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FACTORY MANAGEMENT WASTES

FACTORY MANAGEMENT WASTES

AND HOW TO PREVENT THEM

BY

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London

NISBET & CO. LTD.

22 BERNERS STREET

W.1

First Published in 1919

PRINTED IN GREAT BRITAIN BY MORRISON AND GIBB LTD., EDINBURGH

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PREFACE

THE purpose of the following discussion is to suggest means for removing some of the prevalent difficulties between employer and employed, between manager and managed. The discussion is based upon extensive personal experience of the writer as student, employee, and manager, as well as on the valuable assistance gained from intimate association with numerous co-workers, who have devoted even more time than the writer to the elimination of industrial waste.

The suggestions are no idle theories, but are intensely practical, as they have been demonstrated by the logic of proved fact. They are not intended to apply to any particular industry, for each factory and industrial establishment has its own peculiar problems. A universal system for the elimination of waste is not possible, but the general principles outlined may serve as a starting-point for those concerned with the solution of this important problem.

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No suggestion is made concerning such proposals as the redistribution of wealth or similar plans of social reconstruction. It is the intention of the writer to discuss the problem as it appears in its present form, under the impression that if there is less waste in industry there will be more money to distribute, which must contribute to the general improvement in the prosperity of the employee, the employer, and the community at large.

Industrial establishments, unlike many philanthropic institutions, cannot depend upon charitable donations for their existence; they must be self-supporting. A factory will exist only so long as it is able to manufacture and distribute its product, as well as, or better than, its competitors. If wastes occur, the cost to the consumer is increased, and the buying public exhibits very little charity, benevolence, or sentiment in its ordinary daily purchases.

Waste is loss; the difference between input and output—the difference between the actual quantity used and the actual quantity required, be it energy, time, equipment, or material. Preventable wastes cannot be excused, nor satisfactorily explained, but the profit resulting from the elimination of waste is pure gain.

The interests of Capital and Labour, of

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employer and employee, are identical and reciprocal. When this great truth is fully realised by every member of an organisation, and it is also recognised that their interests are intimately connected with the elimination of wastes, then the successful solution of a difficult and complex problem is capable of attainment. The problem is not external, but internal; to some extent, eternal.

In many industries the profit is derived mainly from the sale of by-products, a state of things due to the selling price of the original commodity having been so reduced through unintelligent competition as to necessitate the utilisation of waste products. The development of by-products is purely a technical problem, and much highly technical discussion might be incorporated dealing with this subject. Such technique, although important in dealing with certain forms of waste products, has no place in these pages. The subject dealt with herein concerns the preventable wastes in factory organisation and management; wastes not so readily recognisable as those termed by-products, but of far greater importance.

In practice, the average factory is about 20 per cent. technical and 80 per cent. ordinary. The technical portion, dealing with the processing

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and treatment of materials, is usually very efficient and well organised ; the ordinary portion, dealing with the common things, the things which are done, day after day, by routine, is seldom well organised. It is in the latter portion, largely because of unintentional neglect, that the greatest wastes are to be found.

It is the aim of the author to discuss these wastes, their causes, the means for their detection, and their remedies ; and to discuss the subject in such a manner that it will be of interest to the student, the employee, the foreman, the manager, the employer, and the stockholder alike. If the nature of the problem is understood by all concerned, and their co-operation secured, the elimination of preventable wastes can be accomplished without difficulty.

Grateful acknowledgment is made by the writer for the assistance rendered by many co-workers, and for the many helpful suggestions from those executives and students who have so willingly reviewed the subject-matter during its preparation.

JAMES FORBES WHITEFORD.

LONDON, *October 20, 1919.*

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CHAPTER I

INDUSTRIAL CONDITIONS

A PART from the influences which may exist as a direct result of the abnormal conditions obtaining at present in certain industries, manufacturers are faced with the difficulty of diminishing profits.

The cost of material is gradually rising, wages have an upward tendency ; money for renewals or extensions commands a higher figure. All this increases the cost of product, whilst competition tends to reduce the selling prices. These facts confront each manufacturer of any commodity, and from all indications the future holds little hope for increased volume of trade unless the preventable wastes in manufacture are eliminated, or substantially reduced.

The matter is of such importance that leading statesmen, financiers, and business men

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have considered it necessary to draw the attention of manufacturers to the necessity of thoroughly reviewing the entire situation and of instituting such improvements in workshop methods, practices, and facilities as are essential for the well-being of their particular industries. Similar admonitions have been addressed by the same men to the leaders of organised labour in the hope, and that by no means a vain one, that the influence which they exert upon the industrial situation may be carefully considered.

In general, the ultimate objective of a business is a profit on the investment; a net return sufficient to compensate satisfactorily the necessary capital required for the enterprise and the time and energy involved in its operation. As all business ventures must be self-supporting to be permanent, it should not be necessary to mention that all members of the entire organisation have a common interest in the success of the undertaking. Neither should it be necessary for such extensive propaganda to be instituted for the purpose of improving the relations of the various members of industrial organisations unless certain essential matters have been overlooked.

The executives of a business will not knowingly decide upon certain administrative policies

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if such decisions involve the possibility of failure of the enterprise. There are few managers, if any, who are unwilling to abandon existing methods of operation if they are satisfied that more economical means of production are available. Similarly, the managerial staff and the individual workers under their supervision are inclined to support the adoption of less wasteful practices if they are convinced that such changes will result in improvements of conditions affecting their general welfare. The existence of propaganda advocating closer co-operation between the various sections of the organisation indicates the need for a more detailed study of the work of each section.

In recent years the need for this detailed study has become so important that a new branch of engineering has been developed—the industrial engineer, who has undertaken the analysis of the problem of manufacture in order to determine the various factors contributing to efficient performance in factory organisation and management. Their efforts have been directed, first, to improving executive control by engineering methods, in reality much in the same manner as the steam engine, the railway, the automobile, and the aeroplane have been developed; second, in improving the conditions

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of work, education, and environment of the individual operative.

The problem of the mechanical engineer is to conserve both material and energy, and as a consequence the clearance in cylinders and the play in bearings is reduced to a practical minimum. Human energy should also be conserved, since it is of relatively greater importance. But all engineering research is first directed toward discovering the cause of waste, as this information is the basis upon which the effective remedy must be founded. In this connection it is worth while to review briefly the development of industry, for the purpose of assisting the reader to appreciate fully the underlying causes and the appropriate remedies.

In early days, before the term "factory" was coined, the making of wares was a household affair, the majority, if not all, of the family contributing to the production of the article; the purchasing, selling, directing, and instructing being the duty of the head of the household. Business control remained with those who had the money either to buy the raw material and parcel it out to the householders to be returned as finished goods, or to buy the finished product direct from the makers.

Later, with the advent of machinery to replace

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hand work and the steam engine as a prime mover, came the collection of large numbers of workers into the factory, and numerous problems arose in consequence. One of these was the difficulty of disposing of the product, for with the introduction of machinery the quantity produced was greater than could be disposed of in the immediate vicinity, and markets farther afield had to be developed.

The net result of this condition of things was to place the man who could sell in a more dominant position, and so long as a demand could be created in excess of the supply, the cost, or the method, of production was regarded as a matter of relatively slight importance. Further, the confining of the efforts of production to few lines, or even to similar articles, was given scant consideration.

But developments in machinery were extensive, and industry expanded until more and more communities were directing their energies toward manufacture. Machinery became more and more specialised, which resulted in larger quantities being produced, though the scope of the machinery was narrowed proportionately.

With increase in the means of communication and transportation, competition became more formidable, and the question of purchase price

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became an influential factor in the decision of the customer. This factor is destined to become more and more influential in regulating the policies of any concern in a competitive industry.

It follows, therefore, that while the ability to buy and the ability to sell are still of much importance, they do not constitute everything in the management of an industry, for the ability to make must now be regarded as of equal importance with either of them. Successful management involves the efficient co-ordination of buying, selling, and manufacturing, not one of which is of greater or less importance than the others. Modern business, or modern industry, for the terms are synonymous, has therefore, through the introduction of machinery and by reason of various social and economic developments, become a complex institution, wherein the individual as a unit is, in a large measure, obliterated.

In normal times the records of business enterprise over an extended period contain an astonishing number of failures, all of which serve to increase the responsibilities and the difficulties of the more successful. Business failures, whether total or partial, are a prolific form of waste, and this, as well as all other forms of waste that occur in the world, is paid for by the present-

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day inhabitants or by their descendants ; and usually paid with compound interest added to the principal.

When a failure occurs in an industrial enterprise, the capital invested not only fails to yield a profit but the net volume is actually reduced. It follows that all members of the organisation are obliged to suffer owing to lowered wage, temporary unemployment, and enforced change, none of which would have resulted if the failure had not occurred. Further, the public pays for all of these failures through an increase in the price of the various commodities it requires.

These failures have not been deliberate, but have been the direct result of either ignorance of the underlying principles of successful management, or failure in their application. In fact, careful observers have attributed the majority of these failures to inexperience, negligence, and extravagance. It is therefore evident that the number of failures and the consequent waste can be reduced only through a general discussion of the principles underlying success in business, and by providing means for effecting a close check upon actual conditions existing in the business so that preventive measures can be applied before a failure becomes imminent.

When one considers, in the light of recent

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events, the extent to which not only the prosperity and welfare, but even the safety, of a country is dependent upon its industries, it appears to make little difference whether the discussion centres upon the industrial situation before the War, during the War, or after the War. The particular period does not alter the industrial objective, and so any study of the subject must be prefaced by a clear conception of the fundamental purpose of industry. This is particularly true where the subject-matter occupies the attention of many minds each concentrating upon some special section or sub-division.

The primary object of industry is to produce, to convert raw material into a saleable commodity. No theories, however utopian, no sentimentalities, however idealistic, no verbiage, however polished, will alter this fundamental fact.

To produce is the purpose of industry ; to produce efficiently is the purpose of successful industry. Industrial prosperity, which is closely related to the welfare and safety of the people, varies in direct relation to industrial efficiency. Secret processes, patents, tariff duties, and monopolies have only local or temporary influences.

The industrial problem is one of production, which includes both manufacturing and disposing

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of the product with the least waste of material and effort ; for whatever, wherever, and whenever waste occurs, some one pays for it. There can be no moratorium to defer the payment without heavy compound interest being exacted, and there can be no repudiation of the debt. Some one pays.

CHAPTER II

WORKS ORGANISATION

MODERN industry had its origin at some time between the year 1738, when John Wyatt produced a spinning machine, and 1790, when the power loom and the steam engine were given to the world. With the advent of these inventions, the collection of large numbers of employees in factories began, and the consequent problems of administration, now under discussion, emerged.

In the construction of a machine tool there are certain mechanical principles involved which must be followed, if the tool is to render satisfactory service. It seems just as reasonable that there should be certain fundamental principles underlying the management of a factory which must be considered in order to secure effective and economical performance.

Efficiency in a machine is the result of good material, proper design, and careful operation. Rigidity, flexibility, power transmission, lubrication, the proper metal for each part; all these

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points have been carefully studied and embodied in the design according to the particular service required. A factory organisation is very similar ; there must be a definite objective toward which the separate and combined efforts of all members of the organisation are directed.

Many industrial projects have failed, not because they lacked merit, but because those concerned had no accurate idea of the object of attainment and of the regulative principles of operation. Factories have been started without any comprehensive conception of what was to be done, how it was to be done, and when it was to be done. Workers were employed, not so much to perform a specific task, but to occupy their time doing what their foreman told them to do. In many instances the foremen were left to their own volition, since the management did not have a clear idea how the work was to be accomplished and issued orders to the factory organisation with the vain hope that somehow the work would be done properly.

Now an organisation is similar to a machine ; no matter how great the care given to the design and construction of its bearings and to its operation, lost motion, with consequent decrease in efficiency, is produced through constant wear. Failure to appreciate this, and to make the

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necessary provision for remedy, eventually causes discontent and unnecessary friction between the various units of the organisation, with the resultant wastes.

In many factories, when the equipment breaks down, the power fails, the material is poor, or inaccurate instructions cause a decrease in production, the usual procedure is for every one to be reprimanded irrespective of responsibility. In few cases is the situation investigated sufficiently to determine the exact cause so that the proper corrective measures can be applied. Where these conditions exist, little permanent improvement can be reasonably expected until there is a more general diffusion of the knowledge of the principles upon which successful operation and management depend, of the factors involved, of the functions to be exercised, and of the methods by which the various elements can be controlled and co-ordinated.

There are five M's in manufacture—Money, Material, Machinery, Men, and Minutes. Success does not depend upon the available quantity of all or of any one or more of these items, nor upon how well any one of them is organised to advantage, but success is dependent entirely upon the thoroughness with which all of these factors are co-ordinated.

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A factory exists, and will continue to exist, only so long as it can produce and sell its products as well as, or better than, its competitors ; best value or service for the money, and delivery in the shortest time, are the usual factors influencing the decision of the customer.

It is unnecessary to organise money, for it is now so thoroughly organised that it is the medium through which all business is conducted. Systems of credit and exchange are well established, and there are definite standards of weight and value in universal use. But money is not managed. It may be circulated, distributed, deposited ; cheques, drafts, letters of credit, or other forms of exchange, which represent the actual money, may be used, but the term "manage" is not appropriate in connection with such transactions.

It is not necessary to organise material, for it is now purchased by the pound, by the yard, by the gallon, or by some one of the many standards which have been devised for the measurement of different commodities. Again, material is not managed. Executives do not manage wool, or cotton, or steel, or timber, or sugar, or any other of the innumerable materials that constitute the basic elements of the products of manufacture. Material may be handled,

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classified, tested, analysed, mixed, or machined, but not managed.

Machinery is well organised. Machines are built for a definite purpose, and every part, every lever, every gear is designed to perform a certain function contributing to the accomplishment of that purpose. So thoroughly are machines organised that they are usually sold according to definite specifications and guarantees. But machinery or equipment is not managed. Machines are run, operated, or minded, but “manage” is inapplicable.

When we examine the situation thoroughly we find that we do not—in fact, cannot—manage inanimate objects. The term “manage” is applicable only in connection with beings capable of self-determined action. Human beings are managed, so that the important factor, the only factor in management, is the human factor, the human element.

“Organisation” refers to the method by which all of the five factors, mentioned above, are co-ordinated, the plan which permits a number of individuals to direct, both separately and collectively, their several efforts to the accomplishment of a definite task. “Management” refers to the manner in which the actual operation of keeping the members of the organisation at

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work is effected. The problem of any manager consists in the efficient and economic control of this elusive and ever variable human element. In reality, management is about 10 per cent. technique and 90 per cent. psychology.

Now there are distinctive principles underlying effective organisation; there are also definite principles regulating successful management. But the principles of organisation must not be confused with those of management; each must be applied according to the particular problem under consideration, if success is to be achieved.

Responsibility starts at the top, not at the bottom, and managers are successful in direct ratio to the extent to which responsibility can be apportioned to the various members of the organisation. The work must be segregated into the several functions, and the exact limits of each function must be fixed. Responsibilities must be accurately defined, and the less complexity there is in the description, the less liability there will be of confusion in the actual operation of the plan.

In an industrial concern the general functions are — Designing, Purchasing, Manufacturing, Accounting, and Selling; each of these is separate and distinct. The functions should be so defined

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that every department receives the necessary assistance from every other department without disturbing or confusing the responsibilities of the departmental heads.

Designing deals with the product in the pre-natal stage, and the duties of the designer have ceased when the design of the product is complete and the necessary details have been furnished to the other departments. But this does not imply that the work of designing should be conducted without any consideration being given to the facilities for manufacturing.

Purchasing comprises the buying of all materials used both directly and indirectly by all departments in accordance with specifications furnished by those departments. The testing of material is not a function of purchasing; that department is not in a position to know whether the material is suitable for the purpose intended.

Manufacturing consists in converting the raw material into the finished product according to the specifications furnished by the designer. The testing of the raw material to be used must remain one of the functions of those responsible for its employment in manufacture, although such testing requires to be done by a department specially equipped for the purpose.

Accounting embraces the recording and com-

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piling of such data as may be needed by all departments in conjunction with their operations, and of furnishing them in such form that each department may profit from the cumulative experience thus collated.

Selling includes all effort relating to the distribution of the finished products. The products should be those which can best be produced from the facilities available for the purpose, if preventable waste in production is to be reduced to a minimum.

The exact division of responsibility or fixing of its limits depends in all cases upon circumstances. Two or more of the functions named can be assigned to a single individual, or each of these functions can be further subdivided. There must be a head for each section or department, for the line organisation must be maintained, but the aim throughout should be toward more functionalising, so as to make possible greater concentration of effort.

Successful operation consists in securing efficient performance of the several functions concerned simultaneously with the greatest co-ordination of effort throughout the entire organisation. This is possible only when the organisation is so designed that the executives are in full control of the business at all times, and able to

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detect wastes immediately upon their occurrence. This is accomplished by supplementing the regular organisation with a special staff competent to make a detailed study of all factors affecting the operating efficiency, and by providing suitable records so that the management will be constantly in touch with exact conditions in all departments in order that any irregularity or delay can be instantly detected and corrected.

When the various stages in the evolution of factory development are studied, it is found that the problem has always been one of division and delegation of responsibility. Each successive stage has been marked by a greater subdivision of responsibility, and the refinements of present-day practice are no exception.

There must be a head to each department, and certain responsibilities must be concentrated in the individual. The great value of the single command, ably supplemented by competent staff, has been demonstrated conclusively in military operations. In the management of an enterprise decision rests with the directing head, whose time cannot be devoted to collecting the necessary data upon which decisions must be based. The more comprehensive the effect of these decisions, the more necessary it is for the

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executive to be freed from attention to minute details.

The best design of organisation will not take the place of sound business judgment. The organisation plan can only serve to assist the individual executive. Committee management cannot be as efficient and satisfactory as the individualistic plan, but the division and delegation of responsibility must be made in conformity with the natural limitations of individual ability. Committees have not been found effective when employed in executive capacity ; they serve the best purpose when their efforts are confined to advisory functions.

CHAPTER III

WORKS MANAGEMENT

WHEN the making of wares was a household affair, and the head of the household attended to all the intricacies of buying and selling, the individual members of the household performed the various operations. The children combed or spun the yarn, while the mother made the warp and wove the fabric; education was a matter of home training. The receipts were the property of the head of the household; the complex problems of wage payment and the present refinements of costing practices did not arise. The experience gained by the family became, quite logically, the property of the succeeding generation. All responsibility was concentrated in the head of the household; his word was law, and his decision final.

When, through the introduction of power-driven machinery, the work at home ceased and was taken to the factory, the education previously received at the home had to be supplied else-

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where. The result was that this became the duty of the head or master workman of the department; he was entrusted with the same general supervision of a section of the factory, as that previously exercised by the head of the household over its working members. The result was that the most competent worker was selected as foreman, and all responsibilities, all decisions, were concentrated in this single individual. He selected the workers, determined their wage, directed their efforts, decided as to quality of product and all other matters. In some instances he purchased the raw material and disposed of the finished product.

The development of factory management methods and practices has followed no well-defined lines. It has been most haphazard, modifications being dictated by circumstances and immediate requirements. When practices continued without change for a certain length of time, they became traditional, and as such have been accepted by succeeding generations. No one questioned whether the causes which produced them had not long since ceased to exist.

Machines became more extensive; their capacity grew rapidly, their ramifications multiplied, and the operations became more and more

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complex. The head of the department, the foreman, remained supreme ; all of the responsibilities pertaining to his department remained centred in the single individual. These duties were his traditional right.

In the light of present-day practice, it is evident that the requirements were far beyond the rational limits of individual ability long before any effort was made to relieve the head of the department of a portion of his duties. It is probable that many of the present industrial problems, with their inherent wastes, would not have arisen if the adjustments of factory organisation and management had kept pace with the modification of factory equipment and operations.

In the course of factory development, the various individuals, whether managing director, manager, or foreman, have been relieved of certain duties with corresponding benefit to the organisation as a whole. Purchasing, selling, designing, and costing have become independent functions in the majority of factories, while other distinct functions are quite common in many. Further division of duties must follow in the course of efficient development, if wastes are to be reduced.

These changes have proved their value, but

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many executives continue to cling to the traditional methods. In thousands of factories to-day, foremen engage the workers, instruct them in their duties, record their attendance, keep their time, supervise their efforts and inspect their work ; in addition the foremen are required to furnish specifications for material, provide cost information, establish piece or premium rates, and conduct experiments and research work.

Before any great improvement can be effected, two changes are necessary. First, the executives must clearly realise that they are expecting the foremen to do more than any single individual can perform to advantage ; and second, the foremen themselves must admit that it is impossible for them to do full justice to all of the duties assigned to them.

Neither of these changes is easy of accomplishment. Executives so often argue that all the duties assigned are the prerogative of the foremen, and supplement their remarks with the statement that, if their present foremen cannot attend to them, they will secure others more competent. It is therefore no surprise that foremen not only will not admit they are overloaded, but often strenuously oppose any modification in their duties. Nor can it be the cause of any wonder that foremen have often been

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driven by force of circumstances to protect their position by every means within their power. This policy is perfectly natural, for it is usually found that when any improvement in a department is discovered to be possible, the Managing Director feels that the foremen should be dismissed immediately. Before progress is possible, there must be a certain reversal of the mental attitude of the Management toward the condition of affairs.

Foremen have never been trained for their positions. They have been selected because of ability in some particular feature, but it is unreasonable to expect that ability to do one thing well indicates equal ability in all things without the necessary training and instruction. If executives would realise this and provide accordingly, the provision for adequate instruction of foremen in all of their duties would at once disclose the fact that these duties were far too numerous. Even though this fact is realised, the usual step is to provide the foremen with an assistant, but this only means that there are two individuals in place of one overloaded with the same duties. The logical course is to relieve the foremen of certain functions, and the results obtained confirm the wisdom of this policy.

A foreman is an executive ; he is paid for his

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ability in this respect. He should not only be relieved of all functions which can be organised independently to advantage, but he should not be required to be either a messenger boy or a clerk. His work is to lead the workers in his department towards higher achievement, to study methods for effecting greater loyalty, co-operation, and concentration, and to improve the human element in every respect within the rational limits of individual executive effort.

No individual can do everything to be done in a modern factory ; neither can he do many things well. Concentration on certain functions enables the ability of the individual to be more effectively utilised and promotes greater efficiency in operation. It is no less necessary and advantageous to relieve these minor executives of certain work involving attention to details than it is in the case of the Managing Director and other major executives. The influence a foreman may exert toward increased contentment among the workers under his supervision is sufficient reason for providing every facility for his ability and initiative to be given full scope.

Foremen are gradually being relieved of all duties respecting timekeeping. In some factories they are required to initial the time cards as an

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endorsement of the accuracy of the time distribution, but mechanical time-recording is the general practice. Research and experimental work are now conducted in laboratories and separate workrooms specially designed for the purpose. The setting of piece rates has been generally recognised as work requiring the undivided attention of a staff whose training has fitted them for this particular purpose. The inspection of work between operations is now conducted by competent workmen under special supervision; and the instruction of workers, especially apprentices, is, in many factories, attended to by an independent organisation. Latterly, the employment of workers is coming to be considered sufficient to occupy the entire attention of certain individuals.

To each of these changes many foremen have had difficulty in becoming reconciled, and the success of the plan is often temporarily delayed because the foremen either were not consulted, or opposed the alteration for fear of losing their prestige. As a rule, foremen are loyal to their employers, but their influence in any matter bearing on factory organisation and management is such that their sympathetic support should be secured before any alteration is made. Tradition has given the foremen certain rights; these

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should not be disturbed without their approval, if the new plan is to succeed.

Many executives have endeavoured to steer a middle course by leaving research and similar development work to be conducted under the direction of the foremen. This is a mistake, for it only serves to increase the duties of the foremen when they should be lessened. Further, there are few factories to-day where departments are self-contained, so that any change must involve several departments, and it is better to delegate single individuals to be responsible for certain functions in all departments.

Modern methods of manufacture involve numerous operations on the same material at different stages. For this reason, foremen have found it necessary to attempt to keep in touch with the work in other departments in order to accommodate their work to the demands of the situation. This is one of the most prevalent causes of waste in any factory, as it involves considerable loss of time and energy on the part of the foremen, and must have the effect of reducing the output in their respective departments. This waste can be eliminated through controlling the movement of material through a central office where the work of each department will be planned in advance.

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Concentration of effort is not only desirable ; it is essential to the ultimate success of any undertaking. The immense value of such a course has been so clearly demonstrated in all fields of human endeavour that opposing arguments find no support in practice. Industrial enterprise is no exception, for the ramifications of present-day factory administration cannot be successfully *executed* by a single individual.

The foreman of each department must be so relieved as to enable him to concentrate on securing quality and quantity of output from the operatives under his supervision in order to ensure the delivery of material according to the needs of other departments, and to maintain the discipline necessary for effective operation. In other words, he remains as manager of his particular department, his prestige is in no way affected, but he is left more free to apply himself to the particular tasks for which he is fitted.

CHAPTER IV

PRODUCTION CONTROL

FAILURE in meeting delivery dates is one of the prime causes of waste in factory operation. Promises are made to customers when the order is secured by the salesman, but the factory manager finds great difficulty in effecting delivery on the date promised. In many instances, owing to pressure of circumstances, preference is given to certain orders, with the result that several other orders are considerably delayed and the routine of the manufacturing departments is seriously dislocated.

Delays in making deliveries are doubly undesirable. In addition to causing general dissatisfaction to customers, these delays are exceedingly detrimental to effective and economical operation. No promises should be made by salesmen without first securing confirmation from the factory, and no dates should be confirmed by the factory management unless they can ensure deliveries on the dates promised.

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This is one of the most difficult problems with which the average manufacturer has to deal, and the reputation and goodwill of the firm is largely dependent upon its successful solution.

Thorough investigation of the situation often discloses a substantial item of expense in the tracing of delayed orders in the factory and in attempts to satisfy disappointed customers. The same expenditure of money and energy, properly directed, will enable all material in process of manufacture to be properly recorded at the various stages, and to thus permit definite delivery dates to be established and attained.

Without a pre-determined schedule of operation, it is practically impossible for the factory management to make reliable promises of the delivery of goods. Under these circumstances, the salesmen are placed in an unfavourable position for securing orders in a competitive market, which condition must react to the detriment of the enterprise. The only satisfactory method is to provide adequate means for establishing delivery dates before the material enters the factory and for ensuring reliability in operating performance.

I once telegraphed to a prominent English manufacturer for an appointment to discuss certain matters, and received an immediate reply

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fixing 3.30 p.m. on the following Thursday for the conference. During that discussion, I complimented him on his system of planning his time, and he hastened to assure me that he found it necessary in order to avoid waste.

I asked why he had not applied the same plan to control the efforts of the several thousand workers under his supervision. He replied that he had considered the matter very thoroughly, but had decided the work was so varied and the operations so complicated that a time-table for his employees was not practicable. I suggested that the reasons offered made the proposed plan all the more necessary.

Some factories work entirely on orders received direct from customers ; others manufacture for stock and supply their products from the finished store. In certain industries there are few factories engaged in all of the operations from the raw material to the finished product. For example, in the manufacture of textiles, some factories produce the yarn, others weave the cloth, while others are engaged in dyeing and finishing off the fabrics. Each factory in each industry has its own peculiar problems.

No two factories are similar in every detail of organisation and operation. Each factory should be thoroughly studied in order to deter-

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mine the best plan for controlling the movement of material and for regulating the output. Further, each individual department should be carefully investigated, for the same method of control may not be suitable for every department. The best method must be developed for each department independently, but with the whole plan designed so as to ensure entire co-ordination of effort among all departments.

It may be regarded as axiomatic that the greater the variety of lines produced and of the productive effort required, and the greater the irregularities in size of orders and deliveries, the greater the need for a central control to regulate the movements of all material in progress and to direct effectively all inter-related and interdependent effort.

Such centralised control in conjunction with the systematic planning of the daily routine of each department has served, in certain factories, to increase the productive capacity of individual departments by as much as 150 per cent. In fact increases of 60 per cent., and even 100 per cent., in the total output of factories are not uncommon as the result of the application of these methods.

In all factories the production is planned. The foreman plans the work of each individual

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under his supervision. Wastes result, not because the foremen do not plan, but because they do not plan collectively; their various efforts are not co-ordinated. For such planning to be effective, each foreman has to keep thoroughly in touch with the progress of the work in all departments, a necessity which diverts attention from the work requiring his special supervision. Planning of work which concerns several departments must be comprehensive in order to secure economical employment of labour and equipment.

Despatching must be conducted in direct conjunction with planning, as material must be moved from department to department according to the pre-determined schedule. It would not be possible for every foreman to be familiar with the varying requirements of all departments; hence the advantage, in fact the necessity, of creating a special staff for this work is apparent.

With a central office established to deal with the analysing, distributing, and routing of all orders on the factory, the staff can, by means of certain essential records, make the necessary adjustments from day to day, or hour by hour, and thus maintain the proper balance between the various departments. It is necessary, before this staff can begin work, to analyse thoroughly

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the conditions under which the product is manufactured, in order that the best form of control can be established and the most suitable method for regulating the output developed. The plan of control is important, and failure may occur if the attempt is made to install, without previous study, a plan which has proved satisfactory elsewhere.

If the product consists of a single article and each department contributes to the completion of the work, the problem of planning is much simplified, as it is only essential to provide for the necessary operations in the proper sequence. Should the product consist of several articles, each passing through all of the departments in regular quantities, the planning problem is not difficult to solve. When, however, the product consists of numerous articles, which neither pass through all of the departments, nor require the same volume of productive effort, the planning problem becomes more complex. In each case the nature of the work must be thoroughly analysed before a decision can be reached as to the exact problem involved and the best method of approaching it.

Where the work of a factory consists of single orders for one piece which may never be reproduced, the basis of planning must necessarily

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be estimates of time required. Delays between operations are therefore to be expected, and under certain circumstances detailed planning may prove too expensive for practical purposes. Similar conditions may exist where orders are received for several pieces for which there may be no repeat orders. No differential wage system is practicable in these factories owing to the uncertainty of the time required for the work to be performed, and the probable gain from specialised planning is considerably diminished.

Where repeat orders are received at irregular intervals for either single pieces or a number of pieces, centralised planning may be found advantageous, but this must be determined according to the peculiar conditions existing. If it is possible to secure these repeat orders at regular intervals, the value of planning the daily routine becomes more and more evident. The greater the regularity in the quantities required and the periods for delivery, the more effective will planning be in ensuring economical performance. If it is safe to assume that, wherever conditions warrant the installation of a piece-rate or other differential wage system, the creation of a special staff for pre-determining the daily work for each department will prove a profitable investment.

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In those factories where stocks of finished products are maintained, the regulation of production is more easily controlled than in those where manufacturing is for direct orders ; nevertheless, the method of control must be carefully considered. Replenishing of depleted stocks can be effected either by manufacturing large quantities of each product intermittently, or by manufacturing small quantities continuously so that a regular flow of finished goods into the store is maintained. The nature of the products and the operating conditions are the influential factors in deciding on the method to be employed.

Whatever the plan of control adopted, accurate data of the capacity of each department must be prepared for use by the planning staff. Reliable schedules of work cannot be furnished if it is not known how much work can be delivered by any one department within a given time. All planning is based upon the amount of time required to perform the necessary operations, and this amount should be ascertained from existing records of performance. Where reliable records are not available, the operations should be actually timed or estimates of the time required should be secured from the foreman.

In addition, it is necessary for a complete record to be compiled of each article to be manu-

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factured. This record will contain a list of the operations involved, their sequence in the process of manufacture, and the departments or machines where each operation is performed. Where the finished article is composed of numerous parts, it will be found advantageous to deal with the component parts as individual units.

All of these parts will not go through the same departments, neither will they all have identical operations, nor the same sequence of operations in any department. All elements of the finished article must, however, reach the assembling room at the proper time, and in the proper quantities for effective operation. The route, number, and length of the operations involved in the production of each element must be carefully tabulated for guidance in planning. With these data as bases, the special staff is in a position to plan the daily routine of each working unit.

The working units should be as small as is practicable; preferably small sections of departments. In the machine rooms, the unit may be a single machine or a group of machines; in the erecting departments, an individual worker or group of workers. The size of the working unit must be determined by the nature of the work, but the smaller the units can be made

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with advantage, the more effectively the work can be kept under complete control.

A work schedule should be prepared for each working unit rather than for departments. The manufacture of each element of the finished article must be scheduled step by step through all intervening units, and the date on which each element should enter the process of manufacture must be carefully determined. Otherwise, some of the elements may not reach the assembling department at the proper time, and extensive delay may be caused in the erection of the complete article.

Before the schedule of work to be done is actually prepared it is necessary to ascertain that there is a supply of material on hand sufficient to permit the planned work to be completed. The buying of the material required must be in accordance with the needs of the factory as indicated by the records of the Planning Office.

When the schedule is furnished to the several departments, records must be kept of the deliveries from each working unit, in order that comparison may be made daily with the schedule of requirements. It is also the duty of the planning staff to see that the material for each unit is moved in accordance with the pre-arranged

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schedule of work. If it is found that the work schedule has not been completed, the relative influence of each failure upon the other inter-related units must be studied. It may be necessary to make alterations in the schedule in respect of these units for the days following in order to avoid confusion later.

Where work which may be required urgently in other departments is delayed, the planning staff are in a position to decide whether extra-time should be worked to permit the department in question to meet the schedule, or whether the work of the inter-related departments can be re-adjusted without material loss in output. These are matters which must be handled in accordance with the needs of each particular situation; no definite rules can be made to cover all cases.

Preparing a work schedule for machine operation is a simple matter, as the capacity, speeds, feeds, and similar data can be readily ascertained. Records of machine production are easily obtained. The most difficult problem is planning the work to be performed by hand or where the machine output is determined largely by the operator. The human factor introduces uncertainty in quantity and quality of production.

For that reason, special effort has been directed in recent years to developing means for

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ensuring greater reliability of production in work involving extensive manual operations. Material specifications have been carefully studied, operations and working conditions have been standardised, definite working instructions have been supplied, and detailed education facilities have been provided. The more extensive and complex a factory organization becomes, the greater is the need for regular and reliable production in each unit in order to avoid delay and dislocation in the work of other units.

Delays will occur from various causes—machines will break down, the power may fail temporarily, belts may break, material may prove faulty during the machining process, or work may be spoiled either through ignorance or neglect; the causes of delay are numerous. The Planning Office should have a complete record of all delays and of all variations between the planned and the output returns. This information should indicate the changes necessary to eliminate similar delays in the future. The extent to which this information is recorded and tabulated is dependent upon the particular conditions obtaining.

Performance records must be closely watched, as many delays may be considered too insignificant to record when regarded individually

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but when taken collectively may constitute the main reason for the normal production of the factory being so much below the maximum possible. With such information available, the necessity for adjustments in staff or alterations in equipment becomes so apparent that they are usually instituted immediately. In the absence of definite information, it might be thought that the delays are of too little consequence to justify alterations. Without these detailed records no executive is able to detect all of the wastes of time and energy in the departments under supervision.

A planning office is an instrument of control, the medium through which the orders are delivered to the manufacturing departments. If alterations are made in a pre-arranged schedule, there will be a reduction in output; the fact that a central control exists does not permit extensive alterations to be made without affecting the production. When orders are altered, the planning staff, through their ability to keep in touch with the constantly changing conditions in factory operation, can make the necessary adjustments in order that the product may be delivered in the shortest time and at the minimum cost in productive energy.

Intelligent and accurate planning, with strict

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conformance to the schedule, and thorough analysis of results, together with the necessary correction of defects, will eventually produce conditions that will ensure regularity and reliability in both factory output and product. Regular and reliable production enable delivery dates to be promptly met in factories that work to individual orders, and permit of a reduction in the quantity of materials in process of manufacture, or a reduction in the stock of finished goods, in factories that work to stock orders.

The primary object of a planning office is to ensure complete control of production and thus relieve the managers and foremen in order that they may concentrate upon more important duties. If this function of control is consistently exercised, the movement of material throughout the various processes from the raw state to the finished product will be effectively checked at each stage of manufacture. The planning records are the starting-point of all calculations for costing, wage-payment, and storekeeping purposes, and the recording of production should be designed to serve these important functions in factory management.

The supervision of the Planning Office requires considerable executive ability, and the position should carry the title of Production Manager.

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The selection of the personnel of the staff should be undertaken with great care, as those in charge of each section of this important department must be capable of sharing the responsibilities involved.

The Production Manager should report to and receive his instructions from the Works Manager, or, if necessary, from the Managing Director. The duties of the office should be clearly defined so as to avoid any overlapping of jurisdictions or confusion between those responsible for planning and those responsible for operation. The Planning Office is a service department, and should have no authority respecting the management or discipline of the operating departments.

Weekly meetings should be held, attended by the Planning Office principals and the foremen of the main factory departments for the purpose of discussing the general production plan and such other matters as are incidental to the attainment of the greatest co-ordination of effort among all departments affected. At these meetings the experiences of the previous week should be fully discussed, and proposals submitted for further improvement in securing adequate control and economical performance.

The creation of a special staff for planning

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implies that there must be a definite manufacturing policy to be followed. There must be something to plan if planning is to be effective. Comprehensive administrative planning is essential in present-day factory management and operation, and this must include the co-ordination of the problems of production and distribution.

The inclusion of this latter problem necessitates the close co-operation between the production and sales organisation. The factory must produce the articles which the sales department can dispose of in a competitive market, and the sales organisation must devote their energies to creating a demand for the articles which the factory equipment and organisation can produce to the best advantage. The business policy of the enterprise must be sufficient to permit the greatest co-ordination of the efforts of these two branches of the business.

The centralisation of production control will enable the output of the factory to be secured with a minimum of waste in productive energy, and will remove the necessity of a dominating personality in factory operation and management. Such functionalising will not serve to provide means for the employment of idle factory equipment, for this responsibility must remain with those entrusted with the task of securing orders

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from prospective customers. Idle equipment is a source of substantial waste in many factories, and effective production control will serve to indicate where waste-prevention measures can be profitably applied.

CHAPTER V

MATERIAL

MATERIAL remnants produced during manufacturing operations are classified under the general term of "scrap," and, being visible, receive a certain amount of attention. An appreciable increase in the size of the scrap heap occasions investigation, and, as a consequence, efforts are directed, for a period at least, towards reducing the amount of scrap. It is questionable if the real cause is discovered in all cases; whether, in fact, many wastes do not exist for which no corrective measures have been taken.

Decision as to the nature of the material to be used and instruction as to the method of treatment during the process of manufacture fall within the province of the technical section of a factory organisation; usually these matters receive the attention they deserve. Wastes of material may result, however, through inefficient management methods which fail to provide for effective co-ordination of the designing, pur-

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chasing, and manufacturing sections, for proper methods of storing and issuing of material, and for means of ensuring that the wastage in each manufacturing process is kept to a practicable minimum. The resulting losses should be classified as material wastes to distinguish them from the legitimate wastage which is quite properly known as scrap.

Minor details of design are often decided without consideration being given to the question whether such decision may involve waste both in the purchase of the material and in the manufacture of the article. Dimensions may be established without careful study of the sizes in which the material required is usually marketed, which neglect may necessitate the purchase of a special size at an increased price per unit. Specifications of many articles in common use may be loosely prepared or even omitted entirely, leaving actual decision to be made by those responsible for the purchase. More attention directed to these essentials will often serve to eliminate many minor wastes which involve substantial losses in the aggregate.

For example, cardboard, paper, tin plate, bar iron, etc., are marketed in certain commercial sizes. These sizes are supplied at a lower price than special sizes unless the latter are purchased

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in quantities sufficient to permit the mills to produce them economically. Further, as the mill machinery is fitted for producing material of certain established dimensions, the range of sizes which can be furnished to advantage on special orders is comparatively limited. This should receive the attention of those concerned with the design of articles manufactured from such material.

In one factory, no attention was given to this important matter when the dimensions of the cardboard containers were established, with the result that the waste of cardboard reached alarming proportions. Effort was then directed toward adjusting the dimensions of the containers to suit the cardboard sizes in order to reduce the volume of waste in manufacture. These adjustments were accomplished without disturbing the variety of shapes desired, and the weekly accumulation of cardboard scrap was reduced by several tons.

In another factory, it was found necessary to stock thirty-five different sizes of paper to avoid waste of material in the manufacture of the various sheets required. Practicable adjustments in the dimensions of the finished articles reduced the number of sizes of paper to be stocked to six of special dimensions. The special sizes

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were required in quantities sufficient for them to be purchased at the market price of standard sizes.

The designs of the various sizes of office specialities were developed without consideration of the probability of having certain component parts common to all. Numerous special sizes of raw material, therefore, had to be stocked, or substantial wastes incurred during the manufacturing operations. Standardising of the components served to reduce their number by more than 50 per cent., and permitted commercial sizes of raw material to be stocked. Further, the standardisation afforded opportunity for quantity production so that the capacity of the factory equipment was increased by not less than 45 per cent.

In each of these instances the initial designing could have been conducted so that the same results were secured, but the matter had been overlooked. Reference might also be made to those cases where the design of an article has been materially altered to conform to the suggestion of a special customer, when a slight modification would have served the purpose and prevented subsequent waste of material. The influence of the details of design upon the cost of manufacture is so far-reaching that the whole position

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should be reviewed carefully before final decision is made, in order to avoid preventable waste of material.

Of next importance is the question of purchase. The purchasing agent too often permits his decision to be governed by the unit price of the material, when the gain in first cost may be more than lost through waste in manufacture. The manufacturing departments are in the best position to know the material most suited for their requirements, and their decision should be the guide for the purchasing department. The factory should furnish definite specifications as to the kind and quantity of material required, and the buyer should see that the material conforms with these specifications.

It is the function of the factory to test the material before final acceptance, since the equipment is not capable of instant or extensive adjustment and the material which can be used is confined within rather narrow limits. But this testing as well as the furnishing of material specifications belongs to a special section of the factory rather than to the department actually using the material. The necessary research to determine the exact kind of material suitable for manufacturing purposes cannot be conducted by the regular manufacturing department without

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considerable waste of time and energy, if not of material.

The great value of research work in industrial enterprises has been ably demonstrated in recent years, but this work must be conducted independently of the regular organisation. A separate department should be responsible for making the experiments, for providing the purchasing section with the required specifications, for testing the material received, and for furnishing the regular manufacturing departments with the working particulars. The advantage of having such work done independently is that it not only permits the needed concentration on the work, but it ensures that all experiments will be conducted in the proper manner and that all experience gained will be systematically utilised in the future. This will not obtain if experiments are conducted in a haphazard manner by the various departments throughout the factory.

In engineering works it is essential that the manufacturing departments be furnished with detail drawings and working instructions containing the necessary information as to the method by which the raw material is to be converted into the finished product. It would be disastrous to have drawings furnished from which the dimensions of the parts had been omitted and

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allow those important details to be decided by the making department. So important has the technique of material become that all available information respecting its use should be collated and precise instructions furnished for the guidance of those concerned.

In other factories definite recipes and formulæ should be furnished to the manufacturing departments ; nothing should be left to the decision of the individual foreman or worker. Reliability of product is a most essential item in present-day manufacture, but this cannot be assured in the absence of definite specifications of material for purchase, and detailed recipes and precise working instructions for manufacture. The day has passed when haphazard or uncertain methods can be permitted in any factory, if the best results are to be secured and preventable waste eliminated.

Apart from the question of securing the proper material for manufacturing purposes, wastes may exist owing to error in the quantity purchased. Purchasing policies must be dictated by factory requirements and market conditions ; the factory must be supplied and the market fluctuations must be closely watched. It is essential, therefore, that the factory requirements be pre-determined for periods sufficient to enable

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the buying of the material to be accomplished to the best advantage in respect to time and quantity of purchase. The pre-determining of material requirements is also a function of the factory staff, although the co-operation of the sales department in anticipating the probable demands is very necessary.

Assuming that the buying of the material has been arranged satisfactorily, the next step is to ensure that there will be a minimum waste of material before it is actually delivered to the manufacturing departments. This involves the providing of suitable storage accommodation and adequate supervision in order that the material may be properly classified, and reliable records kept of receipts and issues.

Many factory executives are content to have all material delivered direct to the factory department using it even though the material purchased at one time is sufficient to meet the factory requirements for several months. The net result of this practice is that great difficulty is experienced in securing accurate returns of the amounts of material issued for manufacturing purposes. When one considers the care and attention given to the checking of the quantity of material received, and to the verifying of invoices and the approving of vouchers for pay-

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ment, it is a matter of surprise that practices are not in effect to exercise similar control of the expenditures of the material after it reaches the factory.

Responsibility for material in stores should be concentrated in some one not directly connected with its use in manufacture if accurate returns of material issues are to be secured. When practicable, all raw material should be stored in a building separate from those used for the regular factory operations; if this is not possible, then the material should be stored in a separate room, and this room be placed under the jurisdiction of the stores department.

The general supervision of the stores department should be assigned to the Production Manager or to the Cost Department Manager, in order to ensure adequate control of issues, for accurate stores records are the prime requisite in reliable cost figures. All material issued by the stores to the manufacturing departments should be accurately measured; each issue should be covered by a properly authorised requisition showing Date of Issue, Quantity, and Order No. or Account No., to which the material is to be charged.

A stock ledger record should be kept for each kind and size of material stored, and the receipts

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and issues should be promptly recorded. In this manner a perpetual inventory can be maintained, as the balance between the receipts and issues will indicate the stock on hand at any moment. These balances should be verified periodically by actual count in order to detect inaccuracies in the stores records. The test checking of material in stock should be conducted by the Accounting Department staff, who have no responsibility other than the auditing of the entries of all expenditures.

Careful attention to the question of storage of material may reduce much of the waste now arising in that particular section. Fragile or other easily damaged material should be stored with a view of eliminating as many handling operations as possible, while all material should be arranged in the store in such manner as to be easily accessible. These matters should be given consideration in determining the details of the design of the stores buildings, as the cost of handling material may reach substantial figures.

Economy in storage space can be effected by reducing to a minimum the kinds and sizes of raw material, such reduction being another important result of standardisation of design. The question of maximum and minimum quantities to be stocked should be carefully studied,

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in order that the storage space can be arranged accordingly. These stock limits are important, for when properly authorised they provide means for the stores department to regulate automatically the purchasing of material so that the necessary supplies will always be available.

The design of buildings for stores seldom receives the attention it deserves. As a rule, the distance between floors is too great to allow the available space to be used to advantage. Where the ceilings are high, the upper portion of the storeroom cannot be occupied without incurring excessive handling expense or involving considerable damage to the material lying at the bottom. Store buildings should be designed for the particular purpose, and full advantage should be taken of the special equipment available for handling material in large lots with a minimum of labour and equipment expense.

For the purpose of ensuring efficient use of material in the manufacturing departments, some factories have all material issued to the factory through a material supply department. This department receives all material from the stores, cuts it into the proper length or assembles it in the proper quantities for the work in hand, and issues it in this modified form to the making-up departments. In this manner all material

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drawn from the stores can be definitely controlled. The material supply room is furnished with a standard requisition by the Planning Office or the Cost Office, which requisition contains a full statement of the quantity of raw material to be drawn from the store and the method of disposing of the material so covered.

Means should be available for recording the quantity of material at each stage in the process of manufacture, in order that the exact shrinkage in each operation may be determined. For this purpose all material moving between the factory departments should be accompanied by a suitable delivery note which can be approved by the department receiving it, and then passed to the Cost Department to be tabulated. Whenever practicable, independent checkers should be stationed between the main departments, whose duty would be actually to measure the quantity of material passing from one department to another.

It is generally recognised that a certain shrinkage or waste of material in process of manufacture is unavoidable, but many managers are satisfied to charge up certain losses as shrinkage without giving the matter thorough investigation. Certain records of the movement of material are essential in good organisation, so

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as to determine whether this shrinkage is in excess of normal, also to ascertain if the customary normal figure is correct, or in need of revision

Where there is a tendency for the material to gain weight through absorbing moisture, as in the case of textiles, or to lose weight by evaporation, as in the case of soap or similar products, some managers are inclined to the opinion that these difficulties are such that an accurate check is either not practical or too expensive. Material is so important that all shrinkage calculations should be verified periodically in order that there shall be no opportunity for negligence or extravagance on the part of the manufacturing departments.

The necessity for complete and adequate control by means of records of material passing through the factory should not be underestimated. There should be a constant check upon all material in progress, and a balance effected at each stage in the manufacturing operations; it is only in this manner that efficient use of material can be ensured. Otherwise, preventable wastes of material may exist for a considerable period.

Of equal importance with the controlling of material issues and goods in process of manu-

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facture are the storage and recording of the finished products delivered by the factory. The practice of permitting finished articles to remain under the supervision of the manufacturing departments until they are required for shipment to customers is quite common. Under such circumstances accurate records of production are difficult to obtain, and damage to the finished goods is much more likely.

The failure to provide a stock-room to receive and classify the deliveries from the factory may be attributed to the opinion commonly held by managers that theft is the only source of waste. Protection against theft is secured by regulations covering the conditions under which anything except personal property may be taken from the factory. In the absence of accurate records of goods finished and delivered by the various manufacturing departments, it is not possible to determine the waste resulting from this or other causes.

Material is money in a different form, and as such is liable to deterioration, shrinkage, theft, damage, and loss in handling. Means should be available for disclosing the waste due to all causes from the time it is first received in the raw material stores until it has been reconverted into money by disposal to the cus-

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tomer for the factory products. The cost of material is increasing steadily, which serves to emphasise the necessity for adequate control and auditing of all expenditures throughout all of the stages of production and distribution,

CHAPTER VI

MACHINERY

SINCE the advent of the steam engine as a prime mover, power-driven machinery has been one of the important essentials in factory production. So important has machinery become that to-day it is proving the bulwark of the civilisation of the world ; it will also prove to be the salvation of the industrial situation in the future.

Machinery is as necessary in industry as either material or labour, and efficient utilisation of material can only be accomplished through the employment of machines. The industrial world is only entering upon the era of machinery, and in the near future the uses of machinery will probably be substantially increased. Meanwhile, extensive wastes must exist by reason of continuance of hand operations.

In the past, the introduction of machinery to replace hand labour has aroused certain hostility among the labour immediately affected. The strenuous opposition of the Lancashire

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weavers to the introduction of the power looms is a prominent example. This was largely due to the fear of the weavers that they would be deprived of a means of earning a livelihood; but this fear was unfounded, for while the number of weavers in Lancashire in 1840 was approximately 5000, the number at present is upwards of 270,000.

If the necessity for the more extensive use of machinery in industry was more generally understood and appreciated by employees, and if employers took the workers into their confidence more in this respect and made provision for the employment of all who may be temporarily inconvenienced, it is doubtful if the hostility would be in evidence.

This view, however, is not shared by all students of industrial economics, as a recent review of the conditions in industry contains the following comment upon the attitude of labour towards machinery: "The question is not one of the worker's remuneration, but of his position and self-respect. The tendency of work under modern conditions to become a mere mechanical routine, and of the worker himself to become dehumanised during his hours of labour, is at the bottom of the wide-spread intellectual revolt against the industrial system. This feeling is

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not only a natural one, but it is based upon sound instincts."

Such a statement requires considerable modification, as it does not appear to be fair to the numerous classes of workers engaged in machine operation. It is exceedingly difficult to imagine a taxi-driver carrying his passengers on his back lest he become dehumanised as a machine minder; or a ploughman to cease minding the plough and to dig up the soil with his hands for a similar reason.

The author of this criticism seems to be firmly convinced that operating machines is both revolting and degrading, and that individual and independent producers are to be preferred to the complex factory organisation where the co-operation of the many is an essential requisite. He says, however, "It will be admitted by most of those who have thought upon the question that a complete return to the old conditions of handicraft is impossible. It cannot, at any rate, be contemplated as a practical programme for the near future."

Under this plan one man could be an automobile maker while another could be a steamship maker. It may be admitted that an automobile could be made in entirety by a single craftsman, and might be composed of beaten copper, decora-

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tive scroll work, hand-carved oak, and so on throughout. This is possible, but the sum required to purchase and operate the product would preclude its employment for any practical industrial purpose.

How long would it take a single shipbuilder to build unaided a *Britannic* or an *Iron Duke*? If we contemplate the suggestion of a return to what is implied by "the old conditions of handicraft" the efforts of the shipbuilder craftsman must be confined to row-boats.

Were it decided that this craftsman idea should be applied to combing, spinning, and weaving machinery, and that a single individual should construct without assistance a carding engine, a comb, a spinning frame, or a loom, what would become of the textile industry where equipment charges constitute such a large proportion of the investment? Further, if the craftsman idea, as suggested, is carried back to the older conditions, and all machinery in Yorkshire and Lancashire was abandoned and hand weaving instituted, a large percentage of the inhabitants of the United Kingdom would have to go naked as the result.

On their reservation in New Mexico, the Navajo Indians weave their famous blankets in the most primitive manner. The wool is carded

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and combed on a small comb, spun on a crooked stick, and woven entirely by hand ; the design exists only in the mind of the weaver and is applied as the work progresses. Several weeks are often spent upon a single blanket, which sells for ten shillings and upwards per square foot.

There are the old conditions of handicraft ; no machines, no dehumanising, no intellectual revolt. When the conditions in which these people live and work are recalled, the knowledge that any responsible person should have contemplated even a partial return to these conditions excites no small wonder.

It is not to be disputed that the introduction of machinery arouses a certain hostility among the labour immediately affected. The same may be said of the introduction of any new method, although objection to change is not confined entirely to the workers, for foremen, managers, and even employers are not always willing to entertain suggestions for altering established practices. An extensive installation of machinery may involve certain alterations in labour distribution and may induce temporary individual hardship, but in this respect Labour is not alone.

When the steam engine was introduced as a prime mover the value of a watercourse location of a factory diminished as the proximity to fuel

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supply was found more advantageous. With the introduction of electrical generation and transmission the value of the watercourse location improved. With the development of the steam railway, the value of highway communication decreased, but with the development of motor traction the value of the highway appreciated.

These changes entailed serious losses in the immediate localities affected, to Capital as well as to Labour, but no discussion, however lengthy, will alter the situation. The introduction of new machinery may cause certain local inconveniences, but the same is true when another manufacturer gets the business, or when alteration in fashion directs trade into new channels.

Modern economists judge a civilisation by the number and complexity of its wants. The luxuries of yesterday are the necessities of to-day. Human tastes and desires cannot be controlled nor curtailed in the interests of any particular group of manufacturers or of their employees. When the demand is sufficient, the attention of inventive genius will be directed toward the development of machines sufficient for the needs.

It is inconceivable that human ingenuity in machine development should be denied its legitimate field for fear that the product of such

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endeavour may ultimately affect the personnel of some established industry. It is equally inconceivable that, for a similar reason, the great mass of humanity must be deprived of the privilege of enjoying the innumerable commodities which machine production makes possible.

Shall benefits similar to those resulting from the printing press, the power loom, the steam engine, and the automobile be prohibited for the reason that their introduction may dislocate the daily routine of a comparatively few individuals? Must the waste resulting from the failure to employ machinery wherever practicable be imposed as a permanent burden upon humanity at large, and particularly upon the labouring classes, who constitute the large majority? The influence of this burden is apparently overlooked by many of the industrial economists, with a resultant detriment to the welfare of the class they aim to serve.

As an economic matter, the employment of machinery in industry must be either good or bad. No middle course is possible; the use is either beneficial or detrimental. If beneficial, then the employment of machinery should be extended; if detrimental, then it should be abolished. The interests of the many must be

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the decisive factor rather than the interests of the few.

As a matter of fact, the abolition of machinery is neither practicable nor economical. Without mechanical equipment, production of even the bare necessities of the masses could not be accomplished. Further, efficient use of material is not possible by hand-working methods, so that the elimination of preventable wastes in material involves the installation of more and more machinery. The hope of the future lies in machinery, and it is futile for any individual or group of individuals to attempt interference with this development.

If the employment of machinery resulted in a general reduction of the demand for labour, then the greatest unemployment should exist in those countries where the greatest amount of machinery is in use. In the United States, where the mechanical horse power per individual worker is considerably higher than in any other country, there exists the greatest demand for labour. In this connection it is also interesting to note that the hours worked per week are less and the wages paid are higher than in other countries.

But the waste problem is not solved by merely installing the necessary equipment, for machinery alone is not enough. It is not sufficient to place

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machines in a building, to provide the necessary facilities for driving them, and then leave them to establish their value unaided. They must be controlled and operated to be really useful. Machines are instruments for performing definite functions in manufacture, and performing them with marvellous exactness. They are designed and purchased for a definite purpose ; and are only capable of delivering that definite purpose ; but the investment involves charges which must be paid. It follows that no machines should be purchased unless there is sufficient demand for their services to warrant the investment ; and further, if they are purchased, plans should be developed so that they serve the purpose intended.

Owing to the constant attention given to improvement in machine design, existing equipment may, in a large measure, become obsolete, but each replacement should be justified. Less modern machines may, by the improvement of some section, be made relatively equal in productive capacity to the newer designs. Each machine should be carefully studied before it is decided to incur unnecessary expenditure for those of more up-to-date construction.

The introduction of high-speed steel for use in engineering works has practically revolutionised

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the design of machine tools during the past twenty years. The more prudent managers gained the major benefits resulting from the new steel by replacing the essential wearing parts of existing machines with others of sufficient strength to withstand the heavy wear imposed by the newer conditions. Reckless scrapping of equipment may involve wastes of equal magnitude to those resulting from failure to recognise the value of improved designs.

Intimate association with administrative methods confirms the opinion that few managers are in a position to decide whether an existing machine can be profitably modified or whether the wiser course is to replace it with one of higher capacity. Records of individual machine performance, which must include maintenance costs as well as production figures, are the exception rather than the rule in the average factory. A manager should know from day to day what each machine is doing, but he should also know the relation the actual production bears to the possible output; otherwise the relative advantage of other available equipment cannot be determined.

Hasty conclusions should not be reached in respect to the erection of additional buildings or equipment, as the elimination of all preventable

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wastes in existing facilities may be sufficient to accommodate substantial increase in business. New buildings and new equipment must represent a considerable increase in capital investment, and over-equipment is a source of waste which should not have been permitted.

One manager, faced with the problem of increased production which apparently involved an extension of the factory, arranged for an independent investigation of the possibilities for further improvement in the productive capacity of existing equipment. The resultant changes in administrative and operating methods served to produce a 65 per cent. increase in output.

In the several works of a large engineering firm, the standardisation of tools and the centralisation of their manufacture permitted the maintenance costs to be reduced from £97,000 to £44,000 per annum. The business increased 35 per cent. during the period required to institute the betterments.

A careful study of the causes of belt failures in another engineering works and the application of corrective measures reduced the average number of failures per month from 296 to 71, while the average cost of maintenance was reduced from £208 to £52 per month ; a reduction of 76 per cent. in failures and 75 per cent. in

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maintenance cost with a substantial gain in machine and power performance.

The chairman of another firm where plans had been prepared for the erection of a new power plant arranged for a competent engineer to be employed for the purpose of investigating conditions. Preventable wastes were discovered in the generating, transmission, and use of power, the elimination of which would increase the capacity of the existing facilities by not less than 35 per cent. This report was so startling that it was challenged, but after a test of several days it was proved that the proposed power plant, requiring an investment of £13,000, was unnecessary.

Each individual factory presents its own individual problems. Analytical study of conditions in any department of any factory has always disclosed a volume of preventable waste sufficient to make the study an exceedingly profitable investment. The methods of machine operation must be closely studied and carefully analysed so that minimum and uniform effort will be secured. Equipment, either wholly or in part, should be standardised wherever practicable, as this makes possible improved efficiency in operation together with reduction in cost of maintenance. The elimination of wastes, both of

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material and time in machine operation, must also result in the saving of power. In fact, the whole problem of preventable wastes of machinery must include the study of every factor involved.

Where the production is largely a matter of machine operation, the study for determining the proper operating speed for each kind and quality of material is of special importance. In the average factory some machines are speeded much too fast, others are speeded much too slow ; in each case the machine should be operated at whatever speed is proved to be the best.

Many managers are content to have the machines operated at the speeds recommended by the machine manufacturers, although the latter have no definite information concerning the variables of the materials used when the machine is in operation. Others are satisfied to make provision at the start for operating the machines at certain definite speeds, but take no steps to ascertain regularly whether the correct speed is being maintained. Few managers test the speeds of the shafting periodically, although the waste of power in transmission is very extensive.

Regularity and reliability are the two essentials of power generation and transmission,

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for the extent of high speed machinery in ordinary factory use is such that substantial waste of time and material may easily result from irregular or insufficient power supply. The usual result of analytical study of machinery wastes is to disclose the necessity for thorough investigation of the operation of the power plant.

The transmission of power must be reliable, and this means that all driving mechanism must be kept in proper condition. The best method of ensuring a minimum of waste in power transmission is to have a standard speed for each machine and to record and verify these standards regularly. If the speed is found to vary from the standard, the belts and pulleys should be examined and the cause located so that the proper corrective measures can be applied.

It is not uncommon in textile mills to find the managers carefully reviewing the piece-rate earnings of the operatives for the purpose of detecting lack of application, while no attention is paid to ensuring a regular power supply so that the machine speed will be uniform. In textile manufacture, the greatest losses are occurring when the machines are idle and the operators are at work, and, conversely, the greatest output is being secured when the machines are at work and the operators are

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idle. The necessity for devoting the greatest attention to maintaining proper machine speeds, for keeping complete records of machine stoppages and scrutinising them thoroughly, needs no emphasis.

Under the most favourable of conditions, from 25 per cent. to 30 per cent. of the power generated is absorbed by transmission losses, so that approximately only 70 per cent. of the power developed by the engine is available for useful work at the spindles. This is important by reason of the fact that power represents a substantial portion of the operating expenses in the average mill. Losses in transmission of 50 per cent. and even 60 per cent. are not uncommon.

As the power transmitted by belts varies with the humidity of the room, and the quantity of material processed is similarly influenced, it is essential that air-conditioning in textile mills be given every attention to ensure reliability in these respects. The proper lubrication and inspection of bearings is an important matter, and this should be done regularly by those competent to handle such jobs. The supervision of this work together with the adjustment and repairs of belts should be concentrated rather than left to the managers of each department.

Power generation is a most important item,

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and unless this is closely supervised, much preventable waste may result. The cost of fuel is equal to fully 50 per cent. of the grand total of all expenses of power generation, and consequently the use of fuel requires the greatest attention. The best means of prevention of waste in this respect is the provision of suitable instruments and records for the guidance of the power plant employees. For this purpose the quantity of fuel used, the quantity and temperature of water delivered to the boilers, and the quantity of steam delivered by the power plant should be definitely measured, as in this manner suitable performance records can be compiled over extended periods. The CO₂ recorder, the draft gauge, the steam and water meters, the temperature record, and analysis of the flue gases are some of the means by which the causes of waste can be discovered.

In recent years so much specialised attention has been given to the subject of power generation that accurate standards of performance have been established. Comparison with these standards enables any manager to ascertain definitely the extent of preventable waste in the power-plant. This is one of the very few factors in industrial management for which reliable performance standards have been developed.

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As the result of this specialised study and continued experiment, the generation of power has reached a high state of efficiency. One of the most influential factors in securing these results has been the development of instruments for providing accurate, reliable, and immediate records of performance. But these instruments have been largely provided for the guidance of the operator rather than for use by the manager in the office.

Formerly, the steam gauge to show the pressure and the water gauge to indicate the position of the water in the boiler were considered to be sufficient for the assistance of the stoker in the power plant. For the elimination of waste, it has been found necessary to provide the operators with every means for making their efforts effective and for instructing them in the use thereof. Reliable records of performance are also provided to keep the manager advised of the exact position.

It seems probable that similar methods must be adopted for assisting the operator to eliminate the preventable wastes of machine operation in all departments of the factory. Power plant employees, particularly the stokers, are usually the least skilled of all of the factory operators. The installation of reliable performance-guides

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and detailed instruction has proved valuable in this instance, and it is not unreasonable to assume that similar benefits may be secured elsewhere by the adoption of similar methods. Progress in waste elimination depends largely upon the attention given to this important feature.

CHAPTER VII

THE HUMAN ELEMENT

MANAGERS of factories are usually too much inclined to regard the waste due to the human element as something to be tolerated. They have failed to appreciate the great advantage to be gained from studying and developing this somewhat elusive and variable factor.

On the other hand, considerable attention has been directed by industrial investigators to the study of fatigue and the waste of human energy resulting from strain and overwork. Substantial contribution to this study has been made by the experiments of scientists on animals. Research of this nature is highly desirable, even though application of the results obtained may be exceedingly difficult to realise in practice.

Industrial fatigue experiments convey to the popular mind an impression of much abused workers being compelled by force of circumstances to make undue effort. Yet these same workers may exert themselves even more violently

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in a football or cricket match and the observing public has only applause ; and, in fact, condemns the player who fails to make a spurt at a critical moment.

Science is an impartial judge. When the principles underlying fatigue have been developed conclusively it is not unlikely that the vexing problem of muscular and mental effort will be regarded in its true perspective. Meanwhile, hasty conclusions should not be reached as a result of mere appeal to the emotions.

Practical results have, however, been obtained at this stage of the experiments, and manufacturers are taking the steps necessary to prevent the wastes which these studies have shown to exist. Fatigue results not so much from the amount of effort expended, as from insufficient care being given to selection, control, instruction, welfare, and environment. Preventable waste of human energy exists in each of these factors.

Unlike material and machinery, the human factor cannot be standardised. A study of each individual is necessary to ascertain his (or her) capability of performing a required service. Fatigue comes more quickly if the individual is not adapted either physically or mentally to the work.

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Human beings differ in respect of physical and mental endowment, environment, and training, so that their value in any organisation is dependent upon the care given to the selection and assignment. Glass transmits light and copper transmits electricity, but an attempt to employ one in place of the other will produce negative results. Workers may be similarly situated, and students of fatigue must give this matter careful consideration if their efforts are to possess practical value. If, for example, a tall man should be employed on work involving much bending or stooping, or a short, heavy-set man should be assigned to work necessitating constant walking about, the fatigue experiments will not serve any useful purpose.

Individuals vary in their qualifications and aptitudes to as great an extent as do materials or machines, but the selection and assignment of employees in general is unscientific and haphazard. Employment practices are not in keeping with the modern methods which have been frequently adopted in other parts of the industrial establishment.

A man applies for work, or answers an advertisement to fill some particular vacancy. He is asked a few questions concerning his education, his experience, his last position, the union

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to which he belongs, and, perhaps, he is given an oral or written examination. In many instances, even those preliminaries are omitted, and the man is sent to interview the foreman or the head of the department interested. More commonly, if the applicant does not appear objectionable to the foreman, or to the superintendent, he is taken on for trial. In fact, he usually obtains the position largely upon the estimate he advances as to his own individual ability.

Very few workers are familiar with their own qualifications, and, consequently, should not be permitted to decide as to their competency for any position. Neither can the particular qualities of the applicant for work be recognised off-hand by an observer who was not specially trained to the scientific study of persons.

The primitive process of trying out workers for positions is costly from nearly every standpoint and entirely out of place in any modern industrial establishment. It is estimated that the net loss resulting from the employment of new workers ranges from £10 to £20 per individual. As the ratio of new workers employed during the year to the total on the pay-roll is seldom less than 30 per cent. and often as high as 250 per cent.,

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the waste resulting from inefficient employment methods represents an extensive loss annually in any industry.

The qualifications of a foreman differ from those of a worker, and this difference must receive full consideration in their selection. The usual practice for selecting foremen is to choose a particularly skilful or diligent worker, or perhaps one having a record of long and faithful service. These performances should receive full recognition, but they should not be regarded as indications of executive ability. Managers must carefully select those to be placed in charge of others, as such positions involve greater responsibilities than are usually recognised.

The employers must be familiar with the requirements of each particular task and position of a supervisory character in order that the entire personnel may be selected and assigned in an intelligent manner. If the requirements are not known, the employers must resort to the expensive method of trying out, although it would be difficult to imagine the result if similar ignorance obtained with respect to material and equipment.

The existing personnel of a factory organisation should be closely studied. Expert investigators have found that fully 75 per cent. of the

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individuals in the average factory are badly placed. Intelligent readjustment has often served to increase the output by as much as 40 per cent., as workers were thereby engaged upon work for which they were better suited.

A poor performance need not imply a lack of application on the part of the individual. Even though lack of application is in evidence, there is no assurance that work cannot be found where the interest will be sufficient to induce continuous and effective effort. No worker should be dismissed until the possibilities of employment in other capacities have been exhausted. In this connection it is a matter for surprise that so few managers and executives are thoroughly familiar with the latent abilities of the members of their own staff. The development of foremen and executives within the ranks of the existing organisation is, from every standpoint, preferable to the introduction of individuals from outside to fill the positions.

Efficient training raises the grade of the worker and makes possible selection from the ranks for positions of responsibility. It also has the ultimate result of securing an organisation wherein all members contribute to harmony, co-operation, and improved efficiency in performance; an organisation fully equipped to

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meet the constantly increasing demands of progress and intensive competition.

Employees, educated and encouraged in their work, automatically increase their earning power. There is no better method for improving conditions and increasing profits than by systematic instruction and by encouragement of initiative on the part of the existing staff. Under proper guidance and direction, the individual members of a factory organisation will display the same interest in their work as the members of a cricket team do on the field. The great captains of industry have been and are, above everything else, successful managers of men.

In their misguided efforts to overcome what they consider inherent difficulties with the human element, many managers have turned their attention toward machinery, thinking that in this manner they eliminate the trouble. The net result is that factories are considerably over-equipped for existing requirements. But in truth, however much machinery is installed, the human element is not eliminated; its importance is only greatly accentuated. Machines must be operated to be useful, and the more efficient the operating is, the more useful will the machines be.

The executives of industries are intent upon

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profit, and rightly so, but they often fail to realise that there is no profit made on a machine, nor on a machine operator. The profit is made on the article produced by the machine as the result of the operator's efforts. Well-constructed and elaborately-equipped buildings filled with expensive machinery of the latest design, and supplied with an abundance of the finest of raw materials, do not serve the purpose intended until competent workers have been selected who apply themselves to their several tasks.

Management, in its truest sense, consists in directing the human element, training the workers in their tasks, encouraging initiative, recognising ingenuity, rewarding effective effort, and enlisting the hearty support and thorough co-operation of each individual in the organisation.

Comprehensive systems of apprentice instruction are now in operation in many factories. But education, to be effective, must be based upon sound lines, and be designed for the particular purpose in view. There may be many ways of performing the same operation ; but there is one best way, and this should be determined and instructions issued accordingly, so that there is a minimum waste of effort.

A trained mind is necessary for studying an

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operation and for deciding as to the best method of performance. In complex operations it is advisable to separate the individual elements and study each element as an independent operation. It may be found advantageous to make careful note of the motions made, so that wasteful and unnecessary movements may be eliminated.

Such detailed analysis of operations is termed "time study" and "motion study," and innumerable instances might be given where study of these minute details have resulted in substantial elimination of wasted energy. The cinematograph has been used with much success in the original investigation and in subsequent instruction, but it is evident that such means can be profitably employed only where repeated operations are involved.

In the past, factory managers have not been disposed to go to the expense of such intensive study and instruction, under the impression that the best methods will be developed by the worker. Incentives to this end have been provided in the nature of piece-rates or bonus rewards for efficient performance. The results obtained where the question has been carefully investigated demonstrate conclusively that such incentives do not accomplish the purpose.

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Some students of industrial subjects hold decided objections to detailed analysis and instruction. Their argument is that these practices are dehumanising in that they tend to destroy the individuality of the worker. If this view is correct, then the specification sheet for the testing of material, the detailed drawing of the machine part, the temperature chart for use in the heat treatment of metals, the recipes for the manufacture of food products, the Jacquard card-set for controlling the designs in weaving cloth, and the chemical formulæ for the bleaching and dyeing of fabrics must be discontinued.

Well-intentioned but misguided economists have condemned the practice on the assumption that workers are reduced to the position of mindless automata. In fact, many attempts on the part of managers to improve conditions have been temporarily frustrated owing to these accusations. Intimate knowledge of the subject confirms the opinion that these economists are unwittingly prejudicing the interests of the great mass of industrial operatives.

The coach of a rowing crew studies the individuals under his care. He studies motions, fatigue, and rest periods, and the greater attention given to these matters, the better are the results obtained. It is difficult to understand

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the distorted perspective of any one who could stand on the banks of the Thames with Oxford and Cambridge rowing a dead heat as they pass under the bridge at Barnes and designate the sixteen members of the crews as mindless automata.

Fatigue students, if their work is to accomplish the results desired, must profit by the methods of study and instruction as practised by the athletic coach and the gymnasium instructor. Avoidance of undue strains can result only from a detailed study of conditions and from observance of the minute instructions so developed.

Education of apprentices and semi-skilled workers must receive greater attention in the factories if preventable waste of effort is to be reduced to reasonable limits. The traditional method of educating apprentices by association with the master craftsmen must be abolished. Skill in performance is no indication of skill in instruction, while the contrary is the assumption underlying the traditional method. Improved methods of education are as necessary in the factory as elsewhere, and there is no good reason why the usual period of apprenticeship should not be substantially reduced if the training receives the attention it deserves.

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Of equal importance is the necessity for studying the length of the work day and the hours of labour. In the Lancashire and Yorkshire districts, where the factory day begins at 6 a.m., it has been found that some of the operatives must ride as much as forty minutes on the tramcar to reach their work.

In order to begin the work day in proper condition, it is essential that workers should have a warm breakfast first, but as this would necessitate rising not later than 4.30 a.m., the prevailing method is to begin work without breakfast. Food is carried to the factory and eaten cold during the breakfast interval at 8.30 a.m. It is no small wonder that studies of fatigue in these textile mills furnish such alarming deductions.

It is unreasonable to expect satisfactory results from workers unless they begin the day in good physical condition, and this implies the discontinuance of the pre-breakfast period. In fact, there appears to be every assurance that under suitable organisation methods, the output of the present fifty-three-hour week can be secured in a forty-four-hour week of five and a half days of eight hours per diem.

Another important item is the study of rest periods, a matter that has been receiving con-

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siderable attention from engineers and others whose efforts have been directed to developing the productive efficiency of workers in general. No definite rules can be laid down on this head which are capable of universal application, as these matters can only be determined after careful examination of all of the influencing factors.

The experiments of F. W. Taylor in the handling of pig-iron, and of Frank Gilbreth in the laying of bricks, are notable examples for the guidance of all industrial managers. In each of these cases the individuals were carefully selected, the facilities for working were suitable and adequate, the method of working was definitely outlined, and the instruction in the performance of each task was complete in every detail.

Attention must also be directed toward eliminating the wastes resulting from bad working conditions. Among these may be enumerated poor lighting and inefficient ventilation. According to investigations made by competent engineers who have specialised on the subject of illumination, insufficient lighting is responsible for as much as a 15 per cent. loss in productive capacity.

Modern factory buildings offer, in the area

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of glass employed, a distinct contrast with many of the older buildings used for factory purposes. As much as 75 per cent. or 80 per cent. of the wall area is devoted to windows as compared with 40 per cent. in the older type of building. Similar contrasts are in evidence in the provision of adequate apparatus for proper heating and ventilation of the workrooms and offices.

The intensity of illumination necessary for effective operation can be calculated for each variety of work, and failure to provide this assistance to the workers involves much preventable waste. Accidents are more numerous, and the volume of spoiled work is greater in those factories where illumination has not been given the necessary attention. It is estimated that adequate illumination can be provided at 1 per cent. of the cost of the waste resulting from the absence of this requisite for good work.

The volume of pure air required every hour by each individual in a workroom or office is definite, and the cost of furnishing this requirement can be readily determined. The failure to provide the necessary apparatus for efficient ventilation is owing to the fact that managers are not acquainted with the loss resulting from its absence. Of equal importance is the provision

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of adequate facilities for heating during inclement weather. Workers cannot be expected to work effectively if the rooms are not comfortable, for all persons are directly influenced by their immediate surroundings.

The great demands made upon industries during the four years of war in producing munitions and other supplies for military operations have developed the necessity for detailed study of working conditions. As a result of this study, attention has been directed toward improvement in the numerous matters grouped under the general term of welfare work.

Increase in production and decrease in the amount of human energy involved has been clearly established in those factories where the subject was thoroughly studied and where the application of efficient welfare methods was effectively organised. The managing executives in these factories have given their unqualified approval to the methods employed, and the records of performance are sufficient to justify their statements that the gain from waste elimination was more than sufficient to pay for the expense of maintaining the service.

In the past, the efforts of the early advocates of welfare methods in industrial establishments were generally attributed to philanthropic or

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paternal motives. In the light of more recent experience, where the conservation of human energy simultaneously with increase in productive effort was of national importance, the practices instituted by the pioneers of this important industrial movement have received a well-merited but much delayed recognition. This is by no means the least important of many valuable lessons to be learnt from the industrial effort during the war.

The critics of methods of industrial management often lose sight of the fact that the advocates of these methods have been and are directing their efforts toward the conservation of human energy. The detailed analysis of conditions has as its primary object the discovery of means for eliminating the preventable wastes arising from haphazard selection and assignment, improper environment, and inadequate instruction and control.

The investigations concerning industrial fatigue must, however, be made on a wider scale. These studies have as yet been devoted entirely to the workers at the machine or bench, but the studies must be extended to include also the executives. The human element at each of the various stages in the administrative scale is subjected to the detrimental influence of fatigue

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equally with those whose efforts have been receiving much needed attention during recent years.

Executive fatigue should be subjected to intensive study, and means must be developed for the avoidance of strains resulting from overwork. The influence of individual fatigue upon the work of an organisation varies directly with the importance of the position occupied by the particular person affected, and fatigue on the part of an executive must react adversely upon the entire organisation under his direction.

Many industrial disturbances and their resultant wastes would have been avoided if the factory executives had been free to investigate and remove the minor causes of discontent, the neglect of which has such disastrous consequences. It is probable that the majority of labour difficulties have not resulted primarily owing to real disagreements between employer and employed as much as owing to the fatigue imposed on executives by the absence of suitable organisation methods of affording relief. Those persons who are to direct the efforts of others must be made the subject of fatigue investigations as well as the individual workers.

The human element will always remain the most important feature of industrial enterprises

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irrespective of the plan of the administrative organisation. Recent developments have disclosed excessive wastes resulting from the neglect of the study of this factor, and means must be devised for ascertaining the location and the extent of these wastes in order that their elimination may be effected.

Managers should remember that each name on the pay-roll represents a human being capable of intensive development. Permanent benefits cannot be secured in an industrial organisation without careful attention being given to the selection, assignment, and training of the personnel. Reasonable expenditures directed toward the provision of proper working conditions and of the conservation of human energy will prove to be a profitable investment.

CHAPTER VIII

PERFORMANCE RECORDS

IN the absence of reliable records, the volume of preventable waste in a factory cannot be measured properly, nor even estimated correctly. No manager is able to detect all wastes by mere observation in the regular routine of his work. Neither will a statement of the actual waste be of value without supplementary information relating to the primary cause.

Waste material, being visible, usually receives considerable attention. In a few factories the material waste is regularly recorded at each operation, but in the majority the attempts to determine the extent of wasted material are only periodic. In fact, quantities of material are often wasted regularly without the management being aware of the occurrence or of the possibilities of prevention and of reclamation. The steady increase in the purchase price of material is tending to direct greater attention to this important matter.

But the waste of material may be of much

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less importance than the waste of time and effort, for these may occur constantly without such knowledge on the part of the management. A system of reliable performance records should be developed in order that the management may ascertain the exact position with respect of the last-named wastes in each department. Further, the performance record of each individual in the factory organisation should be made available for the information of the executives without these records being subjected to any other personal influence.

The most important of all factory records are those having as their object the registering of the actual performance of individual service. In the average factory reliable records of personal performance are the exception, and not the rule. Few managers have records sufficient to correctly indicate the actual quality of service rendered by the individuals under their control. They should provide for a regular and reliable survey of the efforts of each individual so as to remove the possibility of injustice in making awards.

As the members of a factory organisation may number several thousand, it is impossible for the management to be directly in touch with each individual member. When the opportunity

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for intimate acquaintance has thus been removed, the executives of an industrial enterprise must devise means for effecting direct contact in some other manner. The absence of this contact may easily lead to unfortunate developments unless each member of the organisation is made to feel that the quality of his service is recognised.

The great bulk of human beings are honest, but no individual, however well intentioned, can be entirely free from personal prejudices. The conception of what constitutes fair play depends, after all, upon the relative point of view, but the point of view of an individual may become distorted without realising the consequences which may ensue from a biased perspective.

It is an unfortunate fact that, in many factories, promotion, extension of privileges, and even increases of wages depend largely upon the favour with which the individual concerned is regarded by his immediate superior than upon actual merit of efficient service. The far-reaching influence of such a system should not be underestimated, for favouritism and personal bias may play a prominent part in the selection of individuals for rewards. This condition may easily have the effect of making the less fortunate an easy prey to pernicious agitation.

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Every member of an organisation holds his own interest paramount, but no individual is entirely at ease when he feels that he is living in the shadow of some one higher up in the scale of position. Means must be provided so that each individual may feel assured that his record is always in evidence and that it is influenced in no way except by his own actions.

The operatives at the machine or bench, the numerous foremen, the various superintendents and managers—the quality of service rendered by each of these must be the basis of his individual performance record. In order that these records may be useful, it is necessary that suitable standards of performance be developed, and that each person affected be made fully aware of the nature of the standards.

There are standards of time—the hour, the day, the year; there are standards of measurement—the inch, the foot, the yard. There are standards of value, standards of weight, standards of quality and of strength of materials. All of these standards are beyond the influence of any individual, and have been developed and perfected from time to time as necessity required. It is equally necessary that standards of performance should be developed with respect to individual service, if the preventable wastes

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in factory organisation and operation are to be eliminated.

These service standards must have reference to the punctuality, deportment, attendance, discipline, skill, and application of the individual worker. Late arrival, poor deportment, irregular attendance, and insubordination are no less detrimental to successful accomplishment than failure in actual performance of the task. An irregular worker with a pronounced tendency to fail to conform to general instructions may easily destroy the discipline and disrupt an entire organisation notwithstanding the efforts of the best manager.

Standards of quality of workmanship are generally recognised, as the inspection of parts in process of manufacture has become a necessity in the modern factory. Instruments of precision are used to determine accuracy of such parts in order to avoid difficulties in subsequent operations and to ensure reliability of product. Standards of application are being gradually developed, but this development implies a detailed study of the work to be done, the method of operation, and the preparation of definite working instructions.

These studies will disclose the existence of great wastes for which the operator is in no way responsible, although without this study the

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failure is attributed to lack of application on the part of the operator. Managers must learn that their responsibilities do not cease when the worker has been assigned to a job.

Conditions of work must be standardised. The material must be suitable within certain definite limits, and the machinery or other equipment must be capable of performing the functions involved. The power supply must be reliable, the lighting, heating, and ventilation must be adequate, and the instructions must be sufficient for the purpose. Without these requisites, records of individual performance are unreliable and misleading as a measure of application and diligence.

Executives, whose only effort to ascertain the relative qualities of the workers consists in a periodic review of the piece-work earnings of the individuals concerned, will do well to study the whole situation in a thorough and consistent manner. Variation in piece-work earnings may easily result from inaccurate rates and from difference in the working conditions imposed rather than from lack of application. The latter conclusion is, unfortunately, altogether too frequent on the part of those who are not usually prone to snap judgments.

Again, while records for visualising the per-

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formance of managers exist to some extent, in the majority of cases the unit of measurement has not been developed with a clear idea of the factors involved. Ease in calculation appears to have been given greater consideration than the actual value of the record in securing the results desired.

It is a common practice in some industries to give prominence to the percentage of turnover consumed by operating expenses—the operating ratio. This ratio is extensively quoted by financial persons as a measure of the soundness of an investment, and, from an investment standpoint only, this figure may possess some value. When it is used as an indication of management performance, as is now the common practice, it serves only to mislead and often is of extremely doubtful value. Established usage is supposed to confirm the value of the standard adopted, so that it is difficult to eradicate it even though its fallacious character is easily demonstrated.

Unstable market conditions may increase or decrease the selling prices of the product so that the total turnover is not directly under the control of the management. Similar conditons may alter the purchase price of the raw material, or of fuel, which is an important item in the cost of factory operation. These factors may readily

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affect the operating ratio quite apart from any efforts of the management.

Another equally misleading standard for measuring managerial efficiency is the cost per piece, the cost per ton, or other common unit. If the factory product was a single article involving an equal effort on the part of all departments, and the material and labour unit prices remained stationary, the employment of this standard of measurement might then serve some useful purpose. As the majority of factories have a number of products, each requiring various degrees of productive effort which must influence the material and labour costs, the attempt to develop a common unit for measuring performance is useless.

Other executives, realising the need for having a standard more directly related to the management of the factory, have attempted to compare the relation between "productive labour" and "non-productive labour." As these terms are capable of different interpretations, and as they are found to be meaningless when subjected to careful analysis, any figures resulting from such compilations cannot in any way be regarded as furnishing the measure of performance.

Modern industrial methods require an increasing amount of effort toward developing

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conditions favourable to the so-called "productive" work, and this effort, if the above-mentioned terminology is to continue, must be classified as "non-productive." The applications of the principles which have been so conclusively proved to contribute to improvement in efficiency of management must tend to increase the "non-productive" effort. The value of such comparisons is at once destroyed, and the need for the employment of less misleading terms is very evident.

Reliable standards are the first requisite in the establishment of performance records, and these must be developed from detailed study of the work to be done. No single unit of comparison can be developed capable of reflecting the efficiency of performance of the factory as a whole, and the sooner those responsible for the management realise this fundamental fact, the more will the development of reliable standards be accelerated.

Rational standards of performance must be applicable to the individual workers as regards labour and to the individual units of product as regards material. A system of records must be devised and installed which shall be sufficient to disclose the volume of preventable waste in each instance. These records can

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be assembled synthetically so that the total wastes of time and material separately can be compiled for each section or department according to the particular needs of those concerned.

As many of the data required for performance records form the foundation of the figures showing cost of production, attempts have been made in the more recent developments of cost systems to combine the two functions. Under certain conditions, in highly specialised industries, the combination may have practical value, but it is doubtful if this practice will be generally adopted. Collection of the essential data can be arranged to serve the double purpose, but independent assemblage for each purpose has much to recommend it.

Labour standards must be in hours and material standards in quantity. Conversion into cost figures involves unit prices which do not assist, and may hinder, the correct deductions in their use as a performance record. Further, tables of "actual hours" and "standard hours" may be compiled for several departments and for several periods without losing any of their value as performance records. In a similar manner, consumption of material and standards of material required may be compared in

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terms of length or weight and serve a useful purpose. The same comparisons in cost figures may mislead owing to variation in the unit prices.

The elimination of wastes can be effected by the aid of such performance records, as they can be easily understood by the worker, the foreman, and the manager concerned. The actual unit price is not an essential in this respect; in fact, the inclusion of cost figures in the discussion may serve to introduce unnecessary complications. Again, performance records in the original classification are the more readily obtainable, and records to be effective must be as immediate as possible.

Records are valuable only so long as they serve the purpose for which they were created. When they are not available until the influencing conditions have been forgotten, they serve no useful purpose. Records of waste should show Where, When, and Why, and the last named is by far the most important, although it probably receives the least consideration.

When, through analytical study, it is possible to establish definitely what can be accomplished, the record of actual accomplishment will disclose the deficiencies and indicate where effort

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can be intelligently directed to secure the needed improvement. Such study must precede the preparation for the elimination of waste, and more especially must govern any plan for offering an incentive for individual effort.

CHAPTER IX

OVERTIME

MANY years of intimate association with factory management have failed to find the manager who is willing to state that the working of overtime is an unqualified success. In fact, extensive experience confirms the opinion that overtime work is a prolific source of waste.

There are only twenty-four hours in any one day, and human beings, to keep fit, must spend a substantial portion of each day in refreshment, recreation, and sleep. The general tendency of overtime is toward deterioration of the worker. Long working hours, irregular meal-times, and insufficient time for relaxation and rest will eventually break down the most hardy constitution, so that the manager who persists in working overtime is endangering the welfare of his organisation, and must eventually lose substantial profit.

The following reasons for the working of overtime, enumerated in the order of their

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importance, are often advanced by factory managers :

To effect repairs of special equipment without closing the department, as might occur if the repairs were made only during regular hours.

To complete a special order by a specified date for which a definite agreement, accompanied by a penalty, has been made.

To expedite the work on certain parts of an order, where such parts have been delayed, and the delay will, without the working of overtime, dislocate the work in dependent departments.

To accommodate a sudden rush of orders having a time limit, or similar special reason, for completion.

To maintain the normal output of the factory during shortage of labour, when the difficulty cannot be overcome in any other manner.

To increase the output of the factory without increasing the number of workers or equipment.

To provide an increase in wages without increasing the rate per hour.

There are occasions when overtime is ad-

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vantageous, perhaps even necessary, and a review of the situation and the several reasons advanced seems expedient. In the first place a machine may break down and thus temporarily upset any pre-arranged plan of work for the factory. This is not an uncommon event, and as the use of machinery is becoming more extensive in factory operation, the possibilities of machine failures must receive consideration. The management should give this matter careful attention both in the purchasing of machines and in providing means for expediting repairs.

For regular equipment, only standard machines should be purchased. Where two or more machines of the same class are required, care should be taken to duplicate them as far as possible. Spare parts can be carried in stock at a comparatively small expense, a further consideration which emphasises the importance of using standard equipment wherever possible. The spare parts should be those portions of the equipment which are subjected to heavy strains or excessive wear. This provision should apply to belting, shafting, and pulleys used in power transmission as well as gears, and other small parts of machines. Of equal importance is the creating of a special

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staff whose duty it is to make these repairs, and the providing of the necessary tools and facilities for expediting repairs and replacements.

The maintenance of suitable records of all machine failures, setting out the necessary information relating to the cause of each failure, is very important. In this manner many serious delays may be minimised, if not prevented. The actual cost of repairs will be much less when the work is executed during the regular factory hours, but overtime may be necessary owing to other conditions.

The second reason advanced for the working of overtime—viz. to complete a special order—is of far less importance, but the decision rests with the management, and this must be made in accordance with the conditions and attendant circumstances.

In factory operation of whatever description, it is of prime importance that delivery dates be met, for the dissatisfaction to a customer may result in greater loss than that occasioned by the working of overtime by a portion of the factory organisation. The effective control of production through the medium of a planning department will, in a large measure, obviate delays in meeting delivery dates, but the most efficient planning and despatching cannot

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foresee or prevent breakdowns of machines, spoilage of work, or the influence of faulty material.

In certain cases of this kind there may be a distinct advantage in overtime, but the extra time should be employed entirely upon the article in urgent demand. The fact that a portion of one or more departments is working should not be regarded as an opportunity for employing other workers upon less urgent work for the same period.

The third reason of overtime—viz. to expedite certain work so as to avoid the dislocation of work in dependent departments—is entitled to less consideration than the two reasons already dealt with, although many substantial arguments may be introduced tending to confirm the advisability of overtime.

The usual tendency of human workers is toward inefficiency ; to permit themselves to follow the lines of the least resistance. As a result, when their failure to deliver certain specified orders or quantities of work can be compensated for by resort to overtime, the general tendency is towards more failures and more overtime, than towards fewer failures and no overtime. Consequently all managers should discourage overtime in all its phases, and make

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special effort to correct the errors responsible for the failures in deliveries.

The fourth reason of overtime—viz. to accommodate a sudden rush of orders for which a time limit has been set—describes a temptation not easily resisted by many managers and executives.

There are times when a factory engaged in the manufacture of specialities has opportunities presented, through trial or emergency orders, for increasing its business substantially. In general, such orders have a time limit, and recourse to overtime by the affected departments is usually considered the only possible means of accomplishing the task. The success of an enterprise is due in many instances to the ability of the management to sense the future—commercial instinct is, perhaps, the proper term—and no rules, however comprehensive, can be formulated which will serve to guide sound business judgment.

Nevertheless, there may be other means for increasing the output temporarily without indulging in the expensive luxury of overtime. Other orders of less importance may be set back to give preference to the special orders, the number of workers employed may be temporarily increased, or better methods of opera-

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tion may be developed. If machine output is the controlling factor, the machines may be double-crewed temporarily; or the experienced workers may be relieved of some of their less important work in order that their efforts may be concentrated entirely upon the operations requiring skill, while the other work is performed by less skilled workers.

The fifth reason of overtime—viz. overcoming an enforced shortage of labour—is obviously a difficult case, and must be decided according to the merits of the situation. It is evident that only abnormal circumstances would produce this condition. An increase in the wage rates will attract labour, and undoubtedly it will be preferable to increase the daily expense in this manner than to increase the working hours of the regular organisation. The latter course will have the effect of lessening the productive efficiency of the individuals, and will tend to increase waste and the quantity of spoiled work as well as the liability of machine failures.

It seems better to curtail the total output than encourage the working of overtime for an extended period with all its attendant disadvantages. Temporary decrease in total turnover is much to be preferred to gradual deterioration of the regular factory organisation.

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The sixth reason of overtime — viz. increasing the output of the factory without increasing the organisation or equipment — is one which may be given considerable support for various reasons. Under these circumstances it is better to organise a night force or a double shift of workers than attempt to accomplish the result by means of overtime. Both courses present many difficulties, but the latter is easier of attainment and productive of more satisfactory results. A double shift or a night force is entirely practicable, in spite of arguments tending to dispute the statement. It is necessary, however, that such a work plan should be carefully and effectively organised.

Employees working other than the regular factory shift are handicapped by having to work, eat, and sleep at unusual, if not unnatural, hours, and this item is of primary importance in dealing with the problem. Every effort should be made to give them comfortable surroundings, and to supply them with facilities for working without hindrance. Providing them with means for keeping their lunch warm, and furnishing them with hot tea, coffee, or milk at seasonable hours, at cost price or even gratis, are matters well worthy of consideration. As a night force will usually consist of men, accommodation for

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smoking at the lunch hour must be provided, even though a special room is necessary.

Efficient supervision of a night force is one of the essentials for successful operation, and the selection requires great care, since the night foreman has not the opportunity to receive advice from the managers which those on duty during regular hours have. There must be a definite outline of the work to be done and equally definite instructions as to how to do it. In all cases where this is practicable, machines which require extensive setting up should be arranged by the day force, as little as possible of this work being left to be done at night. It is also more advisable, in operating a night force, to have it concentrate on such work as can be best done at night than attempt to have it a duplicate of the day force throughout.

The heating and lighting must receive careful attention, for artificial light at best is not equal to natural light, and the liability of spoiled work and machine failures will be increased with poor light. Further, special attention must be given to keeping the factory departments in order, since the material about machines will accumulate much more rapidly when they are operating sixteen hours per day in place of eight, and congestion may result. This increase in the working

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hours of machines naturally increases the amount of repairs, especially as regards small tools, for reduced lighting facilities tend to increase total breakages.

The working of a night force or a double shift requires adequate provision to be made for supply of material beyond that which can be furnished by the day stores force. For effective work, the stores department should be adequately represented during the hours the night shift is on duty. In a similar manner, the planning, timekeeping, and cost departments must be represented on the night force. Many questions will arise during the night working hours which must be attended to by those in a position to make full investigation and prompt adjustment ; much delay may ensue unless these matters can be so handled.

The records of performance on night work must be kept in a manner similar to those of the day force, and these records must be carefully scrutinised at regular intervals, in order that the management may be kept fully advised as to results obtained. It is a mistake for any management to expect that a night force composed entirely of direct producers can be made profitable, while the clerical work is left to be done by the day office force, or that the clerical work

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can be handled by having the day office force work overtime. The same methods of organisation and operation which are employed with the day force can be applied equally as well to the work done during the night, but all the auxiliary departments must be represented in the night force.

The question of wages is of great importance, for night workers are entitled to higher remuneration than the day force. The nominal hourly wage should be higher for the night workers owing to the abnormal period during which they work. The fact that they may have a longer shift should in no way influence the matter. The total weekly wage should not be considered in this respect; the workers should be paid a higher rate for their time.

Owing to the difficulties attending work by artificial light, adjustments should be made in the standards of performance for night workers. These adjustments can be made by allowing a definite percentage of increase on the day standards. Experience in this respect is comparatively limited, but some have found a 10 per cent. increase to be adequate for the purpose; others, whose experience is more extensive and probably more reliable, strongly advocate increases up to 15 per cent. The exact percentage

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is not of particular consequence, since this can be verified by actual investigation, but the principle of increase in allowances is of great importance.

Arrangements should also be made to inspect work at night, especially such work as requires inspection between operations, so as not to hinder the work. The final inspection of all work should be done during the day, owing to the great difficulties of thorough inspection in artificial light.

The seventh reason alleged for the working of overtime—viz. providing an increase in the weekly wage without increasing the rate per hour—hardly merits detailed discussion, for no permanent benefit can be expected from any attempt of that nature. It is far better to make a regular advance in the wage rate to maintain the personnel of the organisation and conserve its productive energy than have it dissipated by long working hours.

Overtime should always be discouraged, and only be resorted to in extreme emergencies. There is no profit in working long hours and thereby lowering the productive efficiency of the factory organisation. If overtime becomes necessary, the practice should be limited to as few workers as possible, and then only for a brief period.

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When the existing equipment cannot produce the quantity required, a second shift, or night force, should be organised for the purpose. Extensive wastes result from employing workers and equipment out of balance with one another, as must be the case where the equipment remains idle for twelve or sixteen hours each day. A double shift provides ample opportunity for the reduction of fixed charges per unit of output, and it may be necessary for manufacturers in general to give this matter careful consideration at no very distant date.

Some refinements in physical conditions are necessary, also adjustments in wage rates and standards; but with proper care in selection and administration, there is no good reason why a high standard of performance cannot be maintained. In place of the general laxity of discipline, poor work, and low record of production, now so much in evidence where night forces are employed, satisfactory results should be obtained under efficient methods of organisation and operation.

Overtime is a pernicious practice. It undermines the health of the workers engaged; it lowers the efficiency of the organisation; it results in more waste of material; it tends toward a greater number of machine and tool

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failures ; and it serves to dislocate the best of organisations. Thus it throws upon those charged with supervision an unusual amount of detail ; and this at a time when they need to be even more free than usual to study the possibilities of improvements in productive methods.

CHAPTER X

COST FINDING

THOSE unfamiliar with conditions in industry, when confronted with the actual facts, often express surprise that preventable wastes in factory organisation and management should continue unchecked. One of the principal reasons for the continuance of such extensive wastes is the absence of reliable methods for determining the cost of factory production.

It is estimated that not more than 5 per cent. of the manufacturers in the United Kingdom know the actual costs of the various products of their factories. It is further estimated that not more than 1 per cent. know their costs within sufficient time for the information to be of real benefit. For the effective guidance of administrative policy, the actual gain or loss on each individual line of manufacture should be definitely ascertained, and this information should be available within a very short time after the manu-

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facture has been completed or, at least, after the sale has been effected.

Few manufacturers have a special department for ascertaining the cost of their products, or a costing system that comes properly within the definition of the term. In fact, the majority of manufacturers, in their reference to "costs" really mean their "estimates" of the probable costs, but no provision is made to verify these "estimates" by definitely ascertaining the actual cost of production.

Analytical study of many of these methods of preparing estimates reveals an astonishing ignorance of the underlying principles of cost finding, or, at least, astonishing failure in their application. This is particularly true where the manufacturing process involves a number of operations, each with varying percentages of material losses or shrinkage.

In one case it was found that the carriage charges of the raw material were included in the office expenses, and added on at the end of the calculations notwithstanding a 25 per cent. shrinkage of material in the initial operation. In another case, the inclusion of the import duty on the raw material was the final computation, although a 27 per cent. loss was the recognised allowance for the shrinkage in the first stage in

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the process of manufacture. In neither of these cases had provision been made for depreciation charges, even though machinery was extensively used. Both of these manufacturers were calculating the profit item in farthings in their estimates.

One of the most surprising examples is that of a manufacturer who worked out the cost of one of his regular lines at minus 4·21d. Notwithstanding the fact that material, labour, and establishment charges were involved in the production, he was able (according to his calculation) to give away the product and yet make a profit in excess of 4d. per unit on the transaction. From the standpoint of psychology, this case is interesting, but from the commercial standpoint it is disastrous to the trade. And this manufacturer insisted upon having his estimates developed to two decimal places.

Other illustrations — perhaps even more illuminating — can be furnished. The manufacturers who make no attempt to estimate the probable, or ascertain the actual, costs of production are in a relatively better position than those relying upon inaccurate estimates. The one class without any cost data permits the selling prices to be determined by competitors; the other class using an unproved formula for com-

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piling so-called cost figures is so misled by its own errors as to use the figures for the purpose of establishing selling prices and for submitting bids.

One is reminded of the farmer who possessed a circular plot of ground which he desired to enclose with a wire fence. Unwilling to have the ground surveyed and actually measured, he decided to estimate the amount of fencing required. Knowing that an average pace was something between 26 and 32 inches he paced off the diameter of the circle, using 28 inches as the pace length. The resultant figure was multiplied by 3.14159 to give the circumference, and so that it might be absolutely accurate, the computation was carried out to five decimal places.

Nevertheless his answer was wrong. He assumed four things—that the pace length would average 28 inches, that accurate allowance could be made for the irregularity of the ground, that he could walk in a perfectly straight line, and that the line walked would coincide with the actual diameter. Having started with these assumptions, he convinced himself that by carrying the calculations out to a sufficient number of decimal places the answer must be absolutely accurate.

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Many manufacturers have followed the example of the farmer. They rely upon a sort of "dead reckoning" to develop the probable cost of production without making any effort to verify their calculation by means of exact measurement.

Now there are few manufacturers who do not have their ledgers balanced accurately at the end of each fiscal year, all entries being carefully audited by expert accountants. The ledgers, the money expenditures, are balanced to the exact penny, and instances are common where £10 or more is expended in locating the cause of a ledger being a few pence out of balance.

In view of this, it is a matter of considerable surprise that the same scrupulous care is not given to securing an accurate balance of the other factors which enter into the finished product, viz. those of material and time, both of which are more important since they represent money but in a much more elusive form.

It is probable that this is due to a prevalent opinion that manufacturers must "lose profit on the swings and make it up on the roundabouts." When it is possible for competitors, through a knowledge of actual costs, to underbid them on the "roundabouts" and leave them to be content with the "swings," the position of the

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manufacturers who hold this theory seems precarious. Buying without asking the price, and paying without counting the change, which is analogous to the swings and roundabouts principle, is neither good business nor common sense.

The cost of a manufactured article is the accumulated value of all expenditures incurred, throughout the various stages, in the actual production of the article. Accurate costs can be secured only by ascertaining the actual quantity of material, the exact value of labour, and the correct amount of establishment charges required to produce each unit of product.

Study of the subject of costs must be confined to the principles of accurate cost finding, for the details of a cost system satisfactory for one factory may not be suitable in another factory engaged on the same class of product. A thorough grasp of the principles is necessary in order to avoid errors. These principles remain the same for every business, although the method of securing the information, and the forms used, may vary for each factory.

Care must be taken to avoid confusion of terms, and it is particularly important to distinguish between Cost Accounting and Cost Finding. Cost Accounting provides means for ensuring accuracy in the computation of dis-

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bursements. Cost Finding deals with the regulative principles underlying these computations so far as they affect the cost of production. The first is the function of the Accountant, the second, the function of the Engineer.

This distinction is not generally appreciated, since cost finding is usually regarded as accounting matter, a misconception which has resulted probably from the fact that all cost records are expressed finally in terms of money. In consequence, many errors have been unwittingly incorporated in "cost systems," to the detriment of the business they were intended to assist.

When a bridge or building is to be constructed, the work of estimating the cost is assigned to a competent engineer, since no one would presume to ask an accountant, however experienced he might be, to prepare the estimate. This implies no reflection upon accountancy, which is a most important and valuable section of any business, but tends to indicate that such work falls more properly in a different sphere. It follows, therefore, that the preparation of a plan for comparing the actual with the estimated cost of production must be entrusted also to an engineer, as the same methods used for developing the estimate must

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be used in developing the actual cost of the work.

A cost system may consist of an elaborate set of forms and not be really useful owing to the failure of the author of the forms to appreciate the real function of cost records. No set of forms is sufficient for the purpose unless they are developed with the object of accurate cost finding, and, further, unless they are then used by persons who have a definite conception of the object of attainment.

The prime function of a cost system is to enable the manufacturer to detect preventable wastes of profit. According to the generally accepted notion, a cost system is primarily intended to serve the purpose of establishing selling prices. Careful study discloses that selling prices do not, except in a few isolated cases, bear any direct relation to cost, as they are fixed by competition, mutual agreement, or by some other factor quite apart from the actual cost of production.

The failure of managers and manufacturers to thoroughly appreciate these fundamental facts is the main reason for the present chaotic state of costing methods. Their attention must, therefore, be directed to the study of the principles underlying correct cost finding.

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Factory costs are composed of three elements—Labour, Material, and Expense. These elements are separate and distinct, and no one of the three bears any direct relation to the others. The allocation of each to the cost of the product must be handled independently. The essential principle underlying reliable cost finding is that the product must be assessed with its proper share of Labour, Material, and Expense at each stage of operation. Accurate costing must be synthetic, and any plan, to be effective, must be intelligently devised and consistently executed.

Material, as it leaves the stores for the initial operation in the factory, must bear all the expenses which have been incurred by the material up to that particular point, which expenses increase the value of the material beyond the figure shown on the original invoice. As the material becomes more valuable at each successive operation owing to the value of the labour expended upon it, the calculations of wastage at any particular stage must always be made at the enhanced value of the material. Each item of proper material cost omitted, at any stage, serves to increase the percentage of error in the waste calculations in all subsequent operations.

Although Labour and Material costs are com-

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paratively easy to ascertain, it must be definitely appreciated that Labour costs are much more than a distribution of the items of the weekly pay-roll, and that Material costs are more than the prices shown on the invoice. Labour costs must include the cost of employment, time-keeping, supervision, education, welfare, insurance, and similar charges. Material costs must include the cost of purchase, carriage, inspection, insurance, storage, and supervision, together with the cost of issuing, allowance for wastage, and similar items.

The most casual study of the matter will reveal that Labour costs include some Material and Expense items; also that Material costs include certain Labour and Expense items. No definite plan can be outlined for the proper classification or apportionment of the various items of expenses chargeable to Labour or to Material, since there is no system applicable to all cases; and each problem must be solved according to the needs of the particular situation.

The allocation of direct Labour or direct Material charges to the product is not a difficult matter, largely because these items require extensive classification for other purposes, such as the fixing of wages, regulating of purchases, ascertainment of stores, etc. The real difficulty

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in preparing reliable cost records is in dealing with the apportionment of **EXPENSE**. It is the allocation of this item alone which causes the wide variation in costing practices.

In the large majority of factories, and particularly in those where the production consists mainly of machine operations, it is the distribution of **Expense** which constitutes the real problem of cost finding; the solving of this problem is the task of the engineer. The **Expense** element includes rents, rates and taxes of land, buildings, and equipment, insurance, maintenance, depreciation, and obsolescence, in addition to the cost of power, light, heat, and similar charges. In the average factory the land, buildings, and equipment constitute the largest portion of the fixed investment, so that the proper distribution of **Expense** is becoming more and more vital to accurate cost finding.

The problem can be better appreciated if it is assumed that all land, buildings, and equipment are rented, not owned, and that power, light, and heat are each furnished by outside companies, so that none of the items which constitute the **Expense** factor is under the control of those charged with the supervision of the factory.

Under these circumstances, all rentals would

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be estimated upon the basis of time, and the power, light, and heat would be charged upon the quantity furnished during a given time. It is safe to assume that the owners of the land, buildings, and equipment would have taken into account all such items as rates and taxes, insurance, maintenance, depreciation, and obsolescence. It is also quite clear that the owners of the sources of power, light, and heat would have included similar expenses covering their own land, buildings, and equipment in ascertaining their costs of the service furnished. The same practices, therefore, must be followed by the individual manufacturer who owns the land and buildings and supplies his own power, light, heat, etc., if his cost records are to be comparatively correct.

Further, it is evident that since the rentals are charged on the basis of time occupied, the distribution of these to the product must also be on the basis of time. Furthermore, since the power, light, and heat charges are based upon the quantity consumed, the distribution of these charges to the product must be on the basis of the service received.

The method of Expense distribution is a prolific source of arguments for or against the efficacy of any particular form of cost system,

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since no one of the generally accepted methods of distribution can be regarded as unassailable. No matter how elaborate the system may be for the allocation of this element, it cannot be regarded as absolutely accurate.

Take the one item of Power, which in the majority of present factories constitutes a large percentage of the Expense ; its allocation to an individual machine must be approximated in the absence of a meter registering the exact power consumption. Further, even with the power consumption correctly registered, there would remain the difficulty of knowing the exact cost of generating the power at the particular moment.

This is an extreme case, but it serves to illustrate the difficulties of securing what may be termed an " absolutely accurate cost." It is therefore necessary to accept the fact that a certain percentage of error must exist in costs, no matter how elaborate or comprehensive the cost system may be which has been devised. Decision must be made as to what percentage of error can be safely accepted without impairing the serviceability of the cost records.

It is perhaps owing to this condition that certain fallacious practices in Expense distribution have been incorporated in many cost systems, and have been permitted to continue

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without the manufacturer realising that his cost records were not only of little value but actually misleading.

The most common one is that of distributing Expense over the various products as a percentage of direct labour or total labour, as the case may be. The fallacy of such a plan seems so obvious as to preclude any argument in support of the practice, but it is, nevertheless, in actual use in many factories to-day.

Payment according to value received, or service rendered, is the recognised honest procedure in business, but the failure to apply this fundamental principle in the distribution of Expense is one of the prime causes of inaccurate costing methods in manufacture.

Many of those concerned with cost systems, especially where piece-rates are in vogue, hold the opinion that, since the piece-rate is based upon the time required to do the work, the "direct labour" basis for distribution is entirely satisfactory. Inasmuch as piece-rates are paid for quantity irrespective of time taken, and the elements of Expense are incurred on the basis of time, the error in the method is very apparent. Others argue that the "direct labour" or similar basis provides the easiest method of disposing of Expense.

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Another equally fallacious practice is that which provides for the distribution of the grand total of Expense between the various products whether the equipment is fully occupied or not. There is no sound reason for the cost of idle machine hours and of unused equipment and buildings being loaded on to the cost of the product delivered elsewhere in the factory.

A man owning two motor cars, but only having one in use, will not be justified, when calculating the cost per mile run of the one car, in adding in the expense of maintaining the idle one.

Suppose a farmer sows a portion of his land in corn and another portion in potatoes. In order to ascertain the actual cost of producing each crop, it will be necessary to keep separate records for each crop showing the rent paid for the land sown, the cost of the seed, the rental of equipment used, the cost of labour in planting, cultivating, harvesting, and marketing. When the cost of raising each crop has been determined, no one would support the argument that the cost of producing the corn crop would have to be increased owing to the fact that the potato crop was a failure.

Suppose a bank makes five loans of equal amount to five separate borrowers at 6 per cent.

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interest. In the event of one of the borrowers being unable to pay the interest, the bank will not be justified in claiming $7\frac{1}{2}$ per cent. interest from the remaining four in order to make good the loss.

A cost is a cost ; no more and no less. Manufacturers should not use a method of assessing Expense on the various products of their factories which would be regarded as dishonest if introduced in their dealings with other business men.

In this practice, there are two distinct schools of thought: those who argue that all expense incurred in the factory must be distributed over the various products, whether legitimately or not; and those who maintain that only such expense as is actually incurred in the manufacture should be assessed against the product.

The first theory involves the position that all expenditures of a manufacturing plant must be recovered in the sales returns; otherwise the plant will cease to exist. The second theory implies that by segregating the cost of idle time and of idle equipment from the cost of production, the manufacturer is furnished with valuable information concerning waste in profit. In either case, the sales returns must be sufficient to cover the cost of waste, so that while the two

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theories vary in principle they are in agreement, in so far as selling prices are concerned.

All preventable waste in a factory means loss in profit, but if the cost of this waste is distributed over all of the products, the cost figures do not represent the actual cost of production. Even with one-half of the equipment in a factory idle, there should be no good reason for permitting the cost of producing an article to increase, but if expenses are included in the cost which do not properly form part of it, the cost figures cannot be of use to the manufacturer.

Accurate costs necessitate the correct classification of every expenditure. The problem of correct cost finding is more a matter of securing a correct distribution of Labour, Material, and Expense than of providing for the accurate calculation of the cost of product after the essential details have been tabulated. It is necessary to know what has been done, when it was done, what it was done with, and who did it in order to begin the operation of determining the cost of the product. To complete the cost calculation, the records of disbursements must be so arranged that all expenditures connected with the various factors of the operation can be ascertained.

Further, if the cost of the article is higher

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or lower than the original estimate, the cost information is not of real service if the manufacturer is unable to locate the cause of the difference. In each case he must be able to discover —

The Labour Expenditure,
The Material Expenditure,
The Expense Expenditure,

and be in a position to compare each of these three expenses with what it should have been.

For this purpose, it is necessary that every factor affecting manufacturing operations or costs should be closely studied and carefully analysed. Such detailed analysis provides the manufacturer with reliable information as to the exact amounts of material, effort, time, power, and equipment necessary for each operation throughout the whole process of manufacture of any one of the factory products.

This analytical study is valuable, since the manufacturer can, by the synthetic assemblage of the resultant data, build up standards for comparison with the actual cost of each article produced. Cost figures then become reliable guides for indicating the extent and importance of many of the preventable wastes for which the proper corrective measures can be developed and applied. When such a comprehensive sur-

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vey has been made, the influence of many misleading terms now in common use in too many factories will be eradicated. Chief among these is the term "unproductive labour."

No labour is unproductive. The time spent on interviewing applicants for positions, in recording attendance and performance, in planning the work and preparing instructions, in supplying the proper tools, in providing adequate welfare accommodations, and in maintaining records of cost, need not be unproductive. Such labour is needed to supplement the work done at the machine or bench, and the more intelligent is the use which is made of the labour, now commonly termed "unproductive," the less waste there will be and the more will the cost of production be reduced.

But the influence of misleading terms is difficult to eradicate. A low ratio of "unproductive" to "productive" labour is regarded by many executives as indicating a high efficiency of management of the factory. The fallacy of such methods of measuring performance can be readily exposed by dispensing with all clerks, typists, foremen, and assistants so as to reduce the ratio to a minimum.

Another benefit manufacturers will derive from the detailed study of standard costs is the

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realisation that their present cost records and financial statements are not sufficiently prompt to serve their purpose. Records of cost must not only be reliable and accurate; they must also be immediate in order that the management may know what the factory *is* doing rather than what it *was* doing.

Business management to-day is a continual shaping and re-shaping of policies, and the factors which must be grouped for success in enterprise are becoming more and more complex. Policies, to be effective, must be supported by actual facts and, in the absence of reliable cost records, the development of the individual manufacturer must be considerably restricted.

A post-mortem examination, however scientific, never helps the unfortunate victim. A certified balance sheet is of little value to the stockholders of a bankrupt factory. Newspapers describing events some months after their occurrence was notorious would find little support as mediums for transmitting news, and a barometer twenty-four hours late in recording the air pressure would be discarded.

Many manufacturers are beginning to realise that the annual balance sheet, issued some months after the close of the fiscal year, contains no information of any real value in determining

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the present condition of the business. Means must be available for disclosing wastes immediately, whether in the operation of the factory, or owing to errors in administrative policies.

Monthly profit and loss statements are now considered indispensable by the more prudent executives, and records which permit the exact value invested in material in progress to be accurately determined without recourse to physical inventory are regarded as equally important. Recent developments in cost accounting and cost finding permit the operation of the factory to be effectively controlled without recourse to guess-work.

Modern factory accounting is not merely a system of book-keeping, audited annually, combined with the unscientific and laborious system of annual stocktaking. It is rather a well-developed method for providing, at all times, a continuous record of the manufacturing and expense accounts, the quantity and value of raw material in stores, the cumulative value of material in process of manufacture, the actual value of all finished or partly finished products, and the total value of constantly recurring wastes of time, material, and equipment.

In the light of modern practice, such ac-

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counting methods are neither expensive nor unwieldy. When the movement of material through a factory is accurately recorded at each successive stage, the ascertaining of actual costs comes as a by-product of the only reliable means for ensuring economical operation.

CHAPTER XI

PRINCIPLES OF WAGE PAYMENT

WAGES have been, and continue to be, one of the most important items in industry, and there are many varieties of wage systems which have more or less commendable features. Almost all industrial concerns have, for many years, given the question much attention and, though many progressive manufacturers have introduced new systems of wage payment with varying results, the problem seems as far from solution as ever.

Experiments of this nature are often costly in the extreme, both financially and morally, as the influence of many attempts to solve the problem has been felt not only in the immediate vicinity but throughout the entire industrial world. No matter what the result of the attempt may have been, or how thorough the work of an arbitration committee, there always remains a tinge of the spirit that inaugurated the dispute, and, though temporarily quieted,

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it awaits only another opportunity for renewing the battle.

As an abstract proposition it may be premised that the employee must sell his labour and skill for the highest figure possible, and the employer in turn must secure his labour as cheaply as is practicable, so that any method of solving the problem must be of a co-operative nature if all concerned are to be satisfied. There is a certain limit above which wages cannot be increased, although the exact limit is difficult to determine, and apparently the decision cannot be left to either the employee or the employer, but must be entrusted to an intermediary.

The system productive of the best results is undoubtedly one that enables the employees as individuals to set automatically, and without fixed limits, their own wage figure; and the only apparently satisfactory basis is the measure of work performed—the amount of service rendered. Such arrangements must be without regard to the sentiment and the prejudices that so often creep into matters of this nature—a problem that tests at times our engineering skill, especially since the human element is largely the controlling factor.

Wages paid in a factory should be regarded

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in the same light as the money spent upon the material which enters into the article. In fact, labour should be purchased with even more scrupulous care, as to quality and quantity, than is now generally used in the purchase of material.

For centuries it has been customary for every individual performing a service for the benefit of another to receive a stipulated price or wage for his services. The basis of calculation has been the length of time the service of the one was at the disposition of the other, without regard to quantity or quality of work. Biblical historians mention the labourer who worked for a penny a day, and it is interesting to note that the question of quantity and quality was raised in those days, as it is to-day. Constant use of this day-wage method for so long a time has inculcated it in the minds of all men to such a degree that it is not now regarded as a method, but as a custom, and laws bearing on this condition are well established in the statutes of all civilised countries.

If it is conceded that the welfare of the employee depends largely, if not entirely, upon the prosperity of the employer, and that they have common interests—then a satisfactory solution may be attained. A mutual under-

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standing must be reached as to the principles involved, and the following principles are suggested as the basis of discussion.

The first principle is :

Two workers engaged upon the same class of work are not entitled to the same remuneration unless their skill, aptitude, and diligence are identical.

All employers recognise this but many employees do not, and no definite progress can be made until this principle is mutually agreed upon.

Conservative labour leaders have been known to oppose steadfastly the installation of a differential wage plan and to refuse to consider guarantees that there would be no discrimination or favouritism in its administration. When all of their objections had been satisfactorily disposed of, the installation was prevented by the threat of a general strike to begin immediately upon its inception. Workers have been known to intimidate their fellows by a variety of "persuasive" methods in order to ensure a practically uniform wage, even though a differential wage system was in use. Similar methods have been employed to induce the good worker to keep pace with the poor worker in factories where the day-wage plan was in effect.

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These conditions must be corrected, for they not only contribute to the defeat of a satisfactory solution of the wage problem, but constitute a prolific source of waste, which imposes a penalty on the worker, the employer, and the general public alike, through the increased cost of the commodities.

The second principle is :

No employee should be required to be at the service of an employer without receiving a definite remuneration irrespective of output during the period in question.

This means that each employee should have a definite hourly or weekly wage which must be paid to him by his employer in direct ratio to the time spent on the work, without regard to the quantity or quality of work that may be delivered during the period in question.

In this manner the employer assumes all responsibility for delays resulting from accidents, breakages in equipment, loose belts, poor material, inefficient air-conditioning, improper heating and lighting, and many other things influencing the output over which the worker has no control. Many manufacturers favour straight piece-work, because they regard it as a means of escaping the penalty resulting from these delays. But, though the worker is thus

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unjustly penalised, the manager cannot escape the whole of the responsibility.

This hourly or weekly wage may be considered as of the nature of a minimum wage as now provided by law. In fact, the existence of such a legal provision is conclusive evidence that in the past employers have refused to recognise this fundamental principle in the payment of wages.

The amount of the hourly or weekly wage cannot be fixed definitely, as it is practically dependent upon the supply of labour and must necessarily fluctuate from time to time. The law of supply and demand is largely the determining factor, and any employer who does not take account of this variability is inviting disaster to any scheme which he may have in effect, or may be considering with a view to future installation.

Now the employer who pays the lowest wage will secure only the least amount of skill, and this fact must receive careful consideration in adopting the standard hourly or weekly wage for any particular class of work. The higher the hourly or weekly wage the employer pays, the better the class of labour he is able to attract.

The third principle is :

Workers should be paid, in addition to

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their time-wage, a remuneration based on the quantity and quality of the work delivered.

The basic standard for such remuneration must be determined according to the particular conditions that obtain for performance of the work, and the amount must be the sum necessary to secure the maximum co-operation of the worker.

Quantity and quality must be paid for, and the more the employer is able and willing to pay—within certain limits—the greater will be the return on the investment. In this respect the purchase of labour is identical with the purchase of material. No employer in the present day buys material because it is a low price, unless he is in a position beforehand to determine whether he can utilise this material to advantage. No manufacturer, for example, would think of purchasing bituminous or lignite coal because the price per ton was less than anthracite if the power plant was equipped for the use of the latter.

The fixing of a standard by which the quantity of work performed can be measured is all-important, as there must be definite units of measurement for performance as there are definite standards of weight and quantity for material. In the case of labour such standards must be based primarily on the length of time necessary

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to do the work. Whether such standards remain expressed in terms of time or are later converted into money equivalents depends upon other factors of minor importance.

To determine the proper standard, it is necessary that the operation should be carefully studied, and that the time required for the performance of the operation should be definitely ascertained. To do this, in many instances, it is necessary for the operation to be observed by one who is familiar with all the details of the work and able to note any evidence of lack of application on the part of the worker. These observations must be made over an extended period in all cases where there is liability to variation in the conditions under which the operation is performed. Further, no standard should be set for the performance of the work until such time as all the causes of variation have been removed so far as they are under the control of the employer.

The causes of variation which fall under this head may be worn-out machines, poor belting, irregular power supply, defective transmission, insufficient supply of tools and equipment, absence of definite working instructions, inefficient supervision, inadequate supply of material, waiting for work, and similar conditions. Even though

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a manager may be indifferent to his own interests in these things, he has absolutely no right to ask any one to work on any differential wage system while they do exist.

The fourth principle is :

Standards should be established according to the performance of the average worker with a reasonable amount of effort, rather than according to the possible performance of the exceptional worker with the maximum amount of effort.

Reasonable amount of effort means such amount as any good foreman or manager would insist upon from the average worker, for, after all, charity as a principle is hardly applicable in factory operation.

It is a notorious fact that the piece-rates, or similar standards, in many factories will not stand the acid test of thorough investigation. The absolutely unscientific, if not immoral, manner in which standards have been determined has been the cause of almost all the labour troubles throughout the world, and the employers are entirely responsible for this condition. Managers are profiting by their mistakes, and the errors of the past will probably not be repeated in the future, but the task of regaining the confidence of the worker is by no means easy.

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The final establishment of standards should be a matter of joint consideration by representatives of employer and employed. Collective bargaining is an essential in present-day industrial administration, and no single item is of greater importance than accurate performance standards. With the full particulars of a detailed investigation available for this purpose, there should be no difficulty in determining the proper standard for each job under discussion.

Opportunity for earning bonus in addition to the regular wages is provided for the purpose of rewarding application and concentration. This co-operative effort will not be secured if the workers are not fully satisfied that reasonable standards are in effect. The logical course to pursue is to have all standards fixed by mutual agreement in the beginning.

Each standard should be definite. The particulars of each job should be specified and the operating conditions should be outlined in sufficient detail in order that there shall be no opportunity for misunderstanding in the application. These standards are contracts or agreements the conditions of which are binding upon both parties, and as such they are entitled to careful scrutiny before final acceptance.

Now assuming that the proper standard has

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been fixed and accepted, the question arises as to what amount shall be paid to the worker who reaches the standard. This is a matter which must be thoroughly studied, as the amount must bear some relation to the nature of the effort and skill involved. Light work requiring only a small degree of skill is not entitled to the same reward as in the case of heavy muscular work necessitating a considerable amount of skill. The reward in each case must be proportionate to qualities required and effort expended.

Competent investigators have advanced opinions that the rewards should range from 30 per cent. of the regular wage in some work to 100 per cent. in others. Whether these large amounts are equitable is open to question, as it is reasonable to assume that the regular wage would bear some relation to the qualities and effort required in performing the work. Under these circumstances, together with that of fixing the standard on the basis of the average worker, it seems probable that a 20 per cent. increase in the regular wage on reaching the standard may be considered as a reasonable reward.

Whatever the amount or the percentage of wages determined as adequate compensation for attaining the standard, some compensation in addition to the hourly wage should be paid to

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workers whose performance is within a reasonable distance of the standard.

The bonus or premium may begin at a point 25 per cent. or even 50 per cent. above the standard performance, but the rate of increase should be steady, so that steps in the wage-line contour are avoided. It has been found that fixing the commencement of the premium payment at a point 50 per cent. above standard is entirely practicable.

Compensation should be proportional to the productive effort. While it is practically impossible to determine whether there is a direct relation between the effort and the rate of production, it is evident that greater effort is required to reach within 5 per cent. than within 10 per cent. of the standard, and that even greater effort is required to actually attain the standard. The slow but gradual increase in premium payment is conducive to increase of effort on the part of the worker, and the receipt of only a slight premium acts as a powerful stimulus to greater endeavour. In the past, workers have made the effort and attained the standard, and the employer has broken the contract by cutting the rate.

Confidence is the basis of business trade. The man with a habit of breaking contracts is

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soon relegated to the class of persons who use short weights and sell watered milk. If the worker has no confidence that the standard will remain unaltered, he is inclined to put forth effort sufficient only to earn the maximum the employer is willing to pay before the rate is reduced.

The fifth principle is, therefore :

No standard should be altered so long as the conditions under which the operation is performed remain unchanged, and no standard should be continued once the conditions have been altered.

This principle is the most important of all, for workers should have the assurance that their efforts to attain the standard will not result in the standard being reduced. For that reason the setting of the standard should not be done hastily, but only after all improper working conditions have been corrected.

In order to obtain successful results, no timing of operations, no study of conditions, and, above all, no setting of standards should be made without the workers concerned being made fully aware of the situation, and their approval being secured. The evil of setting inaccurate standards, however, has been recognised in the past, as is evidenced by the peculiar features of certain

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wage systems. These systems, too, afford abundant evidence of the extent to which some employers have protected their own interests rather than assumed the responsibility for accurate and reasonable standards.

The real interests of employer and employee are identical, but when the one cuts the rate, the other, profiting by experience, restricts his efforts, and both employer and employee lose by so much as the latter holds in reserve. And thus we find, at times, that the fixing of wages is no more or less than the practice of barter and exchange in its most primitive form, uninfluenced by the refinements our enlightened age has made possible.

Of equal importance, therefore, with the preparation of the standards is the supervision of their application. The more highly developed a machine becomes, the greater attention must be given to its operation, and what is true of machines is also true of wage systems. In fact, the latter require greater attention, for while in the case of machines one is dealing with materials of fairly well-known characteristics, in the wage system one is dealing with the ever-variable human element.

Let some one supervise the purchase of labour who has thorough knowledge of the commodity

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and has at his disposal the time necessary for keeping in touch with all the factors which influence the delivery of the commodity. Foremen as a rule have sufficient to occupy their time and effort in securing quantity and quality of product without being required to determine the proper standards of performance of the workers under their supervision.

The sixth principle is :

Premium or bonus payments should be calculated upon the average performance over a given period rather than upon each separate performance from time to time.

In industry, as well as elsewhere, the cultivation of good and regular habits is of the utmost importance. Differential wage systems are designed to cultivate habits of industry, diligence, and concentration, and this implies continued rather than spasmodic application.

There should, therefore, be no inducement offered to a worker to make an exceptional effort on one particular job and then rest up on the next job or jobs with a view to another spurt. It is better for the worker and better for the organisation as a whole that the output be regular, so that each worker should be encouraged to work at the pace which he is able to maintain throughout the day or week. This result can be

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secured only by the payment of premium on the average performance of the whole period. Payment on the basis of the efficiency maintained over an extended period results in a more regular output from each individual, and tends to reduce to a minimum the minor delays between operations which are so often overlooked.

The principles set forth in the preceding pages constitute what may be considered as the fundamentals upon which a satisfactory wage system must be based. Modification or refinement, from time to time, may be found necessary or advantageous, but it is doubtful if these general principles will have to be greatly altered. The details are not of especial importance, and whether the standards are expressed in hours or in money is largely a question of expediency.

Some managers strongly advocate the use of a piece wage system owing to the ease with which the labour cost of the article is computed. In view of the other important elements entering into the cost of the product, this advantage is of doubtful value; for the length of time consumed, not the money paid, regulates the proportion of overhead and establishment charges, which are often of greater importance than the direct labour cost. Furthermore, as has been already stated, it is necessary in establishing

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standards first to determine the length of time required to perform the operation. If it is desired to calculate the efficiency of performance, it is necessary later to convert a piece-wage standard into terms of time and then compare the resultant figure with the actual time consumed.

It is simpler to keep the standards in hours than to convert the time into pence, especially when there are other distinct advantages in favour of the use of time standards. Time standards need not be altered while the operating conditions remain constant, but money standards must be altered, if changes in wage rates become necessary. Further, with time standards two workers with varying day-wages may be engaged on the same class of work and their efforts be measured by the same standards without unpleasant complications arising.

Workers capable of performing several classes of work are more valuable to their employer than those whose skill is limited to one class. This difference should be compensated by a difference in the hourly wage rate, and not by applying different standards of performance in measuring the output of work.

Another advantage of a time standard consists in its providing means for penalising the

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workers for defective work, for quality must be recognised as well as quantity. This opinion may not be shared by all, and is a matter which can be best decided according to local conditions.

The seventh principle is :

The premium or bonus earnings of workers should be regulated by the amount of good work delivered; but defective work should not affect their regular day wage.

In the use of time standards the performance record of the worker is credited only with the amount of good work delivered, but the actual hours charged comprise all the time spent upon work, whether good or poor. In this manner, if defective work is delivered, their performance efficiency is lowered in direct proportion to the amount of work that fails to pass the inspection. This means that the worker receives the regular day wage for the time occupied on the defective work, but receives less bonus or premium because of lower efficiency.

A further advantage of time standards is the ease with which the average efficiency of an individual may be calculated over an extended period, or that of a single group or of several groups of individuals over any given period. The relation which the sum-total of the hours

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actually employed bears to the sum-total of the hours allowed as standard is the average efficiency of any group for any period irrespective of variations in the rates of pay of the individuals concerned. In this manner, the performance efficiency of an entire department can be determined, a figure of considerable value in measuring the efficiency of administration and supervision.

Wherever the practice of determining the efficiency of departments has been consistently followed, it has proved that the efforts of the foremen have a direct influence on the performance average of the workers under their supervision. In fact, the variation in the relative abilities of foremen is no less great than that in evidence among the workers.

A wage plan similar to that applied to the workers should be developed for determining the salaries to be paid to the foremen, to the superintendents, to the managers, and to all others engaged in administrative duties. Reliable standards should be provided for measuring the performance of each of these individuals, for the underlying principles of wage-payment are applicable to the efforts of all individuals, irrespective of the position occupied.

Each member of an industrial organisation

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should be held accountable for his individual record in the interest of waste elimination. The operatives at the machines are not the only persons who may be efficient or inefficient. For that reason, standards should be developed for every factor over which administrative officials exercise control, in order that the performance efficiency may be determined, and the resultant records should be regularly and carefully scrutinised.

The responsibility for the success or the failure of any wage system does not rest entirely with the employer, for each individual worker must contribute his or her share if complete success is to be assured. The interests of the employer and the employed are identical, and both must be ready and willing to act according to rational standards for the common good; favouritism, unscrupulous rate-setting, wilful restriction of output, or sabotage, have no place in any industrial concern.

The moral influence exercised by an organisation wherein perfect harmony exists and where every individual is endeavouring to reach the highest efficiency is, in itself, an item worthy of the most careful consideration by employers and students of wage systems. Each name on the pay-roll represents a human manufacturing

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unit, entitled to a fair and liberal return on its physical and mental investment, or, in other words, to a reasonable profit sufficient for procuring other things besides food, clothing, and shelter.

The principles and opinions enunciated throughout this discussion are not untried theories ; they have been demonstrated in actual practice over a period of years with satisfactory results.

CHAPTER XII

WAGE SYSTEMS

THE success or failure of any system of wage payment depends not so much upon the design as upon its administration. A poor wage system, wisely administered, is to be preferred to one of more scientific design that is controlled by incompetent persons. The essential aim of every differential wage system is to foster and encourage initiative and diligence on the part of the individual. If these qualities are not in evidence, the wage plan or some method of management is at fault, and the matter should be corrected as early as possible.

In this investigation, as in that of the administrative details of the wage system, the analysis must be intelligent and unbiased, and the observation of conditions must be thorough and accurate. Of equal importance is the synthetic assemblage of the facts thus collected, so that the deductions therefrom may be correct and the proper remedy applied.

The need for some form of differential wage

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plan is made evident by the fact that regulating the efforts of workers by supervision alone and the payment of a flat weekly wage has not given the desired results. It is generally appreciated that in the day-work plan the employer makes all the gain and suffers all the loss, as with a decrease in hours worked the cost decreases, and with an increase in the hours worked the cost increases, the employee receiving the same remuneration for each hour worked.

When the effort of the worker is not subject to variable remuneration, it is quite evident that the only stimulus for increased output is through the medium of capable foremen who possess the ability to so enthuse their subordinates that the maximum effort will be exerted at all times. As a rule, under such circumstances, the foremen, without further incentive, gradually become more and more satisfied with themselves, and a general slackening results. Also, although the worker may be induced to make a special effort for a period, he gradually realises that he is not securing additional remuneration for his extra effort, and proceeds to take such time as he considers sufficient to justify his being retained by his employer.

Further, as a foreman is usually required to

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supervise the efforts of forty or more workers, it is unreasonable to suppose that he can direct every effort of each individual or that he can divide his time so as to devote the necessary attention to those who may need his assistance. While the personality of each foreman is always an important item in factory output, it is probably more in evidence in the day-wage plan than in any other.

The inequalities of the day-wage system of payment are very evident. The employee who performs certain work in six hours receives the same hourly remuneration as the one consuming twelve hours, although the actual cost to the employer has increased twofold without considering the item of surcharge. The usual conditions existing in the majority of factories are such that influence is brought to bear upon the fast worker to make the time consumed equal to that of the slow worker, and the most efficient foreman is unable to cope with this state of affairs. The general tendency of the plan is toward deterioration, as is generally admitted by both employee and employer.

In an effort to correct this unsatisfactory condition, the piece-work plan was introduced, wherein there is no stipulated rate per hour, but each worker is paid in accordance with the

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amount of work done at a stipulated price per piece, without reference to the length of time consumed in doing the work. With this system a poor worker may complete a piece of work in twelve hours and earn one shilling per hour, while a fast worker may do the job in six hours and earn two shillings per hour, or an increase over the other rate of 100 per cent. Were it possible for all influencing conditions to remain static, the variation in time would be in direct relation to the ability of the worker, which in all probability was the assumption made at the inauguration of this system. Actual practice, however, reveals a very different condition.

Inferior quality of the material processed, poor machines, overloaded or inefficient power plant, improper belting, and similar items are often the controlling factors in the length of time taken to perform a piece of work. The same worker might very easily consume twelve hours on a job at one time, and with conditions reversed would perform the same operation in six hours at another time, the same productive effort being exerted in both cases. It is manifestly unfair to penalise workers for circumstances that are entirely beyond their control, or to permit them to increase their remuneration without any additional effort.

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Under the piece-work system, the wage cost to the employer is the same in both cases, although the net cost may be slightly reduced in the case of the six-hour job owing to the decrease of establishment charges. A prominent feature is the instability of the system as a whole, since no provision is made for adjustments of wages when the output is retarded by conditions other than the efforts of the worker, for the guaranteeing of an hourly wage is the exception, and not the rule, where the piece-work plan is in effect. Another unsatisfactory feature is the impossibility of providing adequate recompense for the workers who are capable of performing several different classes of work, since they can only be paid the same price per piece as is given to those workers who have ability to do but one class of work.

Viewed in the concrete instance, the piece-rate plan is more satisfactory than the day-rate plan, for while it is to be admitted that irregularities are in need of correction in order to make the system just and equitable, it should be borne in mind that the incentive for increased effort on the part of the employee is a substantial argument in its favour and supports its claim to adoption. For the piece-rate plan identifies the employee as a separate and distinct unit and visualises more clearly than the day-rate plan

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the individual ability of each worker apart from the influence of the foreman.

These two systems—the day-wage and the piece-wage—represent the extremes, for they are fundamentally opposed. Any other wage system can only be a modification, or a combination, of the two mentioned. Attempts to overcome the inherent difficulties of the systems named have resulted in such a variety of plans that a statement of the accepted views concerning the efficacy of bonus or premium payments to labour as a stimulus to production and efficiency is worthy of reiteration. These accepted views are the opinions held by those who have no partisan or professional interest in the subject ; and stimulus to efficiency means a stimulus sufficient to make the increased productivity a real and important profit to the employer above all increased disbursements, including the administration of the system.

There are two fundamental principles underlying work and wages that are now generally acknowledged by good managers of all schools, scientific or unscientific. The first of these principles is that efficiency reward—extra pay for work superior to the prevailing average—is highly expedient, and almost universally profitable, as it is really the only effective means of

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overcoming and reversing the tendency among workers to restrict their output. The second is that some kind of standard relation between work and wages must be set as a basis for the regular scale, and that premium, bonus, or efficiency reward must be for work done in excess of that regular scale.

With regard to the first principle, it may be stated that the idea of the older school of managers is to pay a man a fair wage and make him do a fair day's work. The study of human nature reveals the fact that the certainty of reward or pleasure will always exert a stronger influence over the minds and wills of most men than the fear of punishment. Forty years of experiment in industrial operation of all kinds has proved again and again that unit costs of production are invariably lowered where increase of output brings direct and certain reward to the worker who increases his output.

The underlying theory is this: collective bargaining, the class wage rate, open or tacit agreement among workers that they will give only so much for so much, is too strongly established and too firmly entrenched to be broken down. No manager is strong enough to overcome it. It can be met and turned only by the supplementary proposition that in addition to standard

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wages for standard work, an extra compensation will be given for better than standard work. The premium or bonus then becomes a voluntary agreement, interfering in no way with ordinary contract relations, but operating voluntarily, automatically, and continuously to lead each worker upward from the level of his class to the higher plane of individual effort and reward for excellence.

Plans for awarding bonus or premium differ very widely, both in mechanism and psychology—that is, in the interpretation they put upon human nature and upon the methods by which it will be most strongly influenced. Each plan has its supporters and its critics, and it may well be that each served for the moment the particular purpose for which it was designed. Whether any one of the numerous plans or systems, either now in use or to be developed in the future, is capable of universal acceptance is problematical. The majority, if not all, of existing wage systems have been modified somewhat from the original plan, but the wide divergence in these psychological features still obtains.

In the Halsey premium plan, which was one of the earliest of the newer plans to receive general recognition, the worker is paid a percentage, varying from 30 per cent. to 50 per cent.

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of the time saved in each operation. The latter percentage is the one in more general use, and provides for an equal division of the saving, in direct wages between the employer and the employee. On the whole, this appears to be an equitable provision, as the premium begins with a slight improvement over past performance and rises in direct and equal proportion to the increase in betterment. A more detailed investigation discloses the fact that the plan may reward various workers disproportionately to the effort expended, since there is no provision for uniform practice in the establishment of standards.

The usual practice is to accept past performance as a standard, or the point at which the payment of premiums is to start; but established records of performance may be unreliable. It is conceivable that two jobs of different nature may be reasonably accomplished in ten hours, but, owing to difference in the skill and diligence of the operators, the established records may be sixteen hours for the one and twelve hours for the other. Assuming that the time was reduced to ten hours in each case, the one worker receives, under the Halsey plan, three times the amount of premium of the other, although both have delivered an equivalent amount of work.

Collective bargaining, trades-union agree-

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ments, or any other co-operative measures are not sufficient to prevent workers from being adversely influenced when they realise that some of their fellow-workers are receiving a remuneration which is disproportionate to the effort expended as compared with their own earnings. The failure to bring the various standards into agreement must eventually tend to retard the benefits to be expected from the introduction of such a system of wage payment.

In the Rowan premium plan, the established performance is also accepted as the standard, but it differs from the Halsey plan inasmuch as the worker is paid a bonus in the form of a percentage of the time taken equal to the percentage of the time saved. Calculations of payments for varying degrees of performance disclose the premium rising faster than the production up to a certain point, and then falling with even greater rapidity.

The Rowan plan was obviously designed to protect employers against errors in establishing standards, without recourse to the customary practice of an arbitrary reduction in the standard allowance. In fact, responsible labour leaders have endorsed the Rowan plan for the very reason that it automatically removed the temptation of the employer to reduce the limits. Under

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this system, the worker is encouraged to improve his performance to a certain point but is actually penalised, through substantially reduced earnings, if the performance is further improved.

In the Paulson, the Cardullo, and certain other similar wage systems, the same design is in evidence : the premium is fairly large for the first increase in output, and decreases proportionately with further increase in performance. In these plans, as in the Rowan, it appears to have been the theory that the rate or standard would require cutting and that the workers would expect a cut, so that a steadily diminishing rate of premium, beyond a certain point, ought to be incorporated in the design of the plan.

More recent developments in wage systems tend toward the establishing of a rational standard without any regard to past performance. In the establishing of these standards, each job is studied and the elements of each operation are timed by a competent observer, careful note being made of all influencing conditions. In this manner, rational standards are determined, and no alteration in the standard is considered so long as the operating conditions remain constant. A particular feature of these systems is that a definite task is set and the details of the method of performance are fur-

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nished, so that there may be no misunderstanding as to the exact amount of work to be done. The Taylor Differential Piece-Rate, the Gantt Bonus, and the Emerson Efficiency plans are the best-known examples of this class.

In the Gantt Bonus plan, which is a modification of the Taylor plan and which it has generally replaced, there is no premium or bonus offered for small improvements ; a large prize, varying from 80 per cent. to 100 per cent. of the time taken, is given to those who manage to attain the standard set. In all cases, the standard is set so high that only the best workers can reach it, and of those, there are few who can largely exceed it.

Two common criticisms of this plan seem to be justified : firstly, that the average supply of labour does not permit such a rigid discrimination in the selection of workers for the task ; and secondly, that those whose performance is within a reasonable distance of the actual attainment of the task are entitled to some additional compensation commensurate with the effort.

It seems unreasonable to expect an individual to make persistent attempts to secure a reward when no compensation is given for the voluntary increase in output. The natural result is that

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the unsuccessful will, at least after numerous trials, relax their efforts as in the case of the day-wage plan. For effective organisation changes in assignment of work must follow inevitably, and, where labour is difficult to obtain, the net gain may be exceedingly doubtful.

Further, the fixing of such absolutely rigorous standards is possible only in a limited number of trades, as such standards presuppose the minute standardisation of materials and machine operation. It is questionable if such conditions can be obtained in those occupations involving considerable individual skill.

With the Emerson Efficiency plan, the premium begins when the worker does better than one and one-half times the standard fixed for the task. In this manner a small reward is given for a small increase in output, and the premium rises in a gradually increasing proportion, the extra payment for attaining the standard being equal to 20 per cent. of the time taken. When the workers exceed the standard, the premium is 20 per cent. of the time taken, plus the equivalent of all of the time saved below the standard.

The theory underlying this plan is that each effort above a certain point should be rewarded,

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and that each additional gain requires greater concentration and is therefore entitled to proportionately larger rewards. To a common-sense interpretation of human nature, this system appears to be the most reasonable, although all existing wage systems have been profitably employed.

While considerable discussion can be devoted to the relative merits of the different modes of wage payment, too much emphasis cannot be laid upon the fact that all these systems work; all have produced good results in varying circumstances and under varying conditions. Therefore, although they differ in secondary matters of policy and administration, the conviction is overwhelming that the cause of their success lies in their uniform assertion of the primary principle of rewarding individual effort.

Premium or bonus payments are a benefit only as an incentive to the worker to break away from the traditions of his class and the restriction of output; as an inducement to use profitably his individual capacity to raise his product above the lower levels to which the average is always pulled down by the poorer workers. With standards reasonably fixed, no hardship is put upon the worker and no unreasonable exertion is demanded of him. When

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standards are thus fixed, and a rationally proportioned scale of bonus reward is in automatic operation, there can be no doubt that greater profits result to both sides, and stability of relations is materially aided.

CHAPTER XIII

PROFIT-SHARING

DURING recent years, considerable discussion has centred upon the term Profit-sharing, and many students of industrial economics have become enthusiastic advocates for the application of the plan to all industrial undertakings. The enthusiasts see in the adoption of this plan the solution of all vexing industrial problems and the automatic elimination of the numerous forms of preventable wastes in factory organisation and management. In short, Profit-sharing is the utopia which has been the objective of the dreamer throughout the industrial age.

Profit-sharing is not a new idea, for it has even been advocated for the past one hundred and fifty years or more, and many interesting experiments have been made with varying results. There are some examples where the plan has been successfully operated which tend to confirm the opinion of the supporters of the theory. The large majority of the attempts

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have resulted in utter failure, and on the whole the results of the past justify the opinion that the plan is not practical, neither is it the panacea for all the ills an industrial enterprise is heir to.

Notwithstanding the unsatisfactory record of the operation of profit-sharing plans, the general purpose of the scheme cannot be universally condemned, since the theory of a more general distribution of the benefits resulting from the enterprise has much to commend it to careful study. The fact that most attempts in this direction have failed completely and that labour difficulties have not been entirely absent in those enterprises where the plan is in successful operation is not sufficient to condemn the idea. The underlying causes of the failures to secure the benefits accruing from the plan should be carefully analysed; the failures may be due to errors in administration rather than to fundamental principles.

It is impossible to review the whole field of endeavour in connection with profit-sharing schemes, and it is unwise to comment upon the failures without having had intimate contact with the details of design and administration in each individual attempt to solve the problem. Undoubtedly valuable lessons can be learned

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by both manager and managed from the history of each effort which can be profitably utilised in dealing with this or other industrial problems.

Before profit-sharing can be made a success, it is necessary for both Capital and Labour to recognise that they have interests in common. This recognition must precede rather than follow any installation of the plan, for it is idle to assume that the receiving of a remuneration in any form will secure support if the principles involved are not thoroughly understood. It is essential that all parties to an industrial enterprise should co-operate in every respect if ultimate success is to be secured, but co-operation is particularly important in the operation of a profit-sharing plan.

The successful issue of any undertaking requiring the joint efforts of many involves a thorough understanding of the problem and a full conception of the purpose and object of attainment. Profit-sharing is a means to an end, and unless the proposal is made and accepted from that view-point there can be little hope of a successful issue to the project. The term itself implies no agreement or contract stipulating definite service to be rendered by each party, but an agreement between the two to direct

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their several efforts to the accomplishment of a definite object. It is open to question whether the various factors involved have been carefully studied in the case of any one of the numerous trials of profit-sharing; the omission of this requisite appears to invite failure.

In the first place, "profit" is capable of numerous definitions, for though the term is in common use, it is doubtful if any two definitions will agree. What is a profit? Adam Smith referred to it as "not a very different thing from the interest on the capital or stock employed," while Bagehot writes: "Profit, as we calculate, means that which is over after the capital is replaced." Other definitions can be submitted, but even the foregoing serves to introduce extensive discussion before agreement will be reached as to the exact meaning of the term, which must be accurately defined before any proposal of distribution can be entertained.

Expert accountants differ in their considered opinions as to what constitutes a profit, and extensive legislation has been enacted bearing on the same subject. When those who have specialised in Political Economy and those who are expert in the preparation of methods capable of developing reasonably accurate profit figures from the maze of business records offer no

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certain guidance, it is no small wonder that the great mass of labour is confused in its understanding of the term. If something is to be shared without subsequent discontent, it is obvious that there must be a clear understanding of what that something is, before a profit-sharing agreement is concluded.

The necessity for providing a more accurate definition is emphasised when an effort is made to segregate the elements of profit. Mill outlined three component elements—"interest on capital, insurance against risk, and wages for superintendence." Each of these provides ample field for discussion, and it is probable that difficulty will be experienced in finding two students of industrial economics whose opinions will be in agreement concerning any one of the elements mentioned.

"Interest on capital" is the most simple of the elements, but though easily understood, is not so easily disposed of, as interest must be given in exact figures. Supposing that 5 per cent. is the legal rate for loans, it is not to be assumed that this figure is to be accepted in the field of industrial activity. A loan at this rate is covered by reliable security and differs somewhat from an investment in a manufacturing project. Limitation of the interest-rate on capital in-

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vested to the recognised legal rate implies a definite guarantee which may not be practical in industry.

“Insurance against risk” requires such a wide range of study that attempt to establish a satisfactory figure appears at first view to be futile. All investment in commercial ventures necessitates considerable risk until such time as the project has reached a position of reliability. Adequate compensation for risk assumed is the just reward for the foresight of the individuals concerned, and satisfactory solution, although somewhat involved, is not impossible. This feature is of considerable importance in reaching a logical settlement of the problem of distribution.

The third element, “wages for superintendence,” is probably the one element involving, if taken literally, no difficulty of definition, for the term bears a most accurate meaning. The question may be raised, however, as to whether superintendence is to be interpreted in the technical sense in which it is commonly applied to industrial enterprises, or whether the term shall be regarded in a larger sense as including all of those whose efforts are directly engaged in the particular industry. Superintendence may mean the directors of the

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company, or it may be extended to the departmental managers and foremen, or even to the individual machine operators and their assistants. If the latter interpretation is accepted, then the term "profit" as commonly used has no place in this discussion. In fact, the further the subject is investigated, the more imperative becomes the necessity for a concise definition.

Assuming that the definition of "profit" has been clearly established and accepted by all parties, there remains the difficulty of reaching a satisfactory agreement as to the details of the distribution. The parties can be grouped under three heads, Capital, Management, and Labour, but the relative proportion of the profits to be allocated to each group must give rise to animated discussion. As the major proposal concerns sharing and not arbitrary dividing, the three parties must consider the matter jointly. Probably no such general discussion has prefaced the installation of any of the established profit-sharing plans; it is doubtful if such a discussion is possible, as this would imply a highly developed state of co-operative effort.

Most, if not all, successful business concerns are the result of the genius, the foresight, and the untiring efforts of a single individual; or,

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at least, of a very small group of individuals. Quite apart from any controversy concerning the opinions held by certain industrial economists, it is certain that those responsible for the successful conduct of a commercial venture have just claim to some substantial reward of their efforts. Without this, there seems to be little hope for the successful development of individual initiative, and if initiative be discouraged the record of successful enterprise will be measurably reduced. Any plan for enlisting the effective co-operation of the efforts of the many members of an organisation will not be really useful if it removes the incentive that produced the organisation ; a profit cannot be shared until it has been earned.

An organisation is only an instrument of accomplishment, and without intelligent foresight and sound business judgment industrial projects will not be sufficiently successful to necessitate extensive discussion concerning the sharing of profits. Theoretically the basis of a satisfactory profit-sharing plan is that the remuneration must in some measure be proportional to the service rendered in making the profits possible. If this principle is accepted, the development of the plan can be continued with a reasonable hope of success.

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The share of Capital consists of interest on the amount adventured in the undertaking *plus* suitable compensation for the risk assumed. It seems reasonable that the remainder of the accumulated profits should be the property of the other two participants—Management and Labour. As both of them represent the efforts of individuals—for the management of an enterprise requires labour quite as much as the operation of a machine—the logical distribution must be based on the service rendered. It is therefore necessary to consider the various factors involved in both the production and distribution of the commodities engaging the attention of the organisation.

Manufacturing is a combination of Designing, Purchasing, Producing, Selling, and Accounting. Management is an executive function of each of these divisions as well as in the co-ordinating of the efforts of all divisions. Labour, as represented by the group, is concerned only in the performance of the several tasks in each of the five divisions in accordance with the plan of control as determined by the management group. Before definite progress can be made in solving the problem of profit distribution it is necessary to establish the relative contribution of each in the earning of the profit.

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Wise purchasing is no less effective in profit making than efficient production or skilful selling. In fact, it is not unusual in those industries where material constitutes a very large portion of the cost of product that the net profit is simply the result of the exercise of sound judgment in buying the raw material. Cases are common (where the raw material is one exchanged in a speculative market) where the profit earned by the enterprise has resulted entirely from the buying and selling of material which never reached the factory. In other instances, the absence of skilful selling is sufficient to nullify the efforts of both purchasing and manufacturing staff so that no profit is made. These circumstances serve to introduce another difficulty in observing the principle of profit distribution on the basis of the service rendered.

As the subject is further studied, it will be found that the profits earned have their origin in the efforts of any one or all of the five divisions of the organisation. Profits may be the direct result of wise buying, attractive design, efficient production, skilful selling, or intensive control. Further, a profit may be earned by any one of the five divisions independently, but the net profit may be nil owing to a lack of application

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or error of judgment in one or more of the other divisions.

Ability to buy and ability to sell can be exercised through the medium of brokerage or commission houses without having direct connection with the factory receiving the raw material or supplying the commodity. Whether the profits resulting from the exercise of these functions are to be shared with the individuals concerned only with producing the saleable article is a most pertinent question for consideration in the settlement of a profit-sharing plan. It is not unreasonable to assume that only those individuals who are responsible for making the profit are entitled to share the benefits; the term "sharing" seems inappropriate if the benefits are to be distributed among those whose efforts are in no way connected with the accomplishment.

Attractive design may easily be the most important factor in creating the demand for an article, and in certain circumstances it may be that the whole profit is due to design and effective control rather than to the influence of either buying or selling policies. Again, intensive selling methods may be the sole means of turning an unprofitable undertaking into one of which the profits reach substantial

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figures. Refinements in control, providing for more complete co-ordination of the production and selling divisions of the business, may also be the direct cause of material increase in the profits of a manufacturing firm.

Careful analysis of successful enterprises reveals innumerable instances of some single factor being entirely responsible for the success of the venture. Ability to forecast the future and to take advantage of the opportunity offered must have its own reward, as otherwise personal leadership and individual initiative will cease to exist. The hope of reward is a powerful tonic in all fields of human endeavour, and though the pride of accomplishment is often sufficient recompense to the individual, it is difficult to prevent the profit of the venture from accruing to the individual. The most satisfactory solution of the problem seems to be that which gives the opportunity of receiving the profit of his labour to each of the various individuals in the organisation.

It is a mistake to assume that a utopia will be created by the universal application of the profit-sharing principle. The dissatisfaction which the plan hopes to remove is based on the feeling that some individuals in the organisation are getting more than their rightful share ; the

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usual assumption being that there are two distinct classes, Capital and Labour, and that the latter class is not receiving its just due. There is no certainty that, however equitable the division may be, there will not arise further dissension between the individual members of each class respecting the amounts distributed among themselves. Profit distribution on a per capita basis without regard to the measure of service contributed in attaining the objective must give rise to as much dissatisfaction as is now existent where no profit-sharing takes place.

In order to attain results of permanent value, further analysis of profits must be conducted for the purpose of ascertaining the amount of profit for which each division of the business is responsible. Profits in the future must be segregated into their components in a manner similar to the analysis of costs now in vogue. Costs are segregated into material, labour, production, selling, and administration, and may each be further subdivided as necessity requires. It seems essential that means should be developed for segregating profits into those arising from design, material, production, selling, and control, and that effort should be directed toward the development of a plan for the equitable distribution of the profit of each group among the

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individuals concerned. Without some such system of segregation and attribution, the ultimate success of profit-sharing plans is exceedingly doubtful.

Detailed analysis of costs serves to disclose the existence of preventable wastes in designing, purchasing, manufacturing, selling, and administrative control. These wastes are in reality profit wastes. Development of means for distributing to the individuals responsible the gains resulting from the elimination of these wastes offers practical possibilities for disposing of the particular problem under discussion. Opportunity to earn profits is more practical than opportunity to share profits, and favourable consideration is more readily secured when direct connection can be established between effort and reward.

The chief criticism of profit-sharing proposals, which includes those plans now in successful operation, is that the reward is too far removed from the effort to secure the ultimate objective, viz. unqualified co-operation. The operator of a machine finds satisfaction in the knowledge that individual effort expended receives direct recognition in the remuneration received; proposals to share bonus earnings with his less successful co-workers finds little practical support from the

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individual worker. The horizon of the average worker is limited to his or her own individual affairs, and no plan can hope for success that does not give full consideration to this primary condition.

Profits are distributed quarterly, or, in some firms, annually ; wages are distributed weekly. Remuneration for effective co-operation must be included in the weekly pay envelope for the worker to establish a direct relation between the effort and the reward. Continuous and whole-hearted application must be recompensed in a practical form, and the loyal worker finds little consolation at the end of twelve months of industrious application, in the somewhat lengthy explanation of the chairman that the customary accounts of profits must be deferred for some cause or other.

The purchase of extensive supplies of raw material on a falling market, the failure of the salesmen to apply themselves to their task, the inability of the designer to anticipate correctly the changing fashions, the absence of a sufficiently comprehensive administrative policy : some or all of these causes, together with others of similar nature, may so disturb the relation between receipts and expenditure that the annual balance sheet will have a most unsatisfactory appearance. The stockholders and the management may

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accept the situation if the prospects for the future are sufficiently promising, but the worker, whose knowledge of the intricacies of finance is confined to paying the weekly household expenses, is not disposed to continue his support of a plan where reward is denied because of the misdirected efforts of other persons over whom he has no control.

The profit on operation as distinguished from that on design and that on control is the property of the workers engaged in production. When the plan of accounting is so modified as to permit this to be determined, and the system of performance records is sufficiently adequate to permit the individual effort to be accurately measured, profit-sharing may assume a practical aspect. The great mass of workers prefer to be employed under a system of payment by results, and objection to any plan of this kind may be attributed to inaccurate rate-fixing or unjust rate-cutting. Every worker is entitled to the opportunity of automatically settling his remuneration, and providing for this by means of a suitable wage system will probably remove the major causes of the agitation in favour of profit-sharing plans. One of the chief sources of preventable waste in factory organisation will then be eliminated.

In addition to the elements of profit men-

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tioned and suggested above, there are other sources of profits in commercial ventures which are not the direct result of either Capital, Management, or Labour. Chief among these are improperly adjusted values, monopoly of supply, and economic disturbances. The product of one factory may require a smaller investment and less volume of productive effort than the product of another factory of an established commodity ; the profit on the former may easily be far in excess of that of the latter. Monopoly of supply affords a temporary advantage to the organisation furnishing the commodity, and the holder of a supply of commodities during an economic disturbance may easily increase the profit substantially without any effort whatever.

The profits resulting from these causes do not belong to either one of the three groups composing the organisation. The logical distribution appears to be to include all three groups on some equitable basis if subsequent discontent is to be avoided. Business is to some extent speculative, and the element of chance must always exert a powerful influence in the conduct of any enterprise. Given equal opportunities, two individuals, or two groups of individuals, will rarely quarrel over the gains resulting from ability to forecast the future. Dissension arises only through the

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knowledge that one group occupies a position giving distinct strategical advantages.

Where increase in profits results from ill-adjusted values, monopoly, or economic disturbance, the benefit is appropriated by those responsible for distribution, as the marketing of the commodities has been accorded the predominating position in the development of industry. Many commodities are marketed through independent agencies, either wholesale distributors or commission houses. In those firms that market as well as manufacture the commodity the sales organisation retain the same dominant position as those of independent merchants. It is probable that this condition is the one requiring the most careful analysis and adjustment to eliminate much of the industrial friction resulting from unequal profit distribution.

Another factor requiring intensive study is the profit resulting from established habits of the consumer. This is commonly known under the term of goodwill. Where the quality of product and reliability of service have become established, the demand for the product need not be created, and the effort required for marketing the commodities is often reduced to negligible quantities. The profit resulting from goodwill

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is not correctly the property of those engaged in the marketing, as quality and reliability have resulted from persistent and well-directed efforts on the part of those engaged in production.

Goodwill is a valuable asset in any commercial undertaking, and there is a considerable portion of the profits which properly belongs to the individuals responsible for creating the reputation of the commodity. As the remuneration of the salesmen directly engaged in distribution is largely a question of commission on the volume of business handled, this class derives considerable profit through the medium of goodwill for which they are in no way responsible.

The true function of the selling staff is to create a demand for a commodity and not merely to act as a transfer agent between the manufacturer and the consumer when a demand has already been created. Without some radical alteration in the established practices, certain of those engaged in the selling organisation will continue to receive a compensation which is disproportionate to the ability required and the effort involved. Suitable adjustment in profit-distribution in this respect will serve to eliminate one of the most prevalent causes for dissension on the part of those directly engaged in production.

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Competent investigators have disclosed preventable wastes in selling organisation and methods of a magnitude equal to those existing in production organisation and methods. The elimination of these wastes is as imperative as the prevention of the factory wastes, for the price to the customer must be sufficiently in excess of the total cost of manufacturing and selling to provide a profit to the enterprise. The analytical methods employed to prevent wastes in factory organisation and management can be used to advantage for the detection and reduction of wastes in sales methods and practices. The existence of these wastes must contribute adversely to the operation of any plan for sharing profits.

Before profit-sharing can become a medium for combating successfully the prevalent wastes in an industrial enterprise, it will be necessary for searching analysis to be made of the profits for which each section of the enterprise is responsible. When this has been accomplished, easy means can be developed for distributing the profits of each section to the various individuals on the basis of the service rendered, and to provide that individuals in one section will not be penalised through the lack of application of those elsewhere in the organisation. In

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fact, the successful solution of the problem must provide opportunities for individuals to earn profits rather than share profits. Profit-earning will prove more satisfactory than profit-sharing for the elimination of waste.

CHAPTER XIV

CONCLUSION

THE methods which have been outlined of reducing the volume of preventable waste in factory organisation and management are not untried theories; they have been proved by results obtained in actual practice. Their application will serve to increase the output of existing equipment, permit the payment of higher wages and salaries, give increased profits to the management, and pay a substantial return on the capital invested.

Preventable waste in any form cannot be excused or satisfactorily explained. Whatever profit results from the elimination of waste is pure gain, and such profits must be shared with all concerned. Each manager and executive should study the situation with an open and receptive mind and enlist the co-operation of the workers in the investigation. There are no risks to be faced by either party in such an investigation. On the contrary, it

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is in non-investigation that danger lurks for both.

Recognition of the underlying principles of efficient management must prevail if a factory is to continue as a successful enterprise. There is preventable waste in all factories, and when an executive claims that a particular suggestion is inapplicable, as his factory is peculiar, he fails to appreciate that peculiarity exists only in technique of operation, but not in the practice of management.

Let such managers study the various departments in their factory and make note of the interruptions of work, the mistakes, the misunderstandings, the wasteful operations, the unnecessary motions, the misdirected efforts, the improper tools, the obsolete methods, and the useless records. These are a few of the many preventable wastes, the continuance of which must involve reduced profits and lowered wages.

Let them look about the factory and decide whether it is a fit place for human beings to spend 35 per cent. of their natural lives. Let them determine the waste due to bad lighting, poor heating and ventilation, as well as the waste resulting from defective design of product, improper location of machines, inadequate admin-

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istrative planning, insufficient and inaccurate instructions, and inefficient distribution of material.

Manufacturers of similar commodities must of necessity work together, as the day of the individual and isolated manufacturer is past. This co-operative effort is essential for improvement in educational facilities, scientific research, trade development, agreements on selling prices, and matters of similar purport.

But, however effectively such combinations are organised and conducted, the ultimate success must depend upon the relative productive efficiency of the individual factories concerned. The only satisfactory method of dealing with the industrial problem is for each individual manufacturer and manager to set his factory in order. This can be accomplished through the education of Labour and the restoration of confidence between Capital and Labour, and these means are wholly within the province of the employer and manager.

When Labour realises fully the amount which it is losing collectively through the failure of managers to apply effectively the underlying principles of management, it will undoubtedly be insistent for their application. Since Labour, as a unit, receives such a large percentage of

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the wealth resulting from industrial activity, it will benefit more largely than any other class from the elimination of such gigantic waste.

Waste elimination is not a problem of easy approach or of rapid solution. Efficiency is not like a garment that can be put on during inclement weather and be removed at will when conditions are more propitious. It must permeate the entire organisation at all times if the waste problem is to be satisfactorily solved. Labour, Management, and Capital must combine their efforts. The goal cannot be reached in a single day, for progress must be slow ; time, patience, and persistence are necessary for permanent results.

Each group concerned must revise its conception of its responsibilities. The various parties concerned with an industrial enterprise must realise that they have interests in common. Without this essential premise being recognised, there is no possibility of a satisfactory solution of the problem being reached. The problem is no more and no less than the elimination of preventable wastes in factory management and operation, and the equitable distribution of the resulting profits will be sufficient to satisfy the desires of all parties.

FACTORY MANAGEMENT WASTES

Industrial executives can never effect improvement until they convince themselves that preventable wastes exist for which they are primarily responsible. Confession of sin is the first requisite of redemption in religion; the principle is equally applicable in factory management. The first step is to revise their conception of Labour.

The majority of employers regard Labour as a commodity for which they pay an agreed price as in the case of material for manufacturing purposes. But Labour is not a commodity in that sense: it is a medium of service, and as such it must be studied and developed in order that the service rendered may be effective. The responsibilities of the manager begin, not end, at the employment office; they cease only when the human energy under his direction has been applied with a high degree of excellence.

Employers must have a sympathetic attitude toward the two great factors which dominate the minds of the workers—the possibility of unemployment and the fear of not receiving fair pay in respect of remuneration. It is a common opinion among the great mass of Labour that there is a limited amount of work in the world and that workers must curtail their productive efforts in order to avoid distress on the part of

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others. It is also a common opinion that individual effort beyond a certain point will result in a reduction in the basic standard by which their remuneration is measured. Unfortunately this latter fear has been amply justified by the injudicious actions of many employers.

Workers are entitled to a continuity of employment, and a portion of the profits of industry should be set aside as an insurance against distress on the part of workers should temporary unemployment be inevitable. They are also entitled to receive a definite wage irrespective of output during the period of employment. Without some provision of this nature, employers will not be made fully aware of the great necessity of exercising care in the selection and assignment of workers in their respective establishments. Neither will they fully realise the urgency for restricting employment to that actually necessary for the particular purpose.

The fear on the part of the workers of enforced reduction in the rewards for individual effort can only be eliminated by safeguarding their interests by means of co-operative agreement between employer and employed in the establishment of standards of performance. This

FACTORY MANAGEMENT WASTES

can be effected by means of a scientific analysis of the work involved in order to provide definite specifications of operations and working conditions in each case. It is only in this manner that the responsibility for a breach of contract, if this should occur, can be established. Collective bargaining is essential to secure practical results.

On the other hand, Labour leaders must see that the individual members of their organisations view the industrial situation in the true perspective. Wages cannot be raised indefinitely out of proportion to the rate of production. Restriction of output must be abolished, for if the rate of production does not increase more rapidly than the rate of wage, the cost of living will rise in direct proportion to the rise in wage earnings. In this manner a vicious circle will be described from which no permanent benefit can result either to themselves or to the community at large. Increased earnings are not in themselves a benefit when the purchasing power of the money received decreases with each increase in wages.

Restriction of output, however, is not confined to the ranks of industrial operatives. Impartial study discloses similar practices on the part of the employers, for prominent manu-

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facturers have put on record their view that "over-production" in their particular industry was detrimental, as the world's markets would not absorb the excess. And yet these same manufacturers severely criticise the workers for holding similar opinions and adopting similar means for protecting what they consider as their legitimate interests.

Wilful restriction of output must be abolished by both Capital and Labour. The development of any trade is unlimited, when the problem of creating a demand is approached in a comprehensive manner. The luxuries of to-day become the necessities of to-morrow. In fact, the buying public is in reality a bundle of potential wants capable of unlimited expansion. But the buying public should not be forced to pay for the cost of the preventable waste in production.

The cry for cheap labour must cease, for no labour is cheap. As with material and equipment, a low first cost may prove more expensive in the end. Labour must be developed, must be educated and instructed, and must work under proper environment. Also, machinery must be introduced wherever possible. The cost of production must be reduced in order that the cost of living shall not rise in direct proportion to the wage earnings. Cost cutting,

FACTORY MANAGEMENT WASTES

rather than price cutting, must receive the attention of factory managers, for otherwise the industrial problems of to-day will be succeeded by even greater problems to-morrow. The reduction of costs can be accomplished by the elimination of waste.

The burden of responsibility cannot be shifted from the executives, but the individual members of the organisation can and should be encouraged to take a greater interest in their work and induced to assume a portion of the responsibility in the enterprise which engages their attention.

But no manager or executive should undertake the problem of waste elimination in a superficial manner, or without the determination to carry the matter to a satisfactory conclusion. Spasmodic efforts only serve to cast reflection upon his own integrity of purpose, and to arouse doubts on the part of his subordinates and the workers as to the ultimate objective.

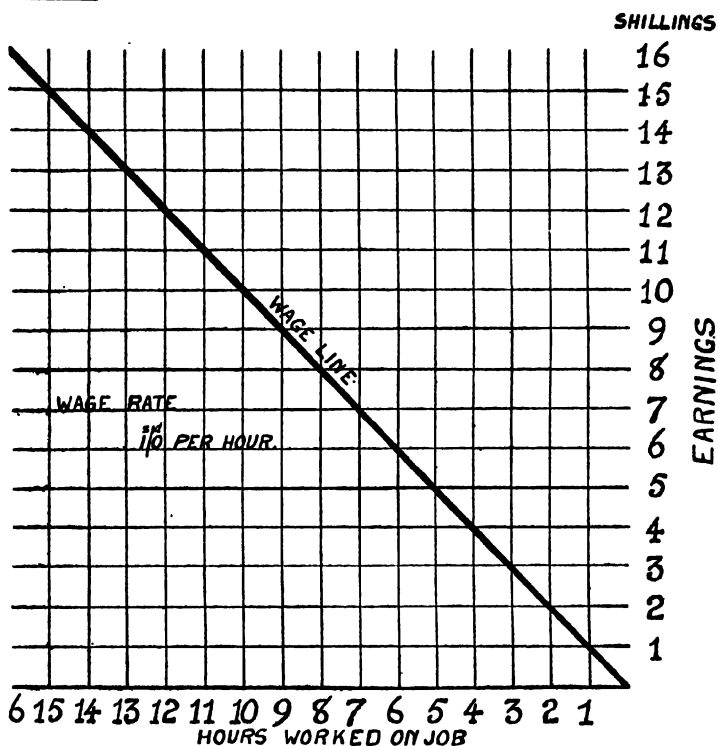
The present-day executives must realise that they are inheriting the results of errors on the part of their predecessors. Any extensive alterations in industrial administration are viewed with suspicion by the majority of those concerned, and partial attempts are

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severely criticised. Traditions are not easily destroyed.

As Harrington Emerson has so truly written :
“ It is the curse of Labour, not its joy, that is to be lessened. It is the ignorance, not the wisdom, of Capital that is to be eliminated.”

APPENDIX: CHARTS 1-8

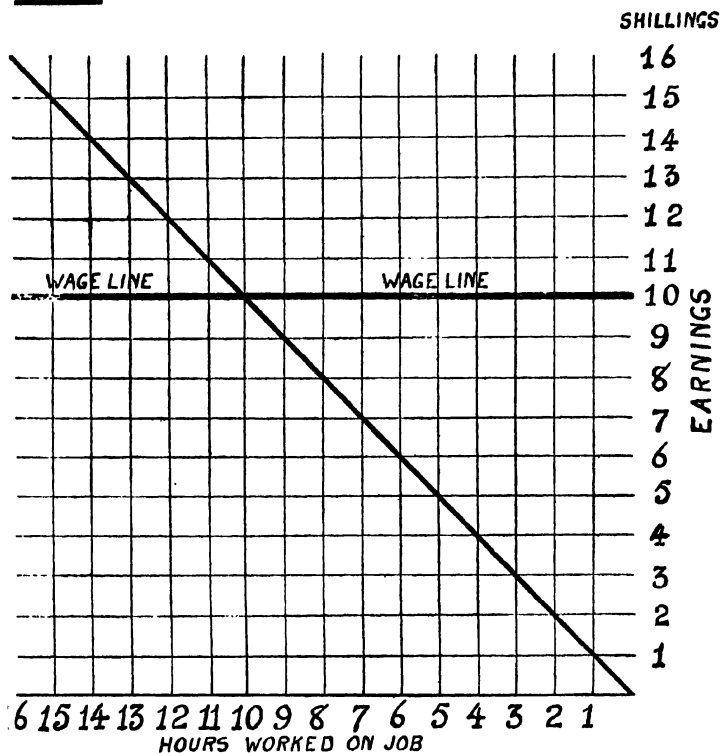


DAY-WAGE PLAN.

Assumed wage-rate of 1s. per hour.

Time taken.						Earnings.	
						Total.	Per Hour.
Hours						Shillings	Shillings
15	.	.	.	.	.	15·0	1·0
12	.	.	.	.	.	12·0	1·0
10	.	.	.	.	.	10·0	1·0
9	.	.	.	.	.	9·0	1·0
8	.	.	.	.	.	8·0	1·0
6	.	.	.	.	.	6·0	1·0

CHART 2.

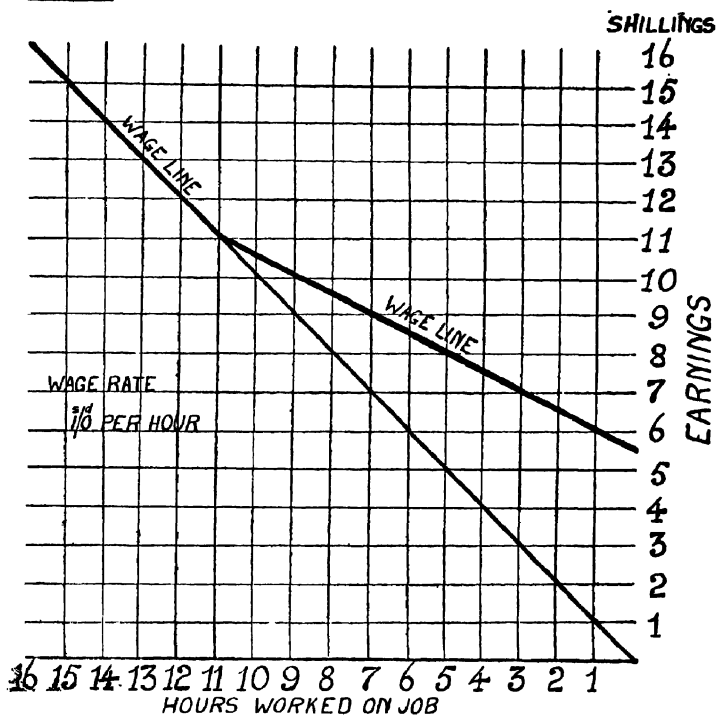


PIECE-WAGE PLAN.

Assumed piece-rate of 1s. per job.

Time taken.					Earnings.	
					Total.	Per Hour.
<i>Hours</i>					<i>Shillings</i>	<i>Shillings</i>
15	.	.	.	.	10·0	0·66
12	.	.	.	.	10·0	0·83
10	.	.	.	.	10·0	1·00
9	.	.	.	.	10·0	1·11
8	.	.	.	.	10·0	1·25
6	.	.	.	.	10·0	1·66

CHART 3.



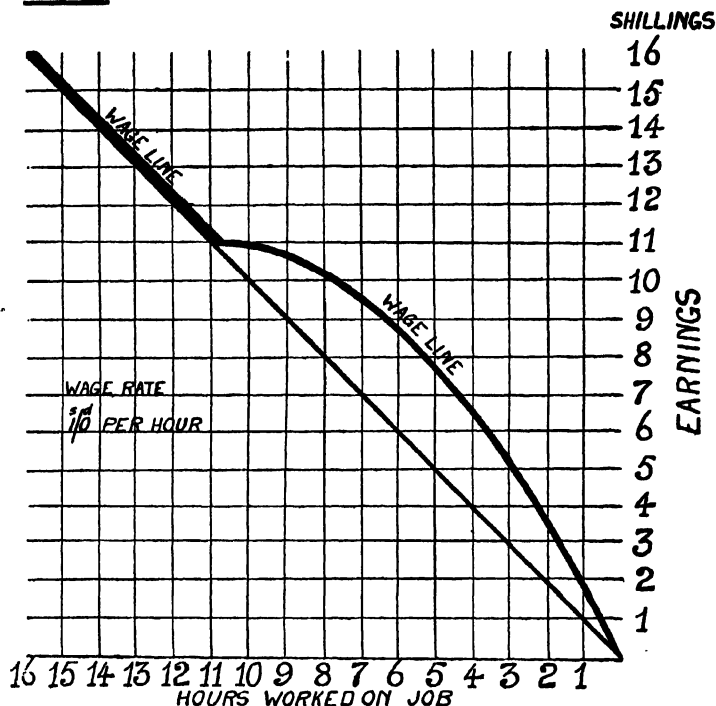
HALSEY PREMIUM PLAN.

Assumed wage-rate of 1s. per hour.

Average past performance on job of 11 hours.

Premium equal to 50 per cent. of time saved.

Time taken.					Earnings.	
					Total.	Per Hour.
<i>Hours</i>					<i>Shillings</i>	<i>Shillings</i>
15	.	.	.	.	15·0	1·00
12	.	.	.	.	12·0	1·00
10	.	.	.	.	10·5	1·05
9	.	.	.	.	10·0	1·11
8	.	.	.	.	9·5	1·18
6	.	.	.	.	8·5	1·40



ROWAN PREMIUM PLAN.

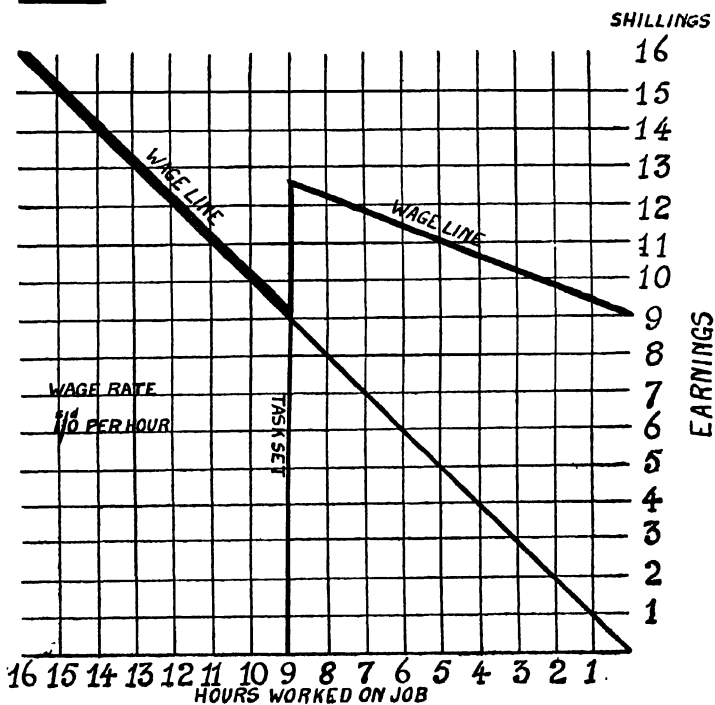
Assumed wage-rate of 1s. per hour.

Average past performance on job of 11 hours.

Premium payment—a percentage of time taken equal to percentage of time saved.

Time taken.					Earnings.	
					Total.	Per Hour.
Hours					Shillings	Shillings
15	.	.	.	.	15·0	1·00
12	.	.	.	.	12·0	1·00
10	.	.	.	.	10·9	1·09
9	.	.	.	.	10·6	1·18
8	.	.	.	.	10·2	1·27
6	.	.	.	.	8·7	1·45

CHART 5.



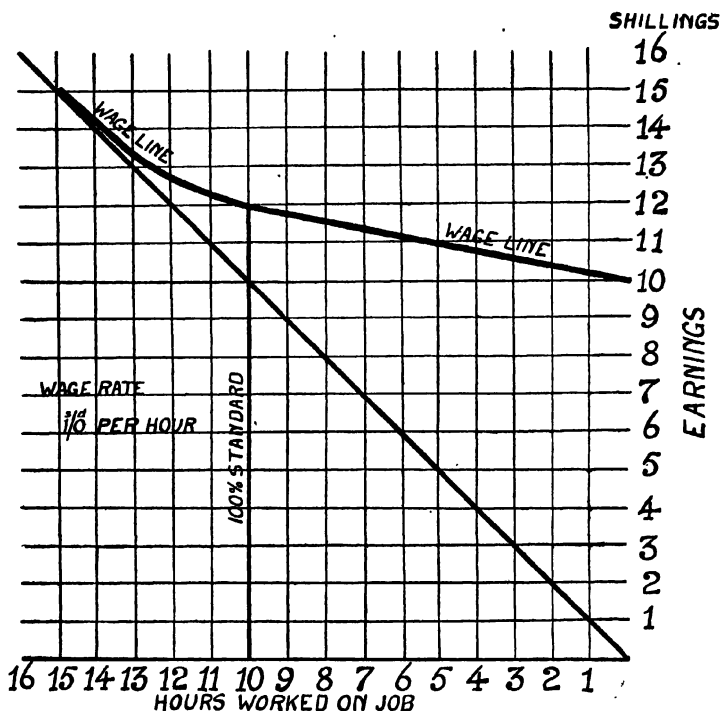
GANTT BONUS PLAN.

Assumed wage-rate of 1s. per hour.

Definite task set of 9·0 hours for completion of job.

Bonus payment equal to 40 per cent. of time taken for accomplishment of task specified.

Time taken.						Earnings.	
						Total.	Per Hour.
<i>Hours</i>						<i>Shillings</i>	<i>Shillings</i>
15	.	.	.	.	.	15·0	1·00
12	.	.	.	.	.	12·0	1·00
10	.	.	.	.	.	10·0	1·00
9	.	.	.	.	.	12·6	1·40
8	.	.	.	.	.	12·2	1·52
6	.	.	.	.	.	11·4	1·90



EMERSON EFFICIENCY PLAN.

Assumed wage-rate of 1s. per hour.

Standard (100 per cent. efficiency) of 10 hours for completion of job.

Bonus payment equal to 20 per cent. of time taken for a performance efficiency of 100 per cent.

Time taken.					Earnings.	
					Total.	Per Hour.
<i>Hours</i>					<i>Shillings</i>	<i>Shillings</i>
15	.	.	.	.	15·0	1·00
12	.	.	.	.	12·7	1·06
10	.	.	.	.	12·0	1·20
9	.	.	.	.	11·8	1·31
8	.	.	.	.	11·6	1·45
6	.	.	.	.	11·2	1·86

CHART 7.

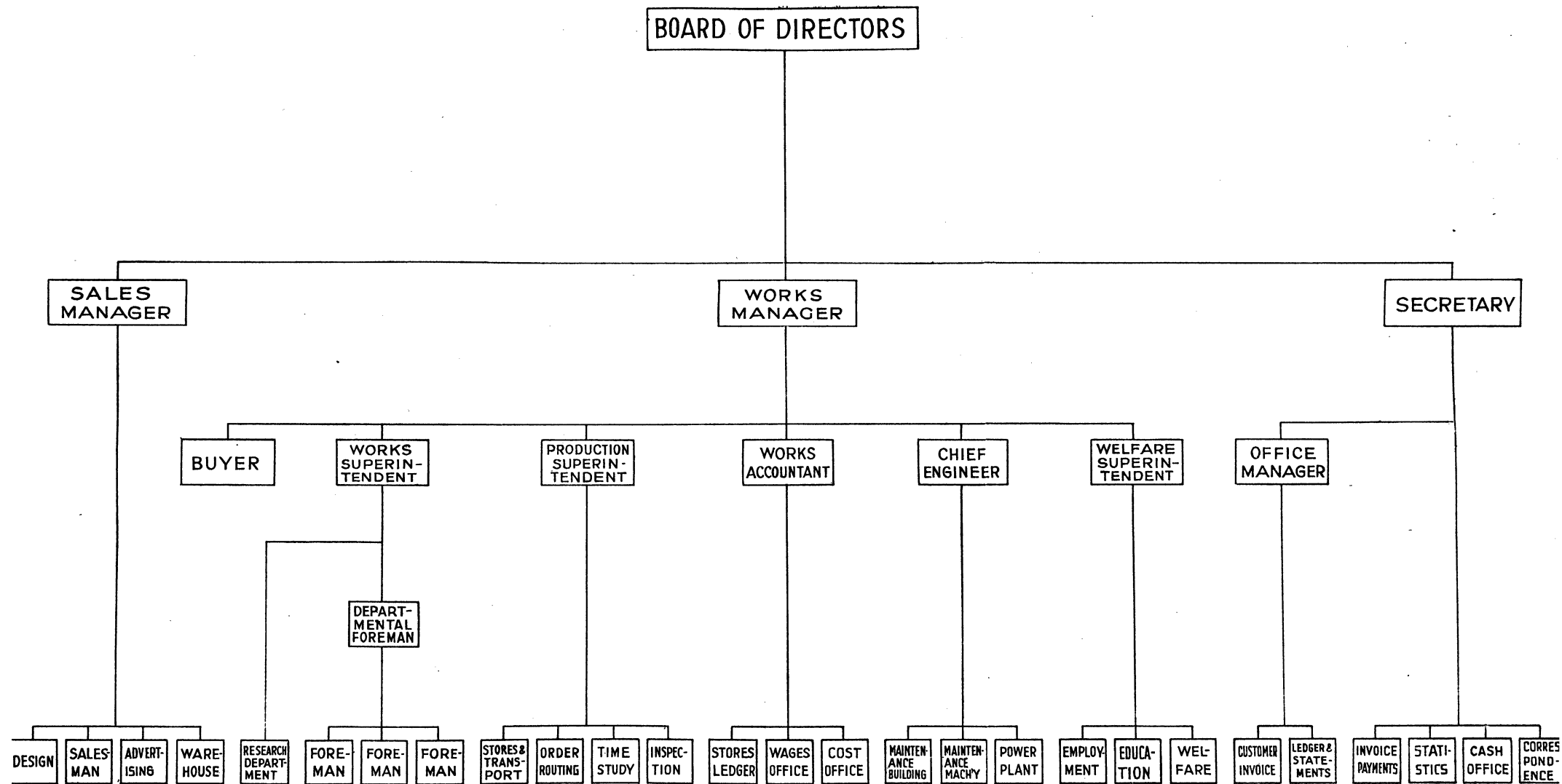


CHART ILLUSTRATING THE PLAN OF ORGANISATION IN A SMALL FACTORY.

CHART 8.

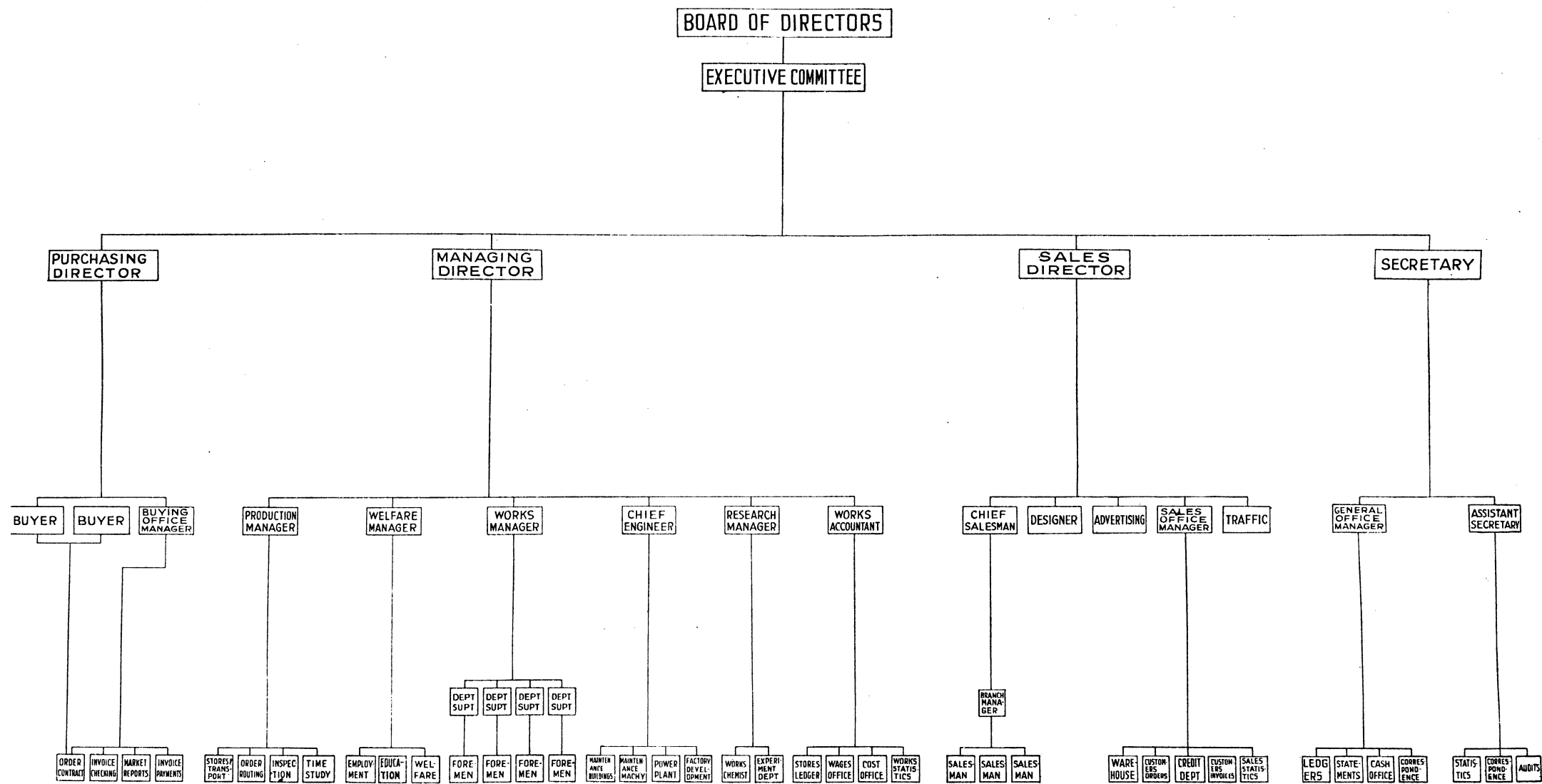


CHART ILLUSTRATING THE PLAN OF ORGANISATION IN A LARGE FACTORY.

