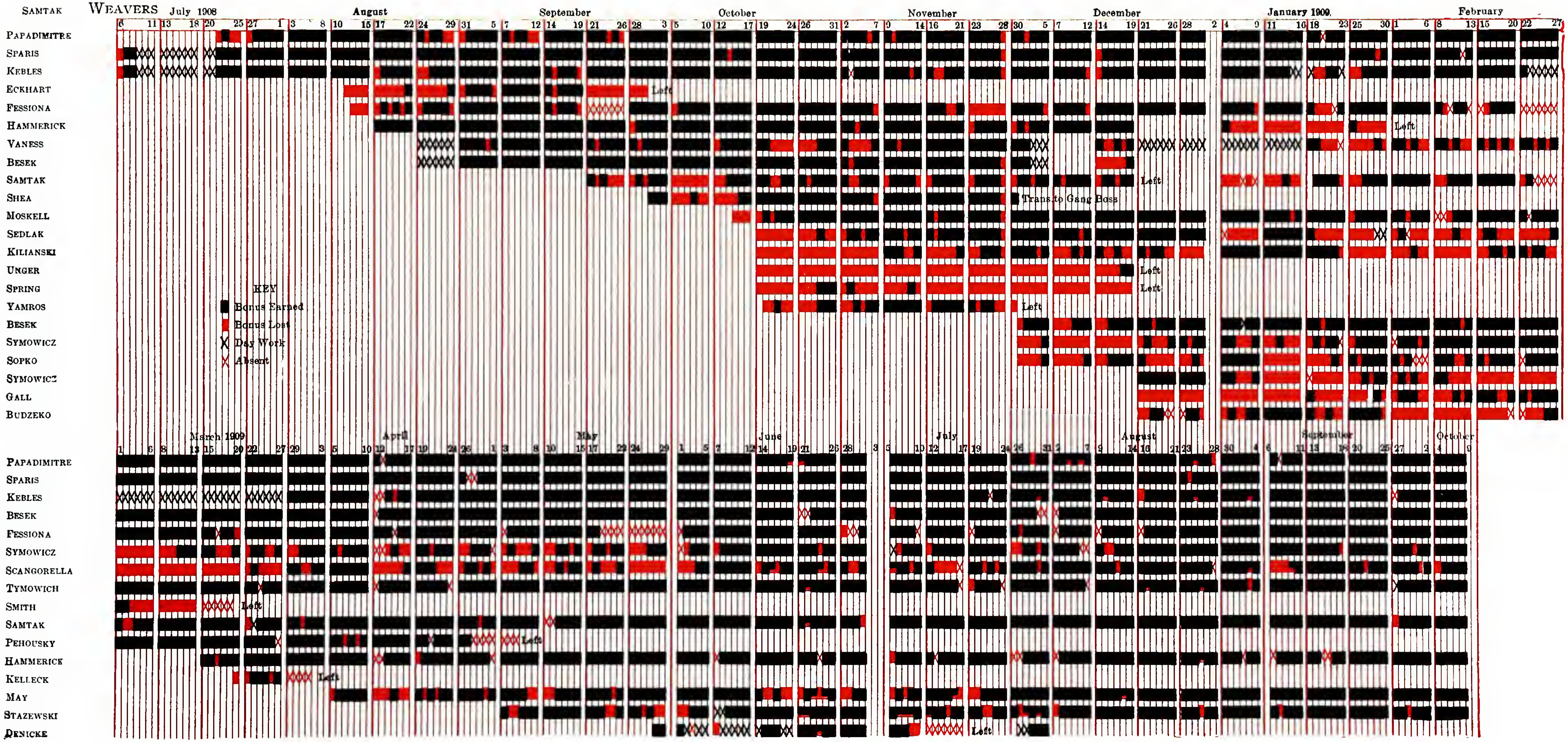


CHART II. TASK AND BONUS SYSTEM IN A WEAVE ROOM. NOTE THE INCREASE OF BLACK (MEANING TASK ACHIEVED AND BONUS EARNED) AS TIME PROGRESSES.
CHART III. THE RECORD OF THE SAME ROOM CONTINUED THROUGH THE FOLLOWING EIGHT MONTHS. THE HABIT OF INDUSTRY HAS BECOME FIXED.

would come back for a job, probably having left his new job for some similar slight cause.

He would not do task work at first, although offered a chance, but took hold when he found others profiting from it. The old habit, however, of quitting on a slight pretext was still on him, and he left before Christmas. By the first of the year he was back, but he had lost his ability to make his bonus, and he spent nearly two weeks before he earned it a single time. Note also that he was absent three days in the first two weeks. Was he again looking for another job? His actions during this time indicate an unsettled frame of mind. Again in the latter part of February the *wanderlust* came over him. Early in May he again had a slight attack, possibly of "spring fever." Since that time he seems to be entirely cured of his roving tendencies.

We knew this man and understood his moods, and we know what kind of a change has taken place. Have not many others been influenced in the same manner?

In considering this work an important element to be noted is the time needed. When we began our study in June, 1908, we already had in operation means for learning how long each worker spent on every job and how much work was done. There was also in existence a system of laying out the work from the office. In other words, the general mechanism of our system was in operation and working smoothly, yet it was several months before we got enough task work going to make any real show. If we had attempted to introduce it much faster we should have met with two difficulties. First, it would have been impossible for us to remove all the obstacles for a large number of weavers. Second, the poor weavers would probably have persuaded the good ones not to try to do as we wished. The best evidence of this is that Papadimitri, one of the very best weavers, declined to do the work at first.

Time is needed to overcome prejudice and to change habits. This is a psychological law, and its violation produces failure, just as surely as the violation of the laws of physics or chemistry.

Chart IV * represents our progress in training workers to do their task in winding weaving bobbins—bobbins of filling that go into the shuttles. Each operative tends a number of spindles, and the work consists

* Chart IV is inserted between pages 186 and 187.

first of taking out full bobbins and putting empty ones in place; second, removing empty spools from which the yarn has been taken, and replacing them with full spools. Inasmuch as the machine runs at a constant speed, the bobbins fill and the spools empty more rapidly with coarse yarn than with fine; hence it was necessary to make a careful detail study of the subject to set a proper task for different sizes of yarn. This study took about six weeks, and, having settled upon proper tasks, we started a girl named Wagner on task work early in February. She would not do it at first but stayed home for a week. At the end of that time she came to work willing to do as we wished, and was evidently surprised at the ease with which she succeeded. On March 1 we began to keep the charts. At that time those doing the task as shown by the chart represented but a small proportion of the whole number of workers. Our gang boss, McCabe, received 5 cents for each worker that made a bonus and 10 cents each if all made it. Our observer was constantly on hand, at first to help him remove obstacles, and to see that the workers had every opportunity to work efficiently. In spite of this a large proportion of the first ones failed to earn the bonus regularly and gradually left. Many of these were girls who evidently found continuous attention to their work irksome, and, even though they were capable of doing the work, preferred the more free and easy method to which they had been accustomed. Others showed but little ability to do the work or to learn. The fact, however, which is evident from the chart —that the larger the number of bonus workers in the mill, the faster the new ones learned—is a matter of great psychological importance. *There is in every workroom a fashion, a habit of work, and the new worker follows that fashion, for it isn't respectable not to.* The man or woman who ignores fashion does not get much pleasure from associating with those that follow it, and the new member consequently tries to fall in with the sentiment of the community. Our chart shows that the stronger the sentiment in favor of industry is, the harder the new member tries and the sooner he succeeds. We must therefore make our compensation such as to encourage the habit, or fashion, of industry; and our charts show to what extent we have succeeded in fixing this habit.

It is interesting to note that although fail-

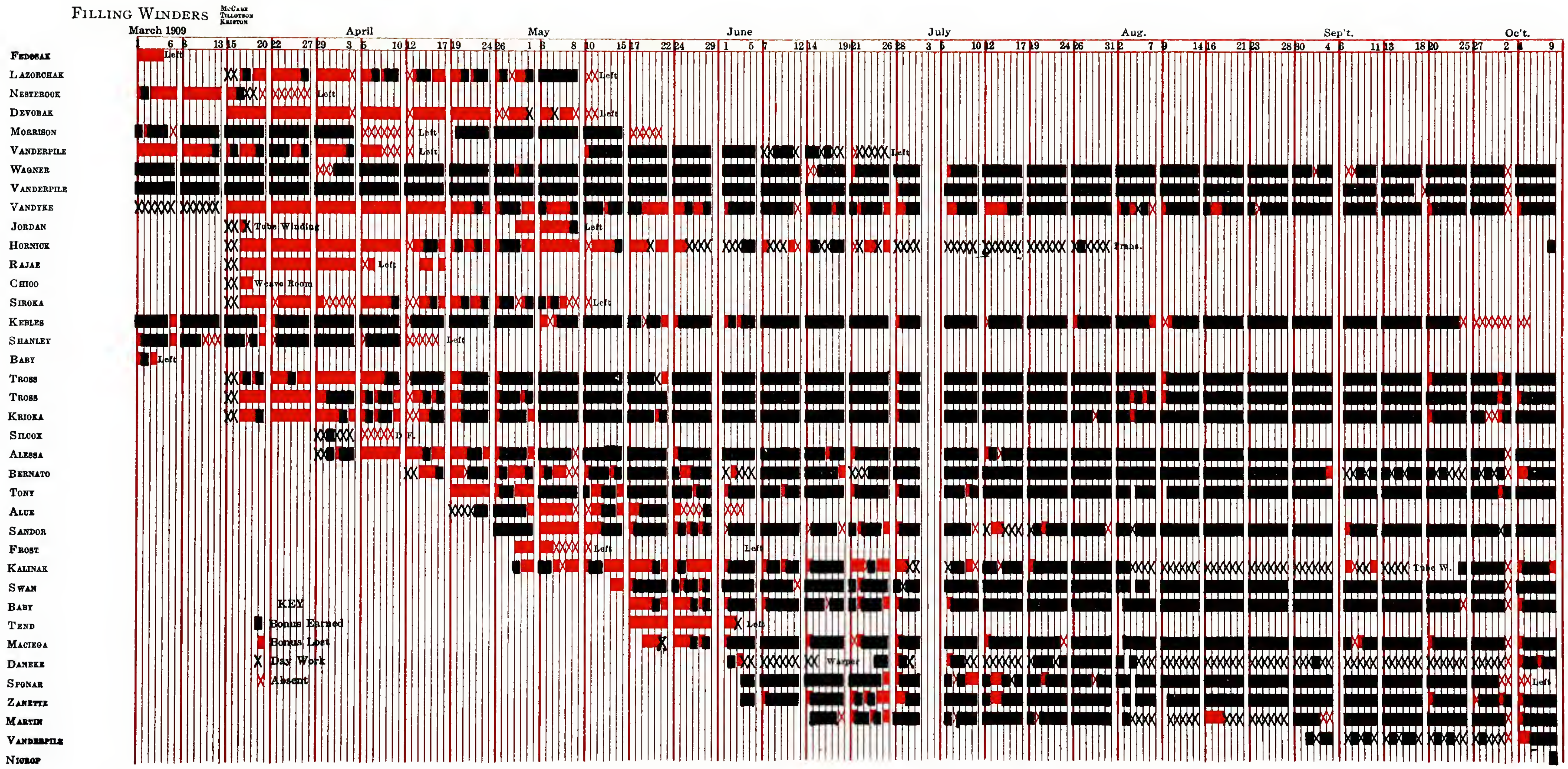


CHART IV. TASK AND BONUS RECORD OF WORKERS WINDING WEAVING BOBBINS. NOTE DISAPPEARANCE OF THE HABIT OF SLACK WORK ON MONDAYS.

ures most frequently occurred on Monday, even this habit could be cured.

The mill shut down for about three days about July 4 to take stock, and, as we had just gotten this room in good shape, that little vacation may be used as a dividing line on this chart. Remembering that solid black indicates that the full amount of work has been done, and that all of it was up to standard for quality, while solid red represents that the work was below standard either for quantity or quality, and sometimes for both; also that the black cross means the worker was doing day work, while the red cross means that the worker was absent, the amount of black on any day is a measure of efficiency for that day and the red is a very accurate measure of the amount of supervision needed, for all cases of failure to perform the task must be investigated, and all cases of absenteeism should be inquired into. The gradual change of the chart from red to black means not only that the workers are becoming more skilful and regular in their habits, but that the machinery is being kept in better order, for the task is so set that unless the machines are in good condition the bonus cannot be earned.

After July 4, not only was the amount of supervision needed diminished and a regular output maintained, but the workmen were much more regular in attendance. The indications of the chart are that the output of the room after July 4 was larger, better and more uniform. It is now easy to predict the daily output and to make promises of delivery that will be kept without special effort on the part of the foreman. Before July 4 such predictions were only estimates, and a proper output was kept up only by constant supervision. As the gang boss in this room gets a bonus of 5 cents for each worker who earns a bonus, and 10 cents each if all earn bonus, it is easy to see that the superintendent does not have to worry much either about the quantity or quality of the product. It is easy to measure the quantity, and the quality is taken care of more easily still, for the weaver who gets poor bobbins refuses to use them.

By permission of the treasurer of this mill I am enabled to show Chart V representing the conditions in this room in 1912, three years later. The preponderance and continuity on this chart of black spaces showing task performed is very marked.

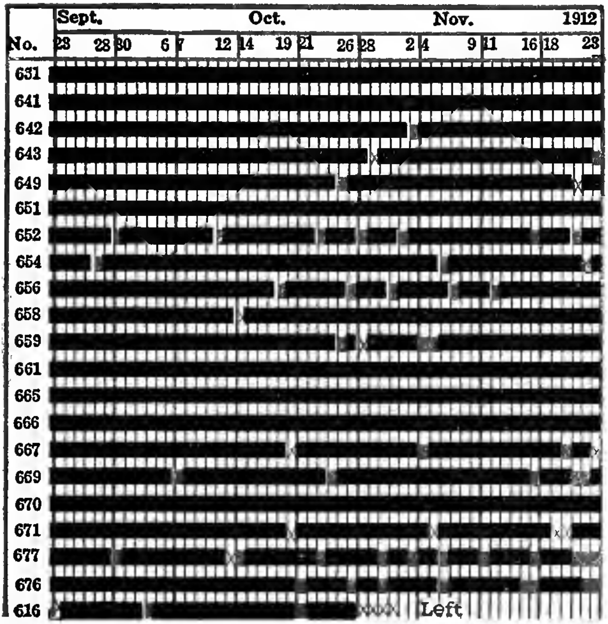


CHART V. BONUS RECORD, THREE YEARS LATER, OF FILLING WINDERS' DEPARTMENT SHOWN IN CHART IV

Chart VI* (facing page 190) represents girls winding yarn on spools. Note that it was the fashion among these not to try for the bonus on Saturday. Most of them could earn it every day if they chose, but there was evidently a feeling against working hard on Saturday.

* Charts VI and VII, on one sheet, are inserted between pages 190 and 191.

Note that on March 6 two girls tried to break this precedent, but it was too strong, and on March 13 all failed. On March 20 another tried. On March 27 one of the first two tried again, but after that all gave it up for three weeks. Then our first two evidently decided that they would defy public opinion, which they did pretty successfully until June 6, when apparently by common consent all "took it easy." After that, however, all gradually fell into line and the Saturday inefficiency disappeared as did the Monday inefficiency on Chart IV.

Chart VII * represents girls inspecting cloth and mending slight defects in weaving, trimming ends, etc. This is high-grade work and all defects must be eliminated. We started the task after careful study, and while most of the girls showed the ability to perform the task only two did it with any degree of regularity. On April 7 three left because they were unwilling to maintain the high standard of quality that had been set. The chart shows the difficulty of getting new ones to do the work. Fortunately the three dissatisfied ones came back for their jobs in a few days, and soon became better than ever.

* Facing this page, on lower half of sheet.

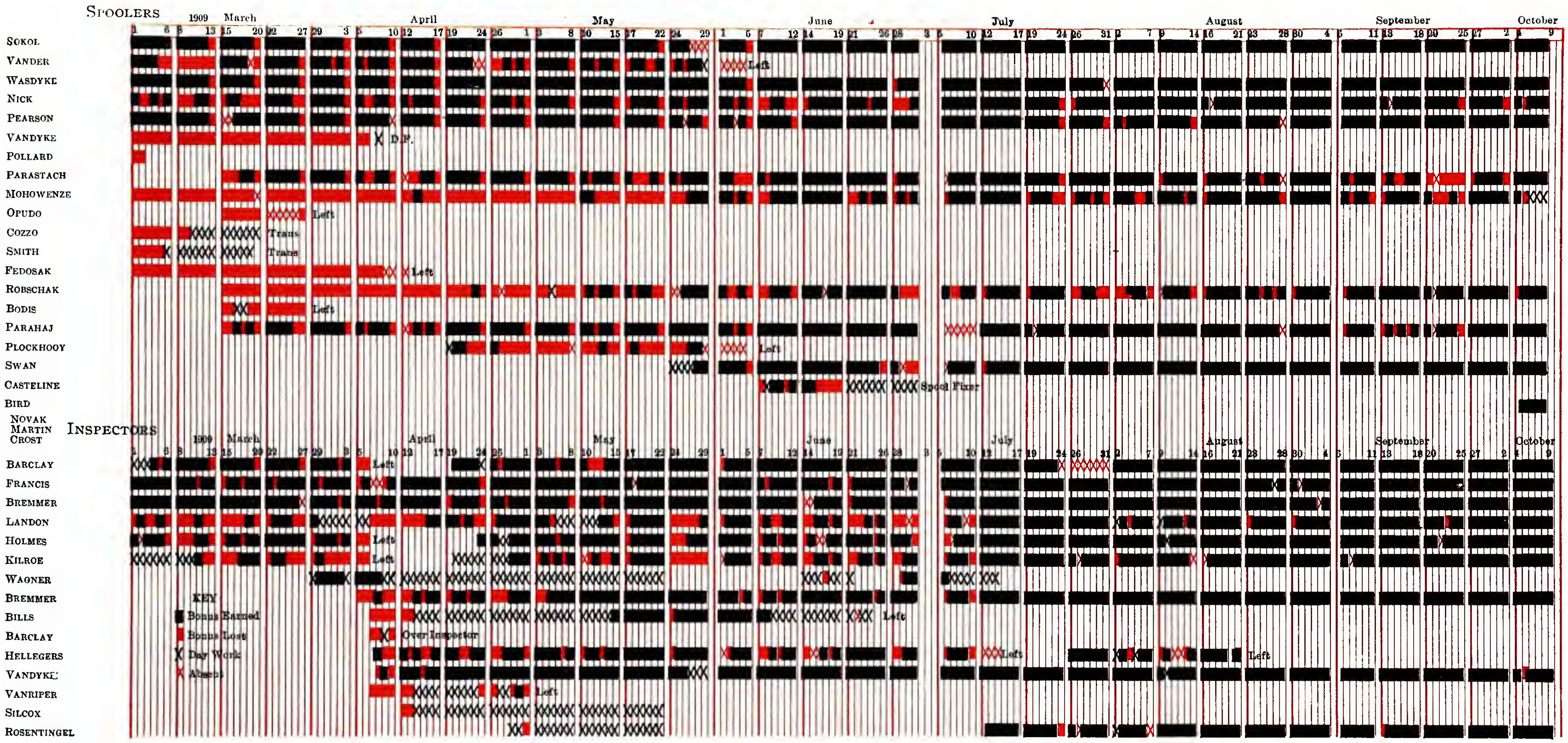


CHART VI. TASK AND BONUS RECORD OF GIRLS WINDING YARN ON SPOOLS. NOTE DISAPPEARANCE OF SLACK-SATURDAY HABIT.

CHART VII. TASK AND BONUS RECORD OF CLOTH INSPECTORS AND MENDERS. NOTE IMPROVEMENT FOLLOWING ESTABLISHMENT OF BONUS TO HEAD WEAVERS EARLY IN JULY.

These inspectors were supplied with work and had the heavy cloth handled for them by the three men whose names are at the top of the chart. Each of these men received 2 cents for each girl that made a bonus. Early in July it was decided to give the boss weaver, who has not yet been mentioned, a bonus. He is an excellent man and was undoubtedly doing his work well, but we felt that his bonus should depend upon the quality of the work turned out. Inasmuch as the better the cloth was when it came from the weaving room, the easier the task of the inspectors would be, we decided to make his bonus in proportion to the number of inspectors that earned theirs. The inspectors at once began to earn bonus with great regularity, for the boss weaver found that the inspectors were only too anxious to point out defects which it was to his interest to have corrected. He visits the inspecting room frequently during each day, and by the reports he gets keeps closely in touch with what his weavers are doing. The result is a continuous improvement in the quality of their work.

The charts so far shown all refer to the same mill. It is interesting to know that in 1912 the Industrial Workers of the World made an attempt to cause a strike in all of the mills in the town where this mill is situated, and actually succeeded in shutting down some of these mills for several weeks. In

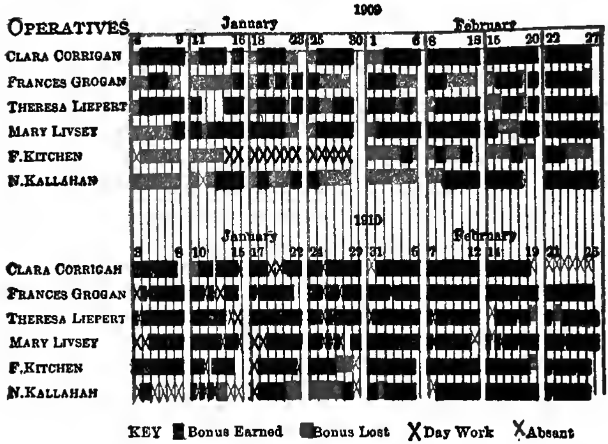


CHART VIII. BONUS RECORD OF GIRLS WORKING IN A FOLDING ROOM

The upper half shows eight weeks in 1909; the lower half, the corresponding eight weeks in 1910. Remembering that red means bonus lost and black bonus earned, the improvement in twelve months becomes strikingly apparent.

this mill, on which they made a very strong attack, they succeeded in drawing out only sixty out of six hundred employes, and the management had no difficulty whatever in filling all their places in a few days.

Chart VIII represents girls working in the folding room of a bleachery—not one of those previously referred to—and is interesting from the fact that they belong to an entirely different class of people from those in the cotton mill (as can be seen by their names), and also from the fact that some of these girls have often as many as ten or fifteen different kinds of work per day. In starting this group, which is much larger than the number shown here, we had exactly the same experience as with the weavers and the winders; one of the girls declined to do as we wished at first, and afterwards became one of our best workers. These three cases illustrate the fact that a worker may hesitate, or even refuse to do work by a new method, and still become ultimately a good and loyal worker under the new methods. The action of a workman when brought up against a new method is largely influenced by his temperament, or the opinions of his friends. When, however, this method has been established, all the evidence available goes to show that these results are not only permanent, but that the workers become more proficient and the product better. This chart shows the improvement after a year's training. We began the task and bonus in November, 1908. The upper section of the chart shows how the girls worked about the time the system got well started. The lower section is a record of the same girls a year later.

Directing attention once more to Chart VIII, it will be noted that the date is 1909. The work was begun some time in the fall of 1908. In January, 1912, the conditions were as follows:—

Three of these girls were still working on the same job, on bonus. One of the three had left for a few weeks in the meantime, but came back again. One girl had been promoted to a better job. One girl had been transferred to other work and had subsequently left. The sixth girl was working in January, 1912, but left before the end of the month.

Charts IX and X represent girls at work in a worsted mill. The best workers were put on bonus work first. Note their improvement. It was nearly three months before we got all on this work. Note how the poorer ones failed at first, also how on the last day shown on the chart all of the poorer workers earned bonus. During the period from April 15 to July 10, 161 girls had been put on bonus work, and 21 out of this number had for one reason or other left

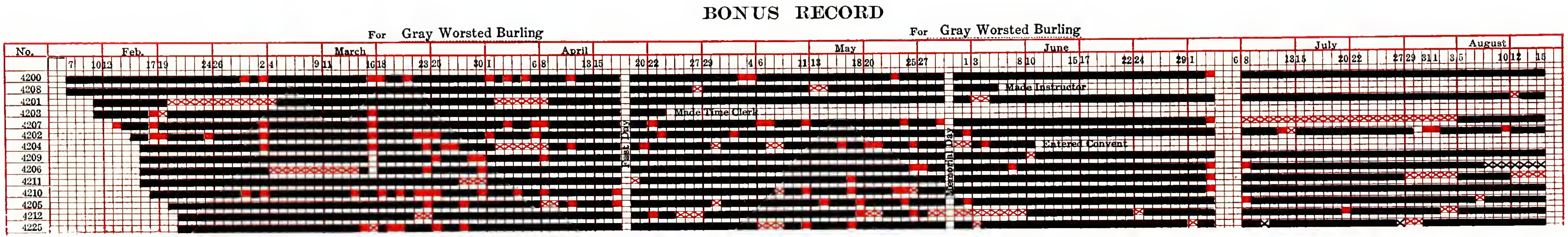


CHART IX. BONUS RECORD OF GIRLS PUT ON TASK WORK FIRST. THESE WERE THE BEST WORKERS. NOTE IMMEDIATE ACCOMPLISHMENT OF TASK.

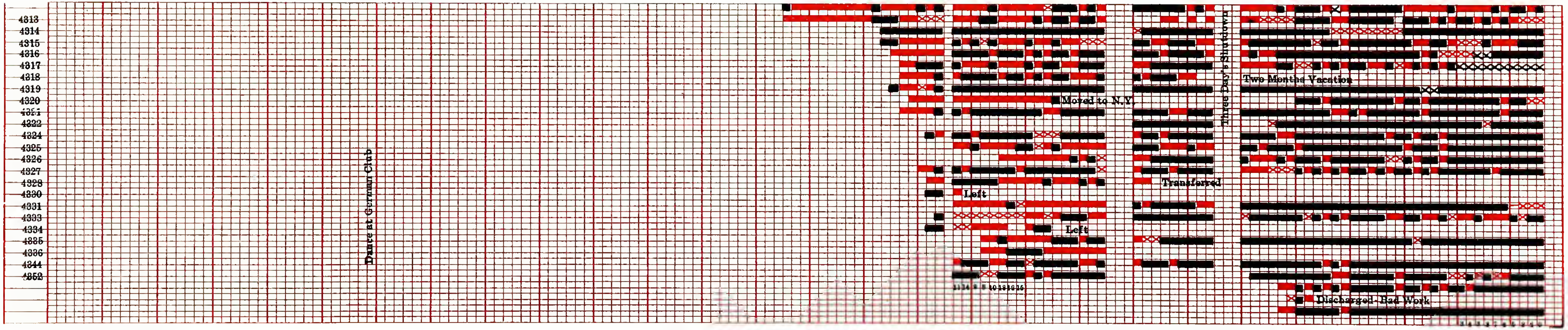


CHART X. GIRLS PUT ON TASK WORK LAST. THESE WERE THE POOREST WORKERS. NOTE FAILURE AND IRREGULARITY IN PERFORMING TASK AT FIRST. BUT NOTE ALSO THAT ALL EARNED BONUS FOR TASK ACCOMPLISHED ON THE LAST DAY SHOWN ON THE CHART.

Charts IX and X refer to the same room, same work, same conditions, the difference being only in the quality of the workers at the beginning of the task and bonus methods. The total number of girls was 161.

the employ of the company. The reasons were as follows:—

4 girls—left; poor health or dissatisfied
1 girl—married
1 girl—entered convent
1 girl—work at mountains for summer
5 girls—left town; gone home to Canada, Michigan and New York
9 girls—discharged

—
21

One of the obstacles, which by the way we nearly always encounter, was prominent in this case. Certain people in authority having once expressed themselves as not approving of our methods, felt it their duty to oppose their introduction to as great an extent as possible, and to use all possible arguments against the work. Their original arguments failed. The argument that we were overworking the girls was then advanced, and they insisted on being allowed to put on piece work some of this work which was in another building, and which had not yet been put on the task and bonus system. Accordingly, on June 19 their piece work was

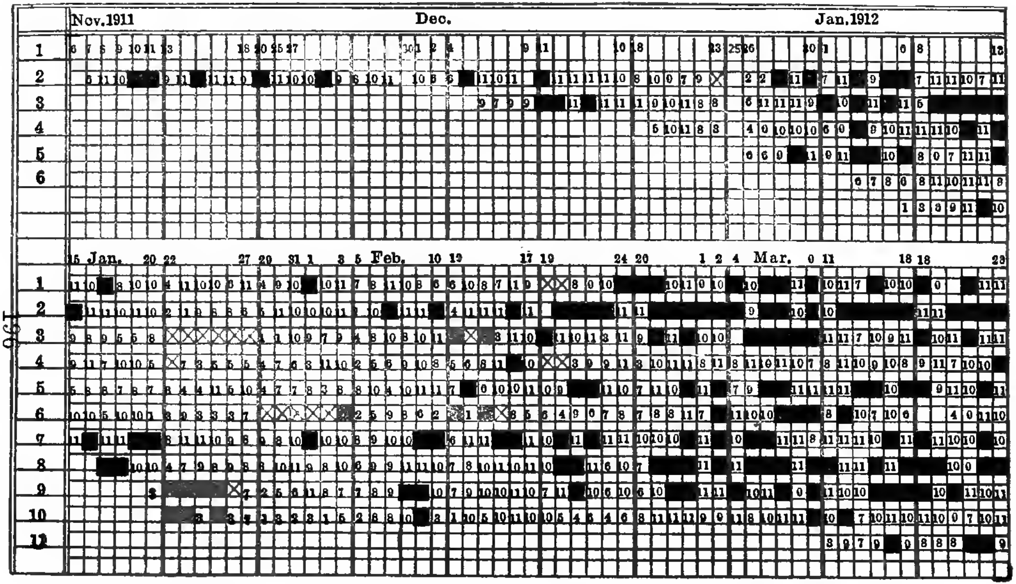


CHART XI. BONUS RECORD OF WEAVERS RUNNING TWELVE LOOMS EACH

Numerals show number of looms performing task each day. Black indicates that all looms performed task; red indicates that none succeeded in performing task.

started. On July 11, the date of this report, nineteen out of a total of fifty-three girls in this building had left. In other words, almost one-third of the girls who were put on piece work, according to the request of the man "who had their interests most at heart," left in three weeks! In the case of our bonus workers, approximately one-eighth of the girls left in fifteen weeks.

Which system was most considerate of the workers may well be left to the reader's judgment.

Chart XI represents weavers in a cotton mill. Each weaver is running twelve looms, and gets a bonus for each loom which does all the work it should do on any given day, and an additional bonus if all his looms do the full allotted amount. The number in the space represents the number of looms on which the bonus is earned. Red is used to call attention to the smaller numbers. The black spot indicates that all the looms earned bonus.

On this job bonus work was started really before we were ready for it, but inasmuch as the management was very anxious to get some bonus work under way we felt it necessary to do what was possible to conform to their wishes, knowing, however, that the work would necessarily go very slowly.

It will be noted that several weeks elapsed after putting the first weaver on bonus before any others were put on. This delay was necessitated by the fact that the failure of the man to make bonus was not always his fault, but was due to conditions over which he had no control, and it took some time to eliminate these conditions as far as he was concerned.

Somewhat more rapid progress was made later in putting other workers on bonus, and for a while things went very well. The chart shows, however, that we soon attempted to go too fast, for not only did those weavers who had previously been making bonus on all looms fail to accomplish this result, but some of the weavers (newer ones) failed to make bonus on any. These facts emphasize the importance of going slowly and bending all our efforts to getting conditions right before we make any attempt to increase the number of people on bonus. When it is realized that each of these weavers was handling twelve looms, it will be seen that we already had quite a proposition on our hands. Inasmuch, however, as the weavers were getting a fair day's pay, they showed patience and gave us all the assistance they could in our attempt to make things go right, with the result that in a few weeks things were on a satisfactory basis again.

This work was being done during the Lawrence strike, and the Industrial Workers of the World had their agents around doing what they could to stir up dissatisfaction among the employees, using, of course, any influence they could against this work. In another room in the same mill work similar to this was being done in almost identically the same way, when a strike took place in that room, probably stimulated by the Industrial Workers of the World. We had extended our system to about half the people in the room at this time, and, strange as it may seem, our workers were not the ones that went out on the strike—all of our people not only stayed on their jobs, but brought in their friends to take the place of the strikers. In another textile mill nearly all the employees went on a strike in 1905; almost the only ones who remained loyal were those working on our system.

Chart XII represents girls making sheets and pillow cases. The work of starting the task and bonus was done by a man who had been connected with me, but who was doing this on his own responsibility. I was not personally in touch with this work when it was done. First, note should be made of the fact that the factory was shut down on a number of days—November 28 (evidently Thanksgiving Day), Christmas Day, and all Wednesdays and Saturdays for the next two weeks. It will be seen that the work started off very well, but the rush to get people on bonus on November 30 evidently upset things, for immediately we find a number of workers back on day work. This was probably due to the inability of the task setter to set tasks on new work fast enough. Note again that just before Christmas week the same condition obtained, and after Christmas there was not enough work to keep the factory running full. However, by the middle of January those that had bonus work were beginning to earn their bonus pretty regularly, and by February 10 the number of workers was just about large enough for each to be supplied with a full amount of work. From that time on the work went smoothly.

This chart is presented to show how easy it is to get into trouble by putting people on

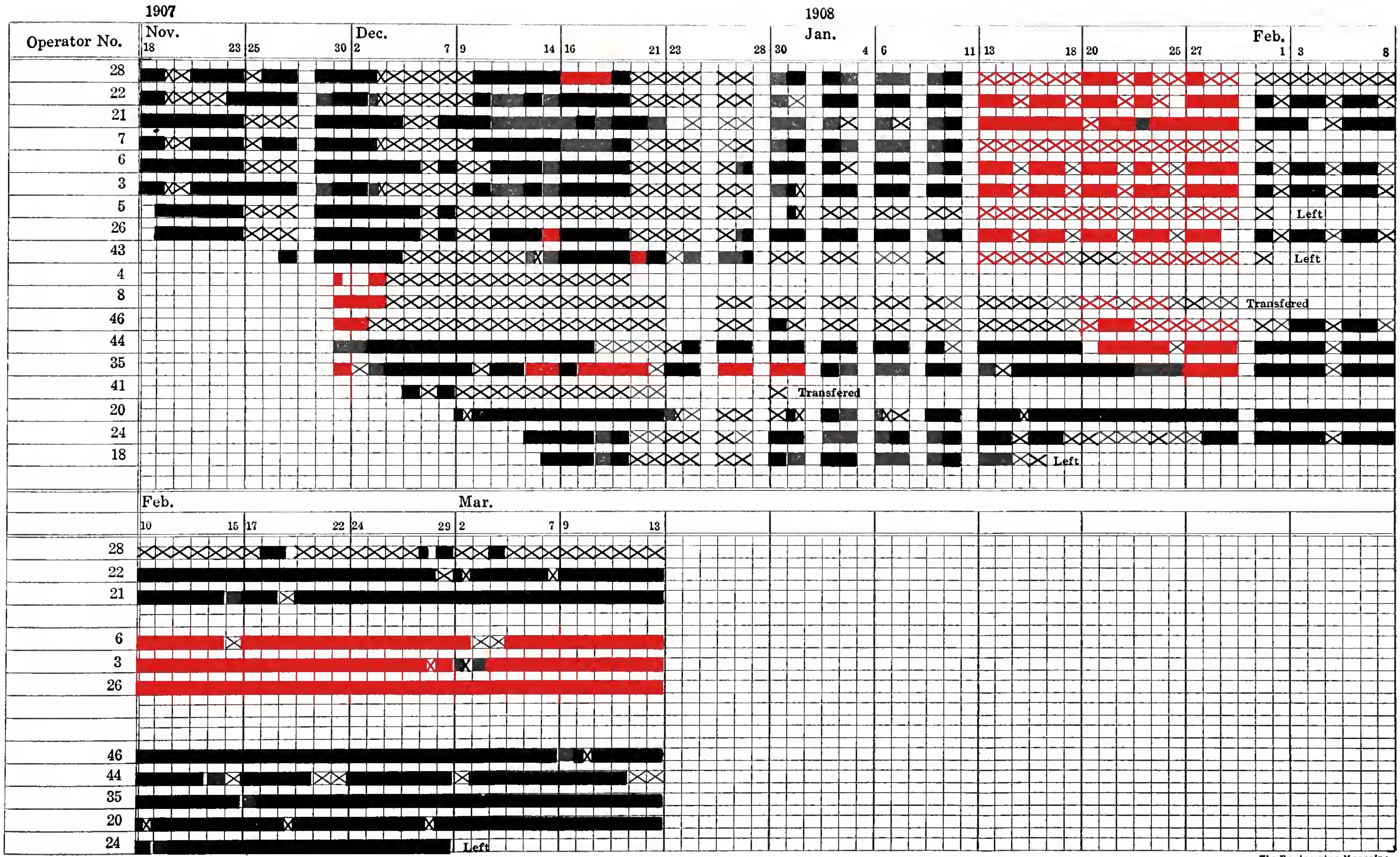


CHART XII. BONUS RECORD OF GIRLS MAKING SHEETS AND PILLOW CASES, SHOWS TROUBLES OF A HASTY START OVERCOME BY PERSEVERANCE.

bonus work too fast. The management has its part to play in supplying work and training workers, and it is perfectly evident in this chart that the trouble was not with the workers, but with lack of proper balance in the managing department. This, however, is not at all surprising, for when the man responsible for the output finds the advantage he can obtain by the task and bonus system, he almost invariably insists on putting as many people on bonus as possible, with the result that he finds he cannot supply all the workers properly and that numbers of them have to be put back on day work.

It may be asked why the task-setter does not explain this to the superintendent, and make it clear that that is the wrong way to do. I can say only that no amount of explanation on my part, or that of my representatives, seems to have much effect, and we have about come to the conclusion that the best way to do is to let managers make their mistakes and find them out; then the question is settled once and for all time.

Chart XIII is a particularly interesting one, inasmuch as it is the most recent—the development is still going on. I am permitted to exhibit this by the manager's courtesy.

It will be seen that here also the work started off very well, and until we began to push it too fast everything went all right. When, however, the desire to get an increased output overcame the conservatism with which it is necessary to establish a new method, those workers who were last put on influenced the others not to perform the task, and on one day nobody made bonus. One girl, however, felt that she needed the money and continued on with the work. The others showed their hostility toward her in a number of ways, but she still persisted. After they had ceased to try to do the work for three or four days, several of the girls sent in their notice that they were going to quit. They were evidently trying to raise an issue, but inasmuch as the management ignored the issue, and went about its business of getting conditions so perfect that the workers could have no cause whatever for not trying to earn their bonus, they were unable to get the issue accepted. It will be noted how at the end of eight days some of the girls became willing to try again, and from that time on the number increased, and soon the number of applications from other girls to work on task and bonus became so great that we were unable for some time to provide proper conditions and to set tasks for them fast enough.

CO-OPERATION

A careful analysis will show that we have established a system of co-operation, in which it is to the interest of each bonus worker to do as much work as he can, and to do it as well as possible. Further, if a workman does poor work, others suffer beside himself, with the result that he either learns to do good work or finds work elsewhere. As it is to the interest of the worker to do good work, and plenty of it, he contracts the habit of doing a large amount of good work. As long as it is to his financial interest he will continue to cultivate this habit.

Taking all of these charts together we note the following: That the amount of supervision needed has diminished; that the quality of the work is better; that the quantity is greater; that the amount being turned out can be predicted accurately, and hence promises need no longer be guesses, but can be made and kept; that the workers are not only earning more money, but are acquiring better habits of work which will make them better citizens.

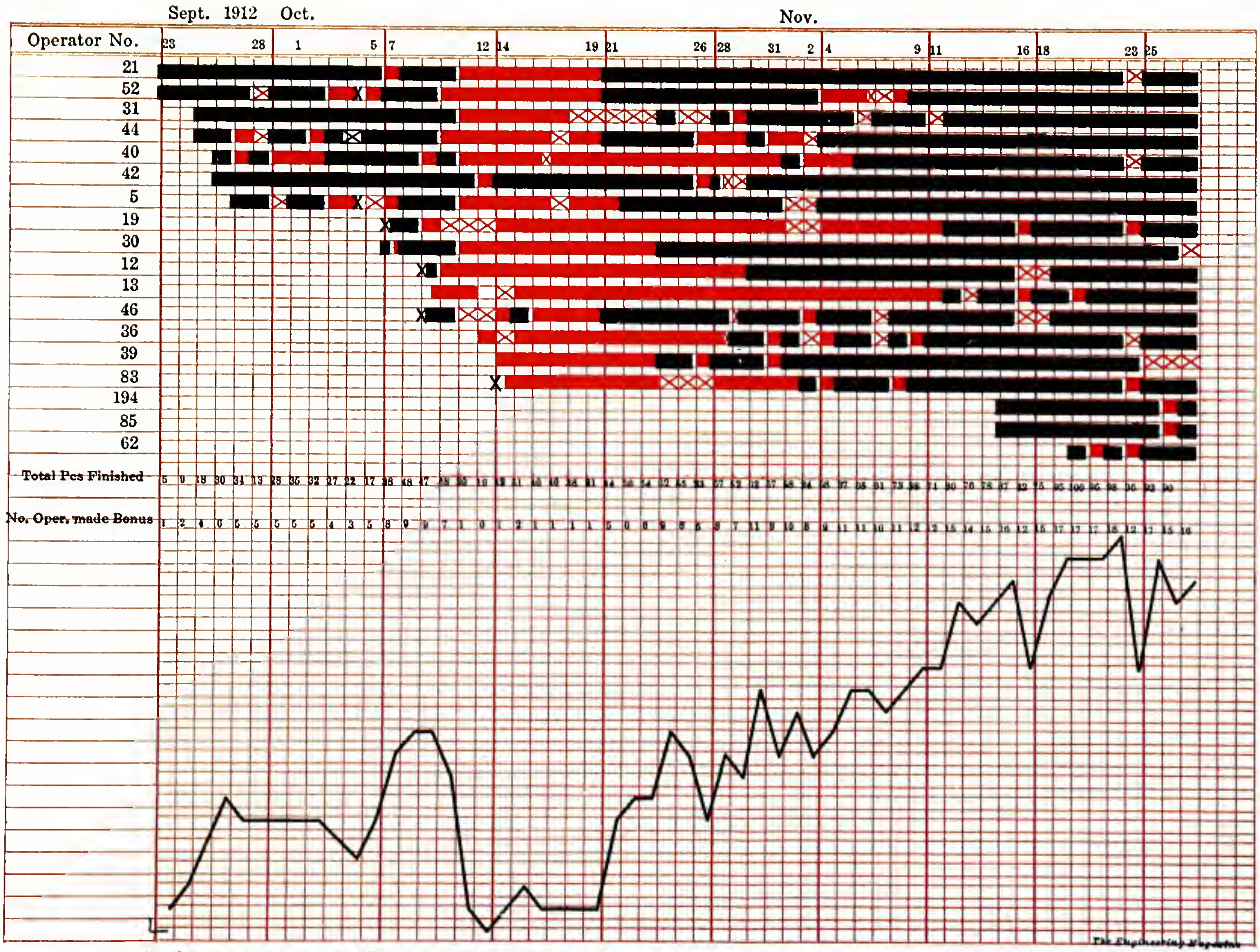


CHART XIII. BONUS RECORD OF GIRLS WINDING ARMATURES.
Heavy line shows number of operators performing task daily. Note complete ultimate success in spite of initial hostility of workers.

RESULTS

CHAPTER X

RESULTS

AFTER seeing the charts in the preceding chapter, the question naturally arises as to the ratio between the amount which is being accomplished now and what was accomplished previous to the beginning of this work.

In order to make these comparisons clear we devised a few years ago what we have called a "Percentage Chart," which compares all results with the conditions existing before the work was started. For instance, the standard production was called 100 per cent. Our new production may be two, three or four times that amount. The wages which were being paid before the work was started were also rated at 100 per cent. The new wages would be an increase over the old standard, usually of 30 to 50 per cent, and the wage cost measured in the same manner would be distinctly below the previous wage cost.

Chart XIV is a chart of this character and

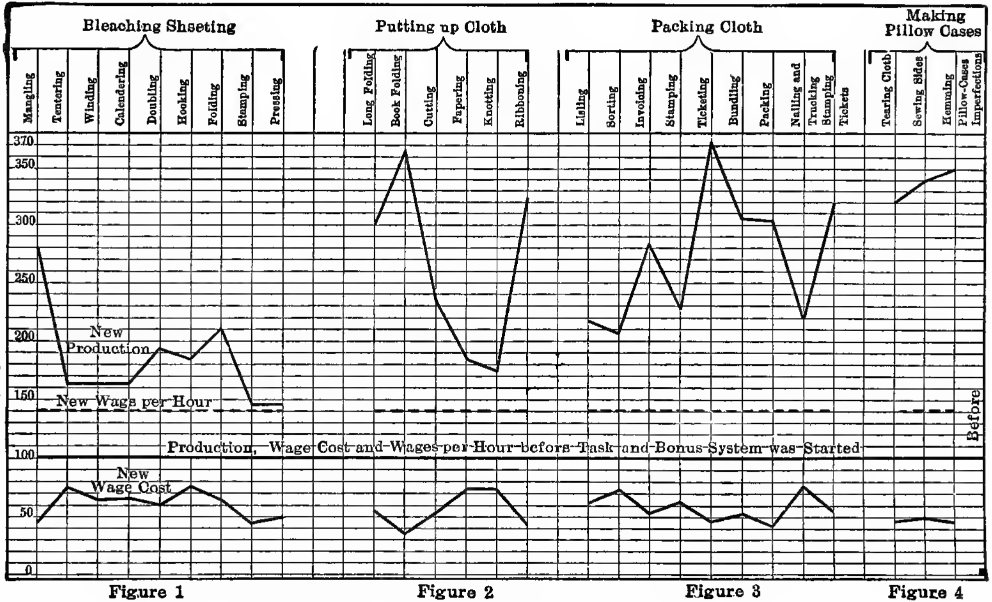


CHART XIV. ACTUAL RESULTS UNDER THE "TASK AND BONUS" SYSTEM AFTER MORE THAN TWO YEARS' OPERATION

The solid horizontal line represents the regular average volume of production, wage cost per unit of product, and wage rate per hour before the system was introduced. On this as unity for each of these scales, the dotted and broken lines represent the conditions secured and substantially maintained. It will be noted that the new wage rate per hour is about 140 per cent of the old; the production has risen to a level from 155 to 375 per cent of the old; the wage cost per unit has fallen to about 60 per cent (from 38 to 75 in different operations) of the old cost.

shows these ratios with regard to some work done several years ago in a bleachery in Rhode Island. Each of the vertical lines represents a different kind of work. It will be noted that the various kinds are represented by the names at the top of these lines. The horizontal black lines marked "100 per cent" represent the amount of work which was done on each of these operations previous to our investigations. The upper lines represent the amount of work now being done, compared with what was previously done. The heavy black line marked "100 per cent" also represents the wages previously paid, and the dotted lines above it represent wages now paid. The 100 per cent line also represents the previous wage cost. The dotted line below represents the present wage cost. Note that the increase in product is about 200 per cent, and the decrease in wage cost is approximately 40 per cent, while the increase in wages is also 40 per cent. Bear in mind that this increase in product is due not solely to the work of the operative, but is much helped by more careful study and co-operation on the part of the management.

It should be noted that this chart represents four different classes of work, all of which illustrate the effect of the task and bonus. In the last three cases the average output is in each instance more than double, and in one, the manufacture of pillow cases, more than three times as great.

The increase in the case of the pillow-case factory was so great as to make some suspect that the work must have been done very inefficiently before. This was undoubtedly true, but probably not more inefficiently than in many shops run by a foreman who has no special training as an executive, and of whom much more is expected than he could possibly do efficiently.

But this is not all; a fortunate set of conditions enabled us to get a measure of the improvement in quality which had been obtained. Soon after the reorganization of the pillow-case factory represented in Figure 4 on this chart got well under way, there was a serious complaint of bad work from one of the largest customers. An investigation proved that the complaint was well founded, and the customer was asked to return all the goods.

About fifty cases of goods were returned, and of course the bad work was all blamed on the new system. The inspection of the first few cases proved that the number of imperfections per case varied greatly, and it was decided to keep an exact record of what the imperfections in each case were, and whether the work was done before or after the installation of the task and bonus system. The result was as follows: In twenty-eight cases of goods done before task work was started, the average number of imperfections per case was 47½. In two cases done after the task work was started, but before the inspection was going properly, the average number of imperfections per case was 2. In eleven cases done under the task and bonus system, after the inspection was going properly, the number of imperfections per case was less than one.

Representing by unity in Figure 4 the number of imperfections per case before the task and bonus system was started, the short line represents the number afterward—less than 2 per cent.

This improvement in quality also points to the fact that the pillow-case factory was badly run; the interesting fact is that it was possible to make such a great improvement in a few weeks.

The next question that naturally comes to one's mind is that of the permanence of these results. On this subject we have some data also.

In 1904 we began the reorganization of a packing-box factory, which made five or six hundred cases per day and was run in connection with two large bleacheries of cotton cloth. This factory had been a sore spot, and whenever shipments were delayed the box factory came in for its share of the blame. It took nearly a year to get this factory into shape, but for the past nine years it has run so smoothly that the manager of the bleachery has hardly been aware of its existence. In 1912 this factory was running substantially as organized in 1904, with most of the original bonus workers still there.

The organization of one of the bleacheries referred to was practically completed on these lines in 1907, and is running today better than it did then. The management of the other bleachery has been gradually remodeled on the same lines.

The management of the pad-ayeing department of a large dye works has been remodeled on these lines, with the result of practically doubling the output and distinctly improving the quality. The workmen are getting much better wages, and the costs are decidedly lower. This department has been running on these lines since 1909, and is running much better today than at any time yet.

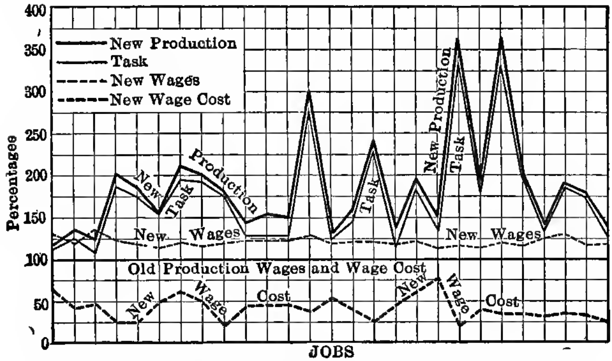


CHART XV. WAGES AND PRODUCTION DIAGRAM ON SMALL AUTOMATIC SCREW-MACHINE WORK

No better testimonial both to the quality of the work done and the economy with which it is being done can be had than the fact that, notwithstanding the increased output per machine, they have been obliged to add other machines to the dye works to take care of the business offered, until they were doing in this department in 1910 nearly three times what they did in 1908.

Chart XV represents similar results for work on small automatic screw-machines. In this case the light line represents the task,

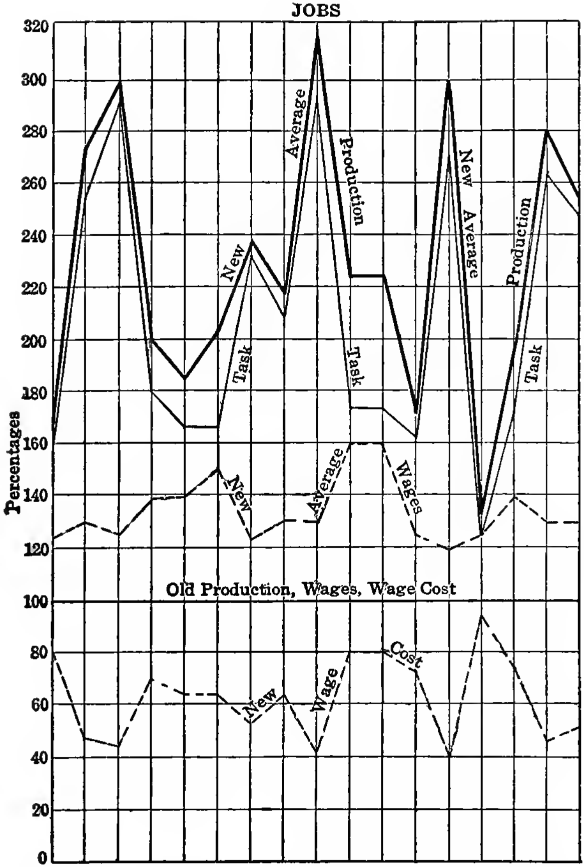


CHART XVI. WAOES AND PRODUCTION DIAGRAM ON LARGE AUTOMATIC MACHINE WORK the upper heavy line representing the amount of work done. The upper dashed line represents the wages now being received, and the lower dashed line represents the new wage cost. In this particular case the shop was very well run before we undertook to study the work, and the workmen were getting very good wages. It will be seen that the increase in production is not quite so high as in the former chart, nor is the increase in wages quite so great.

Chart XVI shows similar results for large automatic machines.

Chart XVII represents the same change for miscellaneous machine-work in a plant manufacturing a small article in quantities.

Comparing all four of these charts, it will be evident that there is a very striking similarity whether we are doing hand work in a bleachery, or automatic lathe work in a machine shop. If the management assumes its share of responsibility in preparing the work, in seeing that the machines are in proper condition, and in training the workmen, we can get from two to three times as much work done as is usually done, pay 20 to 50 per cent increase in wages, and still save about 40 per cent in wage cost.

Of course it will be realized that this increase in output brings down the overhead expense on every unit of product, so that the decrease in wage cost is not the only important item. Indeed, it is not even the most important. Unless the total overhead expense is markedly increased when the product is increased, this expense per unit of product comes down substantially in inverse ratio to the amount by which the product goes up. The reduction in cost from this source is usually markedly greater in dollars and cents than the reduction in wage cost. This side of the cost question has usually been given too little consideration. Mr. Andrew Carnegie was among the first men in the United States to recognize the great value of getting a larger product from his plants, and this fact, perhaps more than any other, gave him the mastery of the steel business. Many times we can afford to pay even a higher wage per piece if thereby we can reduce this overhead expense. In general, however, a thorough study of the work enables us to reduce both wage cost and overhead expense per unit of product, at the same time substantially increasing the earnings of the workman.

On Chart XVII some reader may note at once the discrepancy between the task set and the amount of work performed in certain cases, showing that the workman did a great deal more than it was expected he

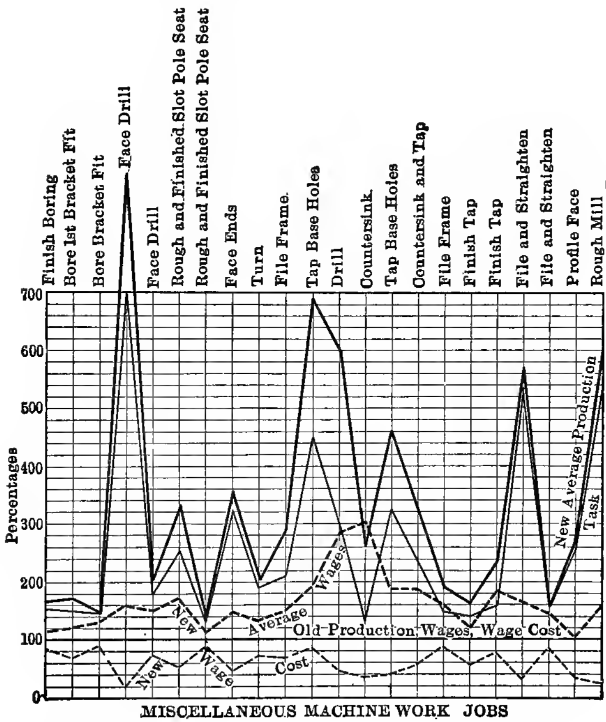


CHART XVII. WAGES AND PRODUCTION DIAGRAM ON SMALL MISCELLANEOUS MACHINE WORK would do. It may be asked, naturally, how we could overcome this difficulty, for many people feel at once that a serious mistake has been made and that the tasks should be increased or the rates reduced.

In reply to this I have to say that these tasks were set by a task-setter who had not had sufficient experience and that he has much improved since the setting of these tasks. We, however, do not consider that because he has made an error it is necessary to change the rates. As a matter of fact, we rather prefer that there should be a few easy tasks so that the workmen may have a practical demonstration of the fact that we are not going to cut rates and that they need have no fear whatever if they do all the work they can and earn all the money possible.

After seeing these charts the comment of some, at least of those who study them, will be that these shops must certainly have been run very badly before. As a matter of fact, that is not so. While some perhaps were not in the class of well-run shops, others were not only in this class, but high up in the class. Before the introduction of these methods the results that were achieved were due to the effort the workman put into his work, with practically but little direct assistance from those over him. After the methods were installed he was taught the best way of doing the work that we could devise, offered a substantial reward for accomplishing the desired results in the manner in which he had been taught, and the conditions under which he was working were so modified that these results could be accomplished if the worker were properly trained. *In other words, these results are not accomplished by the workman alone and unaided. He must have the thorough co-operation of a strong management.*

Another criticism may be that this applies to what might be called direct labor, and that no account is taken of the indirect labor, such as transportation, clerical work, etc.

In reply to this criticism I reply that we find, as a rule, that there has been even less attention given to the proper study and planning of indirect labor, and that the chance for improvement in that line is quite as great as, if not greater than, in the line of direct labor. The clerical work is frequently the most inefficient of all in the factory.

My object in presenting so many charts illustrating the same thing is to show to as great an extent as possible that the principles laid down in this discussion are of wide application, and that in all cases substantial results may be expected, if these principles are properly carried out.

The essential point in carrying out these ideas properly is that they should be understood and thoroughly appreciated by the people who undertake their application. The results shown cannot be accomplished unless we have harmonious co-operation between employer and employee, which is impossible under any form of management that assumes that the responsibility of the manager has ended when he has issued his orders to the shop.

To my mind, the training of workmen to fill all the different positions in a factory is one of the important functions of the management, and we all know that training is slow and expensive; but it is the only method which holds out any hope of producing even a partial solution of our present industrial problems.

While this discussion is of importance to the man considering the adoption of these methods, the most important fact for people in general is that our immigrants as well as our native people can be trained to habits of industry and made efficient, and that a scheme of co-operation can be devised that is beneficial alike to employer and employee. Further, it is of importance that when once in operation these methods are continued and perfected by the workers themselves.

If these methods were introduced extensively, it is without question that the habit of the shop would influence that of the community, and there would be a general increase in efficiency. The habits a man has to acquire to become efficient in one class of work stand him in good stead in becoming efficient in other work. These habits of work are vastly more important than the work itself, for it is our experience that a man who has become efficient in one thing readily learns to become efficient at doing other things. The ability of such people to produce wealth is more to the country than the wealth itself. The productive power is more valuable than the product. Many of the workers represented on our charts are immigrants who cannot speak English, yet in a few months at most they become far more efficient than the average mill operative, who professes to be skilled.

It must be emphasized, however, that this training was done only by the very best workers under the direction of good teachers, that the individual was given the personal attention, day after day, of the teacher and the expert workman, and that he was assured of good compensation if he succeeded. We concentrate on the individual, but when a few have learned, and are being benefited, others are not slow to imitate. One cannot learn to do this work by reading magazine articles; it must be learned in the shop where an educated man studies the work and the workmen. When he has become familiar with both work and workmen he can make a start, but to try to do much without this kind of practical experience is about as futile as trying to learn to skate through a correspondence school.

To succeed in this work the teacher must have the ability to analyze and investigate, and must himself be trained in such habits of industry and concentration as to enable him to become master of his subject.

In his inaugural address, President Lowell, of Harvard University, emphasized the importance of hard and accurate thought in the following words:

"The student ought to be trained to *hard and accurate thought,* and this will not come from surveying the principles of many subjects. It requires a mastery of something acquired by continuous application."

If we substitute for "*hard and accurate thought,*" *hard and accurate work,* his remarks are just as true when applied to the workman as to the student. The workman who has become master of something takes pride in his work and soon distinctly improves in personal appearance. The improvement is so universal and so marked as to be always distinctly recognizable, and is much more than can be accounted for by the increase in wages which enables him to dress better.

This improvement is even more marked in girls than in men, for the girls invariably acquire a better color and improve in health. In one case the girl bonus workers formed a society and adopted a badge which they all wore. Only those who could earn their bonus were eligible. This incident is a little thing in itself, but it shows the feeling that comes with mastery of some subject. They know what they can do and are proud of it. This consciousness of efficiency, this knowledge that they have succeeded and can do it again, puts the worker in a very different class from those who go along day after day watching the clock and doing just enough not to get discharged.

The task gives the worker a definite object to strive for, causes a certain amount of mental exhilaration, and invariably increases the keenness of the perceptions.

From our task workers we frequently get instructors and sometimes investigators. From our investigators and instructors we get an ample supply of superintendents and foremen. The foremen and superintendents trained under this system have proved far more successful than any it was possible to hire.

PRICES AND PROFITS

CHAPTER XI

PRICES AND PROFITS

ABOUT 1890 the financiers of the United States discovered a new and seemingly a very important principle. They realized that, in many cases, at least, the larger factories were making a larger percentage of profit than small ones, and conceived the idea of uniting the small ones under one system of management. By this move, they certainly did give the small factories a better financial standing, at the same time reducing what might be called the financial or business expense.

By this they also reduced competition and decreased the cost of selling, which has always been a large element of expense. Under these conditions, business prospered rapidly, for there was, in many cases, undoubtedly a reduction in cost. The illustrated magazines were filled with the pictures of the *captains of industry* who had engineered these combinations, and it was freely predicted that the economies to be obtained were so great that it would only be a question of time before Europe would be flooded with American goods.

Magazine articles of this character were extremely popular for three or four years, and the formation of consolidations or trusts in manufacturing, and of great systems in railroading, went on at a rapid rate. The economies that had been produced by these methods, together with the fact that, with the elimination of competition, the selling price had been upheld, enabled many such combinations to pay dividends on stock which had originally represented little or no value.

The unprecedented prosperity that followed the introduction of these methods was undoubtedly caused in a large measure by them, and the financier was justly regarded as having done much to promote the prosperity of the country. Our internal trade grew at an astounding rate, but the American invasion of Europe did not materialize; and it was not very long before we began to hear complaints of the *increasing inefficiency of labor.* Wages began to rise, but the output of the workmen did not rise correspondingly. The financier had undoubtedly effected economies on those portions of business directly under his control, but had not succeeded equally in those with which he did not come in direct contact.

As a matter of fact, while the financier had been forming his great combinations of manufacturing interests and railroads, with the effect, at least, as far as the public is concerned, of upholding prices, the workmen had gone him one better. By their Unions not only have they upheld the price of their labor, but in many cases markedly increased it, without rendering any more service than formerly; the employers, in many cases, say less.

Under these conditions, the projected invasion of Europe seems to be postponed indefinitely, and the continually increasing cost of living in this country seems to indicate that we need something more than able financiering to round out our theory of industrial economy. While this fact is recognized by all, it is not so easy to specify exactly what is wrong and how it is to be corrected. Cooperation among employers to uphold the price of their product has been so successful that it is scarcely to be wondered at that the workmen should adopt the same tactics.

On this subject Adam Smith, in his famous book on "An Inquiry into the Nature and Causes of the Wealth of Nations," nearly one hundred and forty years ago wrote as follows:

> Our merchants and master-manufacturers complain much of the bad effects of high wages in raising the price and thereby lessening the sale of goods at home and abroad. They say nothing of the bad effects of high profits. They are silent with regard to the pernicious effect of their own gains. They complain only of those of other people.

This statement made so long ago is just as applicable to the conditions of today, and admonishes us in approaching our problem to do so with an open mind, and not from a partisan standpoint, for a solution cannot be permanent if it benefits one class exclusively. *Any scheme for the utilization of the energies of the community for the benefit of one class of people only would soon destroy democracy, and develop an oligarchy, which would be ultimately overturned by revolution.*

Inasmuch as the object of manufacturing or any kind of industry is to make profits, it is only natural that the part that seemed to yield large profits readily should have been exploited first.

As business increases in volume, profits will normally increase correspondingly; but there are only two ways of substantially increasing the profits per unit of output—one by increasing the selling price, the other by reducing the cost of production.

Inasmuch as increase of selling price yields more prompt returns, and returns that can be measured with great accuracy, much of the talent of our manufacturers has been engaged in this branch of the business. The successful salesman, or the operator who has succeeded in persuading his competitors to join with him in upholding or advancing prices, on account of the increased profits resulting from his efforts has been considered a very important man and compensated accordingly. The recognition of ability, and the compensation for success in this field, have been so great that capable workers from all directions have swarmed into it, and the industry of making prices has prospered amazingly, to the comparative neglect, often, of the production end of business.

With increase of prices comes higher cost of living; with higher cost of living comes demand for higher wages; with higher wages (unless accompanied by greater efficiency) comes higher cost of production. Then, to maintain the same profit under the new conditions, we must again increase our selling price, and the cycle repeats itself. This process has been going on for years, and the producers have been gradually attracted from the field of making products to the more lucrative one of making prices.

Let us now consider the other alternative —that of reducing cost—and ask why more attention has not been paid to it, and what we may expect to get if we cultivate this field as assiduously as we have done the first.

The first cause of the small interest hitherto shown in the effort to improve production is that there is still a lingering feeling among many prominent people that the shop worker is not entitled to the same degree of consideration as the office worker; and this work cannot be done in the office. It must be done amid dirt, dust and the noise of machinery. It must be done by not only studying individually the machines that do the work; but by also studying individually the men that operate them. This is work that requires ability quite as great as, if not greater than, that needed for the making of prices; it also requires long hours and overalls; and the compensation for success in this line does not compare with that accorded the man who adds to the bank account by getting a higher selling price.

On account of these conditions the effecting of economies in factories is usually left to the partially educated mechanic or clerk, who, whatever his success, seldom gets an adequate reward. When the compensation for success in this latter branch is made commensurate with that in the former, and then only, will it attract and hold educated men, to whom we must look for the success in any work requiring study or investigation. Study of men and processes is difficult, and we have done but little in this country to encourage it; but the time has come when we must turn our attention to it at once, for the combination of the high cost of living, and the inefficiency of production in almost all lines, is rapidly producing a condition of which no one can foresee the result.

The horizontal increase of wages being granted by so many corporations throughout the United States is not a cure, but an expedient only to enable the workmen to supply themselves for the present with a larger proportion of the necessities of life. Such a scheme provides temporary relief only, for a general increase of wages increases costs again; and, if such a policy is followed, it will not be long before a new increase of wages will be needed to meet the continually rising cost of living.

No scheme therefore which confines itself to paying high wages offers any solution. In fact there seems no solution as long as selling price is fixed by *agreement* and not by *value*. When, however, "conspiracies for the restraint of trade," as such agreements are called, are eliminated, a policy of increasing the efficiency of the producer and hence reducing costs, under a national system of competition, will have the desired result. This is not an easy problem; and there is no royal road to the desired end, for, as was said before, it means long hours and overalls, and the ability to study men and machines in the surroundings of dirt, dust and noise.

As was said before, also, this work does not attract many educated or capable men, because the compensation for success is so meager; but the time is rapidly approaching when the men that can do this work well will be in demand at almost any price. This is peculiarly the work of the mechanical engineer, and manufacturers who realize this fact and take advantage of it will be surprised at the benefits they obtain.

It is an economic law that large profits can be permanently secured only by efficient operation; and any man, or body of men, that exacts a compensation out of proportion to the service rendered will ultimately come to grief. The supreme importance of efficiency as an economic factor was first realized by the Germans, and it is this fact that has enabled them to advance their industrial condition, which twenty years ago was a jest, to the first place in Europe, if not in the world. We naturally want to know in detail the methods they have used; and the reply is that they have recognized the value of the scientifically trained engineer as an economic factor.

In the United States, superb natural resources have enabled us to make phenomenal progress without much regard to the teachings of science, and in many cases in spite of our neglect of them. The progress of Germany warns us that we have now reached the point where we must recognize that the proper application of science to industry is of vital importance to the future prosperity of the country.

Many of our most prominent men, and men of most influence in the country, received their college training before the possibility of such a condition was even hinted at; and hence they fail to realize its seriousness. Our universities and schools of higher learning are still in many cases dominated by those whose training was largely literary or classical, and they utterly fail to realize the difference between a *classical* and an *industrial* age. This difference is not sentimental, but real; for that nation which is industrially most efficient will soon become the richest and most powerful.

If we wish to hold our place in the procession we must at once accord the scientist the place he is entitled to, and we must recognize his work, and that of the engineer, by such financial compensation as will attract our best men.

A few years ago efficiency in the United States was a local question; today it is a national question, and co-operation for its promotion will not only be of great permanent benefit to those co-operating, but will have a great educational effect on the nation.

Co-operation to uphold or to raise prices is seen on all sides; but it is difficult to find a single case where there has been any serious attempt at co-operation to study economies, and to inaugurate them effectively. Systematic work in this line would do more to increase prosperity, and to reduce costs, than all other influences combined; and reduced selling prices might be made without decreasing profits.

Moreover, if it should become the fashion to co-operate for the effecting of economies, instead of for raising prices, we should not need so much new legislation to restrain the activities of some of our most enterprising citizens.

Although the application of the scientific method to the larger problems of engineering and manufacture has been most rapid within recent years, and the great advances made testify to its success, its application to the innumerable small details of work has been largely neglected. These details have been regarded as being in the domain of trades rather than of engineering, and have been left to the mechanic. Inasmuch as mechanics, as a class, get but little benefit from the development of a better method, or a labor-saving process, they are as a rule little interested in such improvements. It is not surprising, therefore, that labor unions should offer a distinct opposition to such improvements, and that workers trained in the atmosphere of the union should consider it their duty to perpetuate this hostility. To avert this hostility we must begin by giving workmen a different training.

Before the advent of the modern factory system, each master workman owned his little shop, which he ran with the assistance of two or three journeymen, and in which he personally superintended the training of his apprentices. In training apprentices, his first object was to provide himself with capable journeymen; but he also realized that the best way to increase his reputation was to send forth men that should be a credit to him. He was therefore doubly particular that no one should leave his shop who was not able to do his work well.

With the coming of the factory system, the owner became too busy to give much personal attention to the apprentices, and, as the factories grew larger, he was often unable to take from the business end enough time to make himself even a master workman in all branches of his work. With the increasing size of the factory the superintendent also became too busy to give much personal attention to the apprentices, and they were thus left to receive their training from the foreman and their fellow-workmen, who, as a rule, have no financial interest in training additional men, who may, in time, become their competitors. This is undoubtedly the most important reason why the old apprentice system has gradually become less effective, until today it is almost obsolete. It is also a good reason why an attempt to revive it in its old form is foredoomed to failure.

The principles on which the old apprenticeship system was founded are sound—namely, that the success of the pupil should add to the reputation and financial betterment of the teacher and pupil both. It would seem, then, that if our modern methods have a similar foundation they also will be successful. Moreover, if the training is based on the results of scientific investigation, and the methods employed are those which embody our best knowledge on the subject of teaching, we should be able, not only to provide ourselves with an abundance of skilled workmen who are capable of doing well the tasks set them, but to develop many who are able to advance the mechanic arts in a manner superior to that which gave the New England master workman of a generation ago such a wide reputation.

There is really no sharp line between mechanical engineering and trades. Wherever there is a problem to be solved, no matter how small or common-place, there is work for the educated man; and his solution by the scientific method is, as a rule, so much better than that of the mechanic without scientific knowledge, that workmen trained in the light of such a solution are far more efficient than those trained by mechanics in their methods. The increased efficiency of such men entitles them to increased compensation; and, by awarding that compensation in a proper manner, I have never failed to secure the hearty co-operation of the good men. *A system of management based on these methods is just as much a part of our assets as plant, or equipment.*

We are all familiar with plants that were failures under one manager and successes under another, or *vice versa;* but so far no satisfactory method is generally known by which a system of management can be put into such a shape as to be self-perpetuating. This is exactly what the methods described in preceding chapters do accomplish, at least to a large extent. The importance of this fact is second only to that of one other, namely, that they do actually get the highest possible efficiency.

The reason our methods are permanent is that it is to the financial interest of both workman and foreman to maintain them. Systems which are maintained in their efficiency by the higher officers are liable to deteriorate when such officers become old, or are replaced. The system I have described not only makes for the highest efficiency, but is practically self-perpetuating, for the training the men receive fits each to fill a higher position.

In considering in detail the elements that affect cost of manufacture and, through them, profits, most people place them in three classes:—

Wages,
Materials,
Overhead expense.

In the third class they include all the various items of expense that cannot be charged up directly to manufacturing, such as rent, taxes, insurance, salaries, selling expenses, depreciation, power, light, heat, etc. These items, taken together, often amount to more than the wages paid for doing the work. This class of expense is very important, for it goes on with but little change day after day, whether we do much work or little, and it must be added to the cost of the output, month by month. If the output is small, this burden of expense per unit of output is large; on the other hand, if the output is large this expense per unit is correspondingly less.

Andrew Carnegie was one of the first men to appreciate to what extent this was a fact, and, by making good use of it, he laid the foundation for the practical control of the steel industry.

If the output of a plant is doubled, the overhead expense per unit of product is very nearly cut in half. If at the same time we reduce the wage cost 40 per cent and double production, as we have shown can so often be done, the profits mount at a very rapid rate.

In order to illustrate these points, let us assume a hypothetical case in which we are making a profit of 10 per cent on the cost of our products, our expenses for one week being divided as assumed in the following table, which is closely in accord with probabilities:—

Material	$3,000
Wages	1,000
Expense Burden	1,000
	$5,000
Selling Price	5,500
Profit	$500—10 per cent of cost

Suppose now we wish to double our product. The usual method is to double the size of the plant without increasing the efficiency of operation. In this case all expenses will be doubled, except the expense burden, which will be very nearly doubled, and our case may be approximately represented by the following figures:—

Material	$6,000
Wages	2,000
Expense Burden	1,800
	$9,800
Selling Price	11,000
Profit	$1,200—12 per cent of cost

Suppose, on the other hand, we double our product by increasing the efficiency of operation, as we have shown can often be done, without increasing the size of the plant or the number of workmen. The following figures will be fairly representative:—

Material	$6,000
Wages	1,400
Expense Burden	1,200
	$8,600
Selling Price	11,000
Profit............	$2,400—28 per cent of cost

The profit is nearly five times as great as in the first case, and twice as great as in the second. In the second case we have twice as much money invested in the plant as in the first and third cases. *But in the third case, where we have increased efficiency and reduced costs, the profit on invested capital is nearly five times that in either of the first two cases.*

While these figures are hypothetical, and are not applicable to all industries, they are conservative, as they represent a decrease in total cost of only 14 per cent, as may be seen by comparing $5,000, the cost in the first case, with $8,600, the cost of double the products in the last case. To get a similar increase of profit by increasing the selling price without enlarging the plant or increasing efficiency, we should have been obliged to sell goods that cost us \$5,000 for \$7,400, or at a profit of nearly 50 per cent. Such an increase in selling price would simply be an invitation to other competitors to come into the field. If such a competitor should operate as efficiently as we have assumed to be possible in our third case, and competition should force the price down, he could sell his goods for less than our original cost and still make a profit of 15 per cent.

If manufacturers in general realized how much an increase in efficient operation really meant to them, they would be very slow to increase the size of a plant until they had become pretty well convinced that they had gotten it up to its maximum efficiency.

What has been said of the manufacturer is true of that greatest of producers, the farmer, as well; but we must not expect him to understand what the more favored manufacturer so often fails to appreciate, namely, that efficient operation of a small plant, or farm, is more profitable than the slack operation of a large one.

If the same intelligence and industry had been applied generally to the art of production as have been exercised in selling products, I can hardly help feeling that we should be suffering less acutely today from high prices. In the long run prices are governed by supply and demand. When it comes to be generally realized that efficient production and a large, cheap, product form a more stable basis for profits than a small, expensive one, because they form a more stable basis for prosperity, we may hope that some of the talent that has been exploiting the overworked field of making prices will return to the comparatively fallow field of making products.

I do not wish to be understood as intimating that nothing has been done in this field. Much has been done, especially in the steel industry; but it is a mere drop in the bucket, when compared with what still remains to be done in almost all productive industries. The steel industry was one of the first to utilize educated engineers, and to study the methods of efficient operation. The fact that steel products brought high prices has never stood in the way of reducing cost; and today, thanks to this policy, American steel makers can compete with any in the world.

If the much boasted superiority of the American people is really a fact, and the phenomenal progress of the past is really due to the ability of the people of the United States and not mainly to splendid natural resources, we should rise to the occasion, and become the example for others to point to. This cannot be done by making prices; and a tariff that is so high as to enable profits to be made regardless of cost is not a protection, but a decided detriment to the country. A tariff that encourages efficiency is more to be desired than that which will enable its beneficiaries to accumulate wealth, *for any prosperity not based on efficiency is on an unstable foundation.*

In order to bring the efficiency of operation up to the point we have shown to be possible, we must first have absolute control of the materials we use and the tools we work with. In other words, we must see that the proper materials are always ready, and that proper tools for doing the work are available. This is a function of the management, and not of the workmen, and necessitates the keeping of an exact record of the materials used. Inasmuch as material represents money, any attempt to keep an exact record of it, and of where and how waste occurs, results at once in a saving far in excess of the cost of keeping the records.

When therefore we begin to install a system of management on the lines indicated, nearly every step produces a saving; but, as many concerns have no records that show leaks and losses of material, it is usually difficult to show what has been saved by stopping such losses. Again, when we begin to put machinery in condition to enable us to run it at its proper efficiency, and to enable each man to do a proper day's work, the expense incurred to accomplish this end is usually charged against the "new system," whereas *it should be charged against the system that put the machinery out of condition.*

Inasmuch as in any change in management the mechanism of the old system must not be disturbed until that of the new system is working smoothly, there is always some time when we must practically run two systems. From these considerations it is evident that, no matter how much we may be able to increase the profits in the long run, we must not expect results to show in the form of profits at once.

The total cost of making the change from the old system to the new is not greatly different, whether it be done quickly or slowly. If it is done quickly, the benefits are gotten that much sooner; but the expense is concentrated in a short time, and, unless this fact is realized from the start, it is apt to cause a certain amount of hesitation at the very time when the work should be pushed fastest. If the plant is a large one, or one doing a large variety of work, the advantages of controlling the material, planning the work, and increasing the efficiency of the individual are so great that a little done in this direction soon makes itself felt, for the plant begins to run more smoothly, wastes diminish, and profits begin to increase, and we are on the road to our ideal, *a self-perpetuating system of management based on the efficient utilization of scientific knowledge.*

Such a system seems Utopian. Perhaps it is, but we have seen the possibilities of it so clearly, and have in actual operation approximations to it so close, that we are prepared to see its realization in the near future. Under such a system in its best development we have co-operation like that in a foot-ball team, or an orchestra, where each man has assigned to him the part he can do best, and where he does it with pride and joy to the best of his ability. The organization of such a system must be perfected by men familiar with the industries and trained in the methods of scientific investigation. The graduates of our engineering schools are the men on whose shoulders this problem naturally falls, and if they are capable of handling it, they will gain for the profession of engineering the recognition to which it is already entitled, as the most important factor in modern civilization.

A PRACTICAL EXAMPLE

CHAPTER XII

A PRACTICAL EXAMPLE

THIS chapter has been called "A Practical Example" for want of a better term. It is in reality an attempt to summarize the contents of this book and to illustrate more specifically how the principles outlined in the previous chapters are carried out. In such an attempt there must necessarily be many repetitions of what has previously been said. The repetition which is most pronounced is the one concerning the man record, the usefulness of which has been appreciated by but few people. In Chapter IV, on "Day Work," this subject is discussed and a form shown, headed "Machine Record." This particular form is used where the man in question is working continuously on one machine, in which case the man record and the machine record are identical. Inasmuch as our first object is always to train people to utilize all the knowledge that we have, it is essential that we should have some measure of the individual to find out whether he is responding to our efforts or not. Previous to the time of the setting of a task the man record has been our best instrument for this purpose.

The task and bonus system was introduced by me in the Bethlehem Steel works in 1901, as a means of affording substantial justice to the employee, while requiring him to conform to the best interests of his employer. *The employee was not told in a general way "to do better," but had a definite standard set for him, and was shown how to reach that standard, for which he was awarded compensation in addition to his usual day's pay.*

The system may be described in a general way as follows: A card is made out showing in detail the best method we can devise of performing each of the elementary operations on any piece of work, specifying the tools to be used, and setting the time needed for each of these operations as determined by experiments. The sum of these times is the total time allowed to complete the piece of work. If a man follows his instructions, and accomplishes all the work laid out for him as constituting his proper task for the day, he is paid a specified bonus, *in addition* *to his day rate, which he always gets.* If, however, at the end of the day, he has failed to accomplish all the work laid out, he does not get his bonus, but simply his day rate. As the time for each detail operation is stated on the instruction card, the workman can continually see whether he is earning his bonus or not. If he finds any operation which he cannot do in the time set, he must at once report to his foreman, who must show him how to do it, or report to the man who made out the instruction card. If the latter has made an error, he must make out a new instruction card, explaining the proper method of working, and allowing the proper time. If, however, the instructor contends that the work can be done in the time set, he must show the workmen how to do it.

The preferred way of paying the bonus is as extra time, figured as a percentage of the time allowed, usually betwen 25 per cent and 50 per cent.

It is of the greatest possible importance that errors in making out instruction cards should be as few as possible. A man must be allowed time only for what is stated on his card; and, while a reasonable time must be allowed for each operation, he should fail to receive his bonus if time is lost from any cause whatever. (The foremen also receive, in addition to their day wages, compensation proportional to the number of their men who earn a bonus, and an extra compensation if *all* earn bonuses.)

As these cards are made out by a skilful man, with records of investigations at hand, they invariably prescribe a better method for doing the work than the ordinary workman, or foreman, could devise on the spur of the moment. As all the appliances and instructions necessary for doing the work are furnished, and a bonus is allowed the workman in addition to his regular rate if the work is done satisfactorily in the time set, it will be seen at once that this method is really *a system of education with prizes for those who learn.* The results obtained bear out this idea of education most fully, for under this plan men have learned more in a few months than the same men ever did before in years.

SCIENTIFIC METHOD

In order to get the information needed to make good instruction cards, a very large amount of detail work is necessary. When we realize, however, that any operation, no matter how complicated, can be resolved into a series of simple operations, we have grasped the key to the solution of many problems. Further study leads us to the conclusion that many different complicated operations are composed of a number of the same simple operations performed in different orders, and that the number of elementary operations is frequently smaller than the number of complicated operations of which they form the parts, just as the number of letters in the alphabet is smaller than the number of words in the language. The logical method, therefore, of studying a complicated operation is undoubtedly to study the simple operations of which it is composed; a thorough knowledge of these will always throw a great deal of light on the complex operation. In other words, the time needed for performing any complex operation must necessarily depend upon the time and method of performing the simple operations of which it is composed. The natural method, then, of informing ourselves about a complex operation is to study its component elementary operations. Such study divides itself into three parts, as follows:

An analysis of the operation into its elements.

A study of these elements separately.

A synthesis, or putting together the results of our study.

This is recognized at once as simply the ordinary scientific method of procedure followed whenever it is desired to make any kind of investigation; and it is well known to all that until this method was known and adopted, science made practically no progress. I believe that, if it is desired to obtain the correct solution of any problem, we must follow the well beaten paths of scientific investigation, which alone have led to reliable results. The ordinary man, whether mechanic or laborer, if not instructed, but left to himself, seldom performs any operation in the manner most economical either of time or labor. It has been conclusively proven that, even on ordinary day work, a very decided advantage can be gained by instructing the men how best to perform the work they are set to do. When these instructions are the result of scientific investigation, and a liberal reward is given for following them, the gain in efficiency is usually beyond our highest expectations.

It is perfectly well known that nearly every operation can be, and in actual work is, performed in a number of different ways; but it is self-evident that these ways are not all equally efficient. As a rule some of the methods employed are so obviously inefficient that they may be discarded at once, but it is often a problem of considerable difficulty to find out the very best method, and it is only by a scientific investigation of each of the elements that we can hope to arrive at even an approximate solution.

INSTRUCTION CARDS AND PIECE RATES

When a piece rate is made out for any kind of work with which the men are not thoroughly familiar, it is obviously only simple justice to them that they should have detailed instructions how to accomplish each of the elements of the work in the time needed to earn fair wages. Permanent piece rates can be set only when the instructions are such as will insure accomplishment of the work in the minimum time, and to get sufficient information to make out instruction cards suitable for permanent piece rates is often a long and tedious operation. On the other hand, instruction cards may be made out to show the best method of doing work which we can devise with our present knowledge and appliances. Such cards will seldom represent the very best method of performing the work, but will usually represent a method far superior to that which the ordinary workman would employ. If we can get the men to do the work as directed on these cards, we can very largely increase the efficiency of their work. This is a most obvious way of increasing output; but to base a piece rate on such an instruction card would be simply inviting trouble, as but few men could see that it was just to change a piece rate when we changed the method of doing the work. If, on the other hand, we allow the men their day rate and offer them a bonus for doing the work in accordance with our instruction cards, they see at once that they have nothing to lose by conforming to our wishes, and all to gain, with the result that in a short time they will make an effort to do the work in the manner and time set. As stated in advance, these instruction cards do not necessarily represent the best possible method of doing the work, but the best method which we could devise at the time, and we have found that there is practically no objection on the part of the men to a change of time on these cards, *so long as the new time corresponds to a new set of instructions which will enable them to perform the work in the time set. This difference between ordinary piece work and our bonus system is fundamental.*

It is hard to over-estimate the value of a complete set of instructions showing the best method we can devise of performing a piece of work; and when we come to consider the question of piece work, the payment of a bonus, or, in fact, any method of compensation, proper instructions embodying our best knowledge on the subject are indispensable to good results.

APPLICATION OF INSTRUCTION CARDS TO A MACHINE SHOP

In order to make proper instruction cards for a machine shop doing a variety of work, it is necessary to know the laws of the cutting of metals, as well as the time for handling work in that particular shop, which latter depends upon location of tools, equipment, etc. The laws of cutting metals are very complicated, but they have been determined by Mr. F. W. Taylor and reduced to a slide rule for convenient use by the writer. This slide rule has been improved by Mr. Carl G. Barth, who adapted it to planers, drill presses, and slotters. By means of these slide rules we can determine promptly the most economical feed and speed for doing any operation on a piece of metal of given physical qualities.

As an illustration of exactly how instruction cards are made out in a machine shop, let us cite the case of a forging that has to be rough-machined. The drawing first goes to an expert mechanic, who has charge of what is known as the routing of the piece through the shop. He decides the order in which the various operations of turning, planing, slotting, drilling, etc., etc., are to be done. In a shop doing a variety of work too much stress cannot be laid on the routing, for, besides the advantage of knowing in the office the progress of the work, the saving made by performing the various operations in the best order is very great. This subject of routing is large enough for a paper by itself,* so it can only be mentioned here and its importance emphasized.

* See the paper by Charles Day, "The Routing Diagram as a Basis for Laying Out Industrial Plants," The Engineering Magazine, September, 1910.

If the first operation to be performed is to be that of turning, the forging is assigned to the lathe best fitted for handling this particular job. The work to be done on each machine is then analyzed by a first-class machinist, who can frequently make use of the above-mentioned slide rule to advantage, and who makes out an instruction card on which the operations to be performed on this lathe are placed in proper order, with proper instructions, the calculated time being given for performing each operation. The kind of tool to be used, the feed and speed, are specified for every machine operation. For every other operation, such as putting in and taking out of work, setting tools, changing feed gears, etc., instructions are given, and the time that each should take is placed directly opposite the description, in a column designed for that purpose. This system of

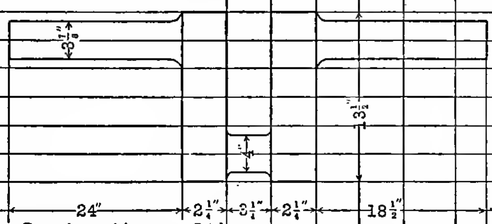
At the Zeiss Optical Works in Germany I found their best expert mechanic engaged in this routing work. I was advised that this practice of having every new piece of work analyzed into its details, and the sequence of operations specified, had been in use at the Zeiss Works seventeen years. Moreover, I was advised that such practice was quite common throughout Germany in the larger works. It is my opinion that this practice itself, if it is as general as I was advised, goes a long way to explain the great industrial progress made in Germany in the last twenty years, for such a practice has an indirect value as great as its direct value, in keeping the management in close touch with the needs of the shop.

DN 38-5030-5,8,1901.

CLASS OF WORK		STANDING ORDER	ORDER NUMBER
Lathe		460	16837
MACHINE NUMBER	**TOOL**	**CLASS OF METAL**	**FORGING NUMBER**
59	ME	14	22706 B. F.

MAN'S NAME ______ SPEED BOSS ______

	DESCRIPTION OF OPERATION	SHAPE OF TOOL	CUT	FEED	SPEED	TIME WORK SHOULD TAKE	TIME WORK DID TAKE	RATE
	Change Machine 20	Min		(For 1st one only)				
1	Chuck for turning webs					12		
2	Turn webs	PRL	3cuts	E	4AF	1:40		
3	Change to pin centers					10		
4	Rough pin to $4\frac{1}{16}''$ dia	PSR		.005	5AF	2:10		
5	Rough face webs use end	double tool	2cuts		4AF	1:40		
6	Fin. " " " "	"	1cut	H	"	50		
7	Fin. turn pin & cut fillets			E	2AF	2:00		
8	File pin round					1:10		
9	Polish pin				2BF	40		
10	Inspect					15		
11	Remove crank					5		
12						10:52	10:50	
13	Pin is *1 finish, webs are *3 finish.							
14	(Bonus earned)							
15								
16								
17								
18								
19								
20								
21								
22								
23	Previous time 54 hours							



DESCRIPTION CARD No.	SHEET DRAWING No.	B.S. Co. DRAWING No.	MONTH	DAY	YEAR	SIGNED
4311	PCMB	$26194\frac{1}{4}$ A	7	17	01	Buckley

WHEN MACHINE CAN NOT BE RUN AS ORDERED, SPEED BOSS MUST AT ONCE REPORT TO MAN WHO SIGNED THIS SLIP *The Engineering Magazine*

FIG. 18. INSTRUCTION CARD FOR TURNING A CRANK-SHAFT. BETHLEHEM STEEL CO., JULY 17, 1901

instruction cards was introduced by me into Machine Shop No. 2, of the Bethlehem Steel Company, in June, 1899.

Form 1029

INSTRUCTION CARD NO ________

CLASS OF WORK PLANING FRAMES MACHINE No P 82

MATERIAL WROUGHT IRON SIZE 28′6″ x 33″

TOOL STEEL MIDVALE CARD DRAWING No. ________

DATE 2/20/02 ORDER No. ________

	DESCRIPTION OF OPERATION	SHAPE OF TOOL	CUT	FEED	SPEED	TIME WORK SHOULD TAKE
1	SET WORK					120
2	ROUGH ONE SIDE		$\frac{3}{8}$″	$\frac{5}{16}$″	30	190
3	FINISH " "			1″	"	75
4	REMOVE WORK AND CLEAN UP					30
5	RESET					90
6	ROUGH ONE SIDE		$\frac{3}{8}$″	$\frac{5}{16}$″	30	190
7	FINISH " "			1″	"	75
8	REMOVE WORK AND CLEAN UP					30
9						800
10	TOTAL TIME					
11	13 HRS. 20 MIN.					
12						
13						
14						

WHEN MACHINE CAN NOT BE RUN AS ORDERED, FOREMAN MUST AT ONCE REPORT TO

MULLANEY SIGNED

The Engineering Magazine

FIG. 19. INSTRUCTION CARD, PLANING LOCOMOTIVE FRAMES. AMERICAN LOCOMOTIVE CO.

Note its equivalence to a detail schedule as explained on page 289.

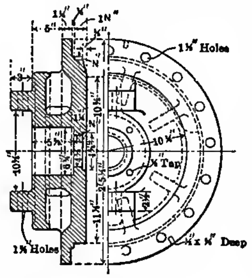
Figures 18, 19, 20 and 21 are sample instruction cards from various machine shops. They need no description.

There was comparatively little difficulty in inducing the men to perform the automatic operations according to the instructions given. For instance, they would run their machines at the feed and speed called for, but the great difficulty was that it seemed impossible to prevent them from losing time between operations. One would frequently find many of the machines idle, and yet every workman could give a more or less plausible excuse why his machine was not running, and this in spite of the fact that tools were ground for him and furnished to him, and the work so prepared that all he had to do was to put it into the machine and begin cutting. In other words, no matter how efficiently the machines were run through their actual working time, the men found good excuses for taking more than the prescribed time on every job.

TASK AND BONUS NOT AN ENTIRE SYSTEM OF MANAGEMENT

Although the scientific investigation of methods and the making of instruction cards are important factors in a system of management, *they are not the whole system;* and a means of utilizing them is even a more im-

INSTRUCTION CARD	LIST NO 28 L 6
Drawing No.	28 L 6
Name	BACK CYLINDER COVER
Class	CYL. DIA. 20" TO 24" INCLUSIVE
Schedule No.	28 L 17 Issue A
Operation	DRILL CYLINDER AND GLAND STUD HOLES, GUIDE BAR BOLT HOLES, AND CASING SCREW HOLES.
Operation No.	2 Material C. I.
Machine	BERTRAM RADIAL DRILL NO. 31.
Tool Steel	TWISTED STEEL.
No. of Pieces	1
Time	0.9 Man-Hours Per Piece
No. of Men	1 Date 3 - 17 - 10
PAY EQUIVALENT	
FIRST PIECE	1.6 HRS.
EACH ADDITIONAL PIECE.	1.25 HRS.



NOTE:- DIMENSIONS ON SKETCH MUST NOT BE USED IN MACHINING
USE STANDARD DRAWING.

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FIG. 20. INSTRUCTION CARD FOR DRILLING A CYLINDER COVER, C. P. R. (FACE)

	DETAILED INSTRUCTIONS	Tool Used	Diam. of Drill	Feed in Inches Per Min.	Spindle Speed	Minutes Allowed
	PREPARE MACHINE FOR 1st. PIECE.					15.0
1.	SET UP AND CLAMP JIG.					4.0
2.	SET DRILL.					0.5
3.	DRILL 17 CYLINDER STUD HOLES	ODF	1 1-6	2 3-4	225	15.5
4.	REMOVE JIG AND REVERSE COVER.					3.0
5.	CHANGE DRILL.					1.0
6.	DRILL 4 GLAND STUD HOLES	ODF	25-32	2 3-4	225	4.0
7.	REMOVE CLAMP					1.0
8.	SET ON SIDE OF TABLE AND CLAMP.					3.0
9.	CHANGE DRILL.					1.0
10.	DRILL 2 GUIDE BAR HOLES.	ODF	1 3-8	2 3-4	225	3.0
11.	TURN ROUND AND CLAMP					3.0
12.	DRILL 2 GUIDE BAR HOLES.	ODF	1 3-8	2 3-4	225	3.0
13.	CHANGE DRILL					1.0
14.	DRILL 3 CASING SCREW HOLES INCLUDING.					
	3 SETTINGS OF COVER.	ODE	13-32	2	225	7.0
15.	REMOVE.					3.0
	B. D. ANGUS SHOP C. P. R.				TOTAL MINUTES	53.0
					TOTAL HOURS PER PIECE	0.9

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FIG. 21. INSTRUCTION CARD FOR DRILLING A CYLINDER COVER, C. P. R. (REVERSE)

portant part of any system of management than they themselves are. In fact, they are of but little value, unless we have already installed a system by which we can be assured that our instructions are carried out. Moreover, such a system is of great value whether we make a scientific study of our processes or not, for it enables us to utilize fully the knowledge we have. It is much more important as a rule to utilize efficiently the knowledge we have than to get new knowledge. As a matter of fact, much loss is often caused by seeking new knowledge when we should be trying to utilize better what we have. While instructions, a task, and a bonus are essential elements in a complete system of management, I feel that they are not the first portions to be installed; and in a number of cases I have absolutely refused to do work with people who wanted this portion before the proper foundation was laid.

In more than one case in my experience, where my advice on this subject has been disregarded, the results have been almost fatal to the success of the work.

In most establishments few people have any idea of obeying orders exactly, nor have many of those in authority any idea of giving orders so that they can be obeyed exactly.

We must first devise means by which we can give specific orders, and see that they are carried out. Having devised such a system, we must train people to work according to it. One difficulty in the way of operating such a system in most factories, as at present managed, is that the amount of clerical work becomes so great as to make its successful operation a burden, and most people prefer to get along anyway rather than assume that burden.

I have given much attention to this feature, and my paper, "A Graphical Daily Balance in Manufacture," read before the American Society of Mechanical Engineers in June, 1903, describes the general method employed. This is a method of scheduling and recording work which has been found most satisfactory, as offering the means by which we could get our work done at the time and in the manner we wished. These schedules form the basis on which I found much of my work, for, by the proper operation of such balances as those described, we can in a comparatively short time begin to get a direct benefit.

In installing such a set of schedules the work must be done in the manner best adapted to the application of the task and bonus system later.

The essentials of a correct system are a store-keeping system and a time-keeping system suited to this method of controlling work, a balance of work, a man record, and a system of expense and cost keeping that *enables the superintendent to know each day what was done the day previous, who did it, and what the expense of it was.*

The following will give some idea of the important elements of such a system:

MAN RECORD

In order to operate such a system we must not only have an exact record of what each workman does each day, in order to find out whether he has earned his bonus or not, but must have beforehand an exact knowledge of the work to be done and how it is to be done. This amounts to keeping two sets of balances; one, of what each workman should do and did do; the other, of the amount of work to be done and actually done. The former, or man's record, is concerned with the training of men to earn the bonus, and consists in an exact comparison of what should be done as determined by our investigations, and what was done, as shown by the daily reports. It is also of great value in the preliminary period of day work before we set any tasks, as it enables us to know each day what every workman is doing for the money he receives. Where the rate of wages is set and advanced in accordance with his record, it has been found to be a very satisfactory method of producing efficiency. While it does not take the place of scientific task-setting, it is far superior to rate-setting without proper study.

DAILY BALANCE OF WORK

This latter is a balance of work on each order, and should show at a glance each day just what has been done and what remains to be done, in order to enable us to lay out the work for the next day in the most economical manner. The importance of such a balance has been long recognized, but the difficulty of getting it is such that it has seldom been attempted. Many concerns get a weekly or monthly balance; but in both of these cases the information is usually obtained too late to prevent delays in work. Again, the value of a balance is dependent largely upon its availability; in other words, upon the ease with which the desired information can be obtained from it. With this idea in mind I devised a combined schedule for work and a balance sheet that is largely graphical in its nature. On it dates are represented by positions, and when work is not done on consecutive days there are no entries in consecutive positions. This practice enables the superintendent to see at a glance what work is going along properly. Such schedules can be made out for all classes of work, and a description of one or two will amply illustrate the principle.

A FOUNDRY SCHEDULE AND BALANCE

Figure 22 represents such a balance sheet and schedule for a foundry. At the heads of the various vertical columns are the names of the pieces to be cast, under each is its pattern number, then, in order, when the pattern is due at the foundry, when it is received, the number wanted per day, and the total number wanted. Below, each column is divided into two columns headed "Daily" and "Total." These are crossed by horizontal lines representing consecutive working days,

FOUNDRY PRODUCTION SHEET A. L. CO.	SCHENECTADY WORKS															ORDER NO. 83	8 ENGINES	D.L.& W.				
PART	BELL STAND		EXHAUST PIPE		TENDER FRAME CENTER PIN		ENGINE TRUCK SWING BOLSTER		GRATE BAR		GRATE SIDE		GRATE SIDE		ASH PAN END		ASH PAN SIDE		GRATE FRAME SUPPORT		GRATE BAR	
PATTERN NO.	17,212		17,939		16,927		15,607		19,458		18,953		18,964		21,343		21,341		18,659		18,661	
PATTERN DUE	2-2		2-2		2-2		2-2		2-2		2-2		2-2		2-2		2-2		2-2		2-2	
PATTERN REC'D.	1-22		1-22		2-5		2-4		2-9		2-10		2-10		2-10		2-10		2-14		2-14	
NO. WANTED PER DAY	1		1		1		1		8		2		2		1		1		1		1	
TOTAL NO. WANTED	8		8		8		8		64		16		16		8		8		8		8	
NUMBER MOULDED	Daily	Total	Daily	Total	Daily	Total	Daily	Total	Daily	Total	Daily	Total	Daily	Total	Daily	Total	Daily	Total	Daily	Total	Daily	Total
1903 FEB. 2																						
3			1	1																		
4			2	3																		
5			2	5			1	1														
6																						
7	7		*1* 1	5																		
9			2	7	2	2	1	2		*P*												
10							1	3	3	3	1	*P* 1	1	*P* 1	*P*		*P*					
11	4	4					1	4	*1* 6	10	2	3	2	3	1	1						
12	*1* 2	5	1	8	2	4	1	5	*7* 2	5	1	4	1	4	2	3						
13					3	7	1	6			2	6	2	6		2	3	3				
14	1	6					1	7	8	13	1	7	1	7					*P*		*P*	
15	2	6			1	8	1	8	*1* 5	17	1	8	1	8	2	4	1	4	3	6	2	2
17									*1* 8	24	1	9	1	9	2	6			4	7	2	4
18									*2* 8	30	1	10	1	10	2	8	2	6	1	8	*1* 2	5
19									*1* 8	37	2	12	2	12			2	8			*1* 1	5
20									8	45	2	14	2	14								
21									8	53	2	16	2	16								
23									*1* 7	59											1	6
24									5	64											1	7
25																					1	8
26																						

Begin moulding not later than date opposite *upper red line*
Finish " " " " " " *lower* " "

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FIG. 22. PORTION OF AN ORDER SHOWING HOW RECORDS IN A FOUNDRY WERE KEPT

The figures in italics represent condemnations. They were usually entered in red ink.

on each of which are entered in the proper column the number of pieces made that day and the total number made to that date. Each column is crossed by two heavy red lines, the upper one opposite the date at which the work should be begun, and the lower one opposite the date at which the work should be completed. These lines have been very appropriately named "danger lines." The positions of the entries with reference to these danger lines, and the amounts of those entries, show to what extent the schedule is being lived up to. If the schedule is being well followed the entries are always in the neighborhood of the red lines, or above them.

Figure 22 represents a portion of an actual order showing how it was filled in the foundry of the Schenectady Locomotive Works. If there is no graphical check on the operations of the foundry, the work that is wanted during a certain week may be spread over three or four; such is often the case, as our records show.

It is an extremely difficult matter for a foreman to get the work done exactly in the order it is wanted. For instance, if we are building two locomotives per day, each requiring four driving boxes, it seems an extremely difficult thing for him to get every day, without fail, at least eight driving boxes. Why this is so is a psychological question, and I can't explain it, but that it is a fact is too well known to admit of discussion. There is a constant tendency when he is rushed with other work to drop to six or seven, with a corresponding decrease in output of locomotives. This tendency to give *about* what is wanted rather than *exactly* what is wanted is the most common obstacle to getting the full output of a plant.

A DAILY BALANCE AS A PERMANENT RECORD

This balance sheet shows not only how much work was done each day, but is a permanent record of exactly how the order was filled, which can be compared with the record of the previous orders and is of great value in planning subsequent orders. This is best illustrated by Figure 22, which shows exactly where failure to comply with the schedule occurred. The letter "P" entered in some of the columns shows graphically the reason for the castings being behind. The pattern was not received until the date indicated. Similar sheets would probably show that it was

A. L. CO. PRODUCTION SHEET. SCHENECTADY WORKS MACHINE SHOP No. 1 ORDER NO. 77 16 ENGINES N.Y.C.

PART		FRAMES										RAILS											
PUR. ORD SKETCH. PAT. OR CARD DR. NO.																							
OPERATION		REC'D		PLANED		SLOTTED		DRILLED		ASSEM'D		REC'D		PLANED		SLOTTED		RE-PL-TOP		RE-PL-BOT		DRILLED	
TO BE BEGUN																							
TO BE FINISHED																							
NUMBER WANTED		15		16		16		15		16		30		30		30		15		15		30	
NUMBER FINISHED		DAILY	TOTAL	DAILY	TOTAL	DAILY	TOTAL	DAILY	TOTAL	DAILY	TOTAL	DAILY	TOTAL	DAILY	TOTAL	DAILY	TOTAL	DAILY	TOTAL	DAILY	TOTAL	DAILY	TOTAL
1903 JAN	20	2	2	2	2							6	6										
	21	2	4																				
	22			2	4							6	12	6	6								
	23	1	5											4	10								
	24	2	7	1	5	3	3							2	12	4	4						
	26	4	11	2	7	1	4					6	18	4	16			1	1	1	1		
	27															4	8	3	4	3	4		
	28	1	12	2	9	3	7	2	2			4	22	4	20	2	10						
	29	2	14	1	10	1	8	1	3			4	26	4	24	4	14	2	6	2	6		
	30	1	15	1	11	2	10	1	4									1	7	1	7	4	8
	31			3	14	1	11	1	5			4	30	2	26	4	18	2	9	2	9		
FEB	2					1	12	1	6	2	2			2	28	4	22	1	10	1	10		
	3			1	15	1	13	3	9	1	3			2	30	6	28	3	13	3	13	2	10
	4							2	11	2	5					2	30	2	15	2	15	4	14
	5							2	13	1	8											4	18
	6					2	15			2	8											6	24
	7							2	15	1	9											4	28
	9									2	11												
	10									1	12											2	30
	11									1	13												
	12									1	14												
	13										15												
	14																						
	18																						
	17																						
	18																						
	19																						
	20																						
	21																						
	23																						
	24																						
	25																						
	26																						

RECORD AS ACTUALLY KEPT

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FIG. 23. GRAPHICAL RECORD OF WORK ON 15 LOCOMOTIVES AS ACTUALLY KEPT

A. L. CO. PRODUCTION SHEET. SCHENECTADY WORKS MACHINE SHOP No. 1 ORDER NO. 77 15 ENGINES N.Y.C.

PART	FRAMES										RAILS											
PUR. ORD; SKETCH, PAT. OR CARD DR. NO.																						
OPERATION	REC'D		PLANED		SLOTTED		DRILLED		ASSEM'D		REC'D		PLANED		SLOTTED		RE-PL-TOP		RE-PL-BOT		DRILLED	
TO BE BEGUN																						
TO BE FINISHED																						
NUMBER WANTED	15		15		15		15		15		30		30		30		30		30		30	
NUMBER FINISHED	DAILY	TOTAL	DAILY	TOTAL	DAILY	TOTAL	DAILY	TOTAL	DAILY	TOTAL	DAILY	TOTAL	DAILY	TOTAL	DAILY	TOTAL	DAILY	TOTAL	DAILY	TOTAL	DAILY	TOTAL
1908 JAN 20	2	2	2	2							6	6										
21	2	4																				
22			2	4									6	6								
23	1	5																				
24	2	7			3	3							2	12								
26	4	11	2	7	1	4					6	16	4	16					1	1		
27	1	12													4	8	3	4	3	4		
28	2	14	2	9	3	7					4	22	4	20	2	10						
29	1	15	1	10	1	8					4	26	4	24	4	14	2	6	2	6		
30			1	11	2	10											1	7	1	7	4	8
31			3	14	1	11					4	30	2	26	4	18	2	9	2	9		
FEB 2					1	12							2	28	4	22	1	10	1	10		
3			1	15	1	13							2	30	6	28	3	13	3	13	2	10
4															2	30	2	15	2	15	4	14
5					2	15															4	18
6																					6	24
7																					4	26
9																						
10																					2	30
11							2	2														
12							1	3														
13							1	4	1	1												
14							1	5	1	2												
16							1	6	1	3												
17							2	8	1	4												
18							1	9	1	5												
19							1	10	2	7												
20							2	12	1	8												
21							1	13	1	9												
23							2	15	1	10												
24									2	12												
25									1	13												
26									2	15												

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FIG. 24. SHOWING HOW FIGURE 23 WOULD LOOK IF THE WORKS WERE DEFICIENT IN FRAME-DRILLING CAPACITY

the draftsman and not the pattern maker who was to blame.

A MACHINE-SHOP BALANCE AND SCHEDULE

Figure 23 is a similar balance sheet for work done in a machine shop on a series of locomotive frames and rails. The order in which the various operations are to be performed has been determined, and the consecutive columns are devoted to the operations in their proper order. It will be noted on this sheet, which is an actual record of work, that the consecutive operations were performed promptly and that there was no serious delay.

Figure 24 represents a record of the same work as it would appear if the works were short of frame-drilling capacity, and the drilling of frames were not done promptly. If it is impossible to make up the delay thus caused the output is limited by it. Such sheets show at a glance where the delays occur, and indicate what must have our attention in order to keep up the proper output. If the delay is always on the same operation we know that we must either get more output from the machine doing that work, or get more machines.

A GRAPHICAL BALANCE AS A HISTORY

A complete set of such sheets for all the work in a plant gives a complete schedule and a daily record of what is being done, and is of the greatest possible advantage if an attempt is to be made to improve the conditions or increase the output of the plant. In fact, if the improvement in the operation of a plant is to be made in a scientific manner, exact knowledge of what is taking place each day is absolutely necessary. Without it, money is often spent wastefully, and but a small proportion of the desired results obtained. In large plants run without such a system of balances it is frequently impossible to tell just what is holding back the output. In a case of this kind the value of such a balance is out of all proportion to the cost of obtaining it. By using the graphical form its value is very much increased, for the general appearance of the sheet is sufficient to tell how closely the schedule is being lived up to. Moreover, such a balance is a history of the way the work went through the shop and is readily comparable with similar work done previously or subsequently, thus enabling us to form a definite idea as to whether the plant is being run more or less efficiently.

This balance of work, or schedule, sheet then gives us a daily analysis of how the work is progressing, and in its graphical form is so easily read that superintendents find it of great value. The man's record shows the efficiency of each man, and the two taken together give us the knowledge, in the clearest way, of what should be done to increase our output.

VALUE OF MAN RECORD AND BALANCE NOT DEPENDENT UPON METHOD OF COMPENSATION

It is not the intention to discuss the making of schedules for doing work, or the subject of compensation for work done, for the keeping of a daily balance of work done and a record of the men doing it are invaluable, no matter what the method of compensation. In fact, I have found the man's record when work was done by the day to be of the highest value, for when men realize that not only their chance for increase of wages, but that of holding their positions, depends upon the amount and quality of their work, they become very much more efficient. Add to this the fact that efficient men, paid in proportion to their efficiency, are invariably better satisfied than less efficient, cheaper men, and we have an added reason for keeping the man's record. Again, a workman easily forgets how many days he has been absent, and how much poor work he has done, and an occasional glance at his record often does him a great deal of good. I first kept such a record in the foundry of the Midvale Steel Company over twenty years ago, and found it so valuable that I have always done it since when possible.

The question is frequently asked as to the cost of keeping these records and balances. In reply I have to say that if such cost were ten times what it is, it would cut no figure.

In day work we buy a man's time, and he frequently gives but little else. Our storekeeper checks exactly the materials we buy, but nobody knows exactly what the day workman has done in the hours paid for. Although we know labor to be the most difficult commodity we have to buy, we give it the least systematic study, and any effort to get an exact record of what we get for our money is the first step toward purchasing it in an intelligent manner. With regard to the balance of work, I can only say that it is hard to estimate the cost of lack of harmony in a plant, and the increase of efficiency produced by get-

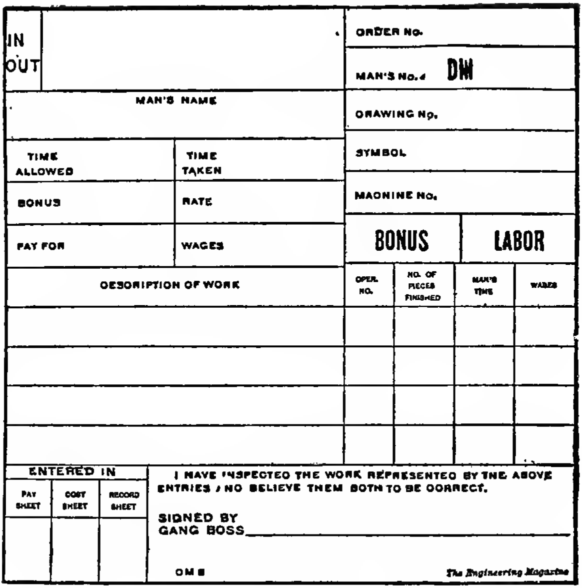
IN
OUT
ORDER NO.
MAN'S NO. DW
MAN'S NAME
DRAWING NO.
TIME ALLOWED
TIME TAKEN
SYMBOL
BONUS
RATE
MACHINE NO.
PAY FOR
WAGES
BONUS
LABOR
DESCRIPTION OF WORK
OPER. NO.
NO. OF PIECES FINISHED
MAN'S TIME
WAGES
ENTERED IN
PAY SHEET
COST SHEET
RECORD SHEET
I HAVE INSPECTED THE WORK REPRESENTED BY THE ABOVE ENTRIES AND BELIEVE THEM BOTH TO BE CORRECT.
SIGNED BY GANG BOSS
OM 8
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FIG. 25. TIME CARD FOR A MACHINE SHOP

ting materials in their proper order rather than according to the judgment of the various foremen is greater than is usually realized.

The value of a balance of some sort is too well understood to need discussion, and the only reason that it has not been adopted is often the fancied cost of getting it. As a matter of fact all I have suggested is so closely allied to the time and cost keeping that when all are done together by the best modern method the cost is not great, although it does cost money to change from one system to another, and the systems in general use are not at all suitable for this purpose. The method referred to is the "time and production card" system, under which a man usually receives for each job a card which is stamped with the time of issuing and of returning.

43 0 4 REC'D ISS'D		CHARGE SYMBOL
OPERATIVE'S NAME		OPERATIVE'S NO. D 4
		MACHINE NO.
TIME ALLOWED	TIME TAKEN	OPERATION
BONUS	RATE	CLOCK READING
		FIRST
PAY FOR	WAGES	LAST
IF WORKING ON BONUS CROSS OUT THIS ☞	LABOR	DIFFERENCE
IF WORKING ON LABOR CROSS OUT THIS ☞	BONUS	YARDS

DETAIL OF WORK ON BACK

ENTERED IN			
SCHEDULE	MAN RECORD	PAY SHEET	COST SHEET

I HAVE INSPECTED THE WORK REPRESENTED BY THE ABOVE ENTRIES AND BELIEVE THEM BOTH TO BE CORRECT. SIGNED BY

FOREMAN__________________

DEPARTMENT D 4 TIME CARD

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FIG. 26. TIME CARD USED IN A BLEACHERY

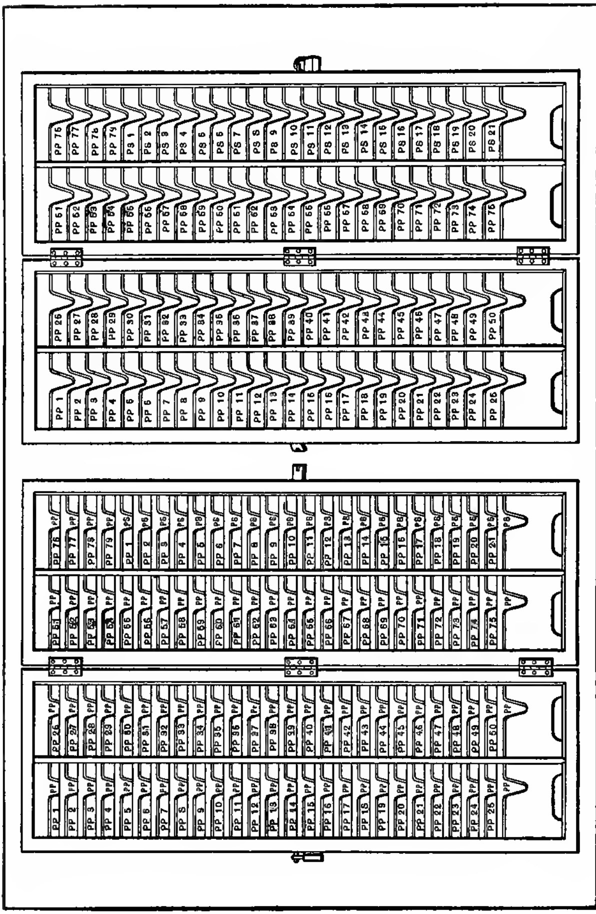

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FIG 27. RACK FOR TIME CARDS

Figures 25 and 26 on pages 282 and 283 are examples of time cards.

These sample cards are stamped with the time work begins and are taken from a card rack, Figure 27, as the men come in at the beginning of the work period. If it is desired to know the time on different operations, the cards are returned to the time keeper at the end of such operations and stamped with the time. A fresh card stamped at the same time is given to the workman. At the end of the work period the workmen place their cards in the rack as they go out.

TIME AND MAN'S RECORD

In order to get a record of the man's time and work for the day, all the cards bearing his number must be gotten together. If these do not give a total of the full number of working hours, the first card of the day must show that he was late, or there must be a pass stating the time he went out. These passes should be of the same size as the cards, and be put in with the time cards and sorted out by the man's number, so that when the clerk begins to enter the time and record he will have all the necessary information for this purpose at hand.

COST

To get the cost on an order the cards are then sorted by "order number" and when the clerk begins to enter up the time or wages against any order, he should have before him all the cards representing work on that order. He is thus enabled to make the final entry directly from the cards, thus doing the work with a minimum of clerical labor.

The total cost of the clerks employed in store-keeping, time-keeping, cost-keeping and the keeping of all records needed for the schedule and production sheets is in some cases as low as 5 per cent of the total pay-roll, and in the ordinary factory should not be over 8 per cent.

PROGRESS OF PRODUCTION

To get a record of the work on any order, the cards which have been sorted out by order number are further sorted by name of part and operation. We thus get together the cards showing on an order the number of pieces on which a certain operation has been finished that day. These are added up and entered directly on the schedule sheet. By this method we can keep an intelligible record of all the work done with a minimum of clerical labor.

DIFFICULTY OF GETTING A DAILY BALANCE

It is not necessary for the purpose I have in mind to dwell further on the details, my object being only to show that the difficulty of getting this daily record of our men and a balance of the work done is not so great as to be prohibitory. In other words, it is an entirely feasible thing to know exactly all that has been done in a large plant one day before noon of the next, and to get a complete balance of work in order to lay out that afternoon in a logical manner the work for the next day.

VALUE OF A SCHEDULE AND BALANCE

The value of such a balance consists in the fact that it makes clear details that no observer, however keen he may be, can see by inspection. It shows us what work is behind and how much, and enables us to trace to its source the cause of any delay. The superintendent sees at a glance what he never could find out by observation or by asking questions. It shows him how efficiently a plant is being run and where the defects in operation are. *In connection with the man's record, it is the most complete analysis we can make of the working of a plant, and the one that will help us most quickly to bring into their proper channels things that have gone haphazard. Such an analysis is far more important than an improved tool steel or a new set of piece rates, for it enables those in authority to see each day how their orders are being carried out.*

ACCOUNTING AND OPERATION

It is my opinion that we can do nothing in a manufacturing plant that will go so far toward increasing the output, or the economy of operation, as obtaining this exact knowledge of what is being done. The cost of getting it is not great and the method of operation need not be disturbed in the least until accumulation of knowledge points out the best course to pursue.

By the adoption of the methods outlined the accounting department ceases to be simply a critic of the manufacturing, and becomes an active assistant to every foreman and to the superintendent. In other words, the accounts cease to be simply records of production, and become potent factors in helping the producing departments to greater efficiency.

SCHEDULE SYSTEM

The instruction card is really a detail schedule which represents our best knowledge of the method and speed of doing work. Hence, this whole system of manufacture, viewed from this standpoint, is a schedule system, and may be *likened to the system of operating trains on a railroad.* The train despatcher is the center of such a system on a railroad, and the head of the "planning office" where all our schedules originate and records are kept has a similarly important job. It is his business to keep the routine operations of the factory going on the lines that have been laid down, and if he does his work properly, an advance once made should never be lost. He is strictly a routine man, and carries out the instructions of the superintendent and the other experts, who study all problems and determine methods of solving them.

ROUTINE AND EXPERT WORK

All work may be divided into these two general classes, and it is an interesting fact that the vast majority of men may be divided into similar classes. We sometimes find a man who can do equally well either kind of work, but this is rare. As a rule a man prefers either to follow instructions day after day, or finds it very irksome to follow instructions at all. The first man usually becomes a good routine man; the second may become an expert if he has honesty, ability to think, and industry. Such men become artists, designers, engineers, investigators, and inventors. They are the men, such as Watt, Fulton, Stephenson, Whitney, Edison, and a host of others, who are primarily responsible for the civilization of today. It is of the greatest importance that such men should be properly trained and utilized.

If such a man has honesty and industry, but no ability, he is apt to spend his time making useless inventions. If he has honesty and ability, but no industry, he is very apt to spend his time telling other people what they should do. If he has ability and industry, but no honesty, he has in him the making of a bank wrecker, or a burglar, as the opportunity offers.

Our manufacturers have given too little attention in the past to this kind of man, and, instead of guiding him, have too often repressed him, to their own detriment as well as his. A proper system of management recognizes that many men belong to this general class, and makes provision for utilizing them.

GENERAL PRINCIPLES AND DETAILS

While this chapter has necessarily been devoted largely to general principles, I have shown enough details to give a general idea of the system advocated, which is one in which the manager *takes the responsibility for managing instead of "putting it up" to someone else.*

While the idea is simple, it has taken a vast amount of work to make the method of carrying it out sufficiently simple to be practicable on a large scale. The attempt to carry this out in a large variety of plants during the past fifteen years has resulted in developing many methods that are common to, or similar in, all kinds of manufacture. This varied experience has greatly helped us to simplify our methods, and those that undertake to carry out this general idea without developing shorter methods than the writer has usually found in vogue will soon be floundering in a hopeless maze of detail, as many have done in the past. These are the men who are wasting so much energy today telling us that this work can't be done.

The failure of one man is no indication that all men will fail, and the energy wasted in attempting to prove such a proposition almost tempts me to offer the following advice given by a celebrated professor to a student who was always trying to tell why things could not be done: "You had better be careful; some damn fool will come along some day and do it."

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