STANDARD COSTS

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SCIENTIFIC METHOD IN THE DEVELOPMENT AND USE OF COST STANDARDS

BY

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PREFACE

THE aim of this book is to explain and to illustrate modern tendencies in the practice of costing. It is not intended to expound these tendencies fully or comprehensively, but to provoke thought along certain specified lines. Work and problems in modern industry cannot follow any cut-and-dried system—methods of approach only can be conceived. While principles can be outlined and technique sketched out, practice, so long as it conforms to recognized principles and technique, must develop in the way most suited to individual circumstances.

The necessity for scientific method in costing has been emphasized. Costing problems are regarded as being analogous to engineering and chemical problems in the respect that the processes of measurement and synthesis are needed for their solution. Hence the term "scientific costing."

A word may be said about the terms "cost control" and "responsibility." Backed by knowledge and facts, "control" becomes guidance rather than the force of authority, while "responsibility" reflects individual capacity and pride of achievement.

Treatment has been broad, and reference to specific industries deliberately avoided. For this reason, illustrations and problems have been worked out in the abstract. Mention of a particular industry often may give the impression that the subject-matter is not applicable to any industry other than the one referred to. This book has been framed with the intention, as far as possible, of avoiding any suggestion that "such methods may be very good for some works but they are not suitable for ours," but, in order to make the subject-matter of general application, lucidity has been to some extent necessarily sacrificed.

Simple cases have been presented as examples. This,

however, in no sense implies that technique and experience will not deal satisfactorily with difficult circumstances and problems.

This book advocates that costing should aim at focusing on essential points and presenting key figures amplified by written explanations, and possibly illustrated graphically by diagrams. Technical managers are neither costing experts nor statisticians, and rarely have sufficient time to ascertain the causes of high costs by abstracting essentials from a mass of figures.

The intention has been to interest directors, managers, engineers, and technicians as well as costing students and those cost accountants who may not be conversant with standard costing.

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CHAPTER I

INTRODUCTION TO PRINCIPLES

THERE is an essential difference between costing by standards and costing by all other methods. The fundamental concept of standard costing best explains this difference—

That it is far more important to know how much a product *should cost* in detail and to ascertain only the amounts and causes of any excess over this cost than it is to know how much a product *has cost* in detail with but perfunctory knowledge of how much it should cost.

Modern industry demands that its functions shall be well balanced and shall progress in alignment. The technique of making has progressed faster than that of controlling and managing. Without measures and gauges, it is impossible to control and manage the increasing complexities of industrial enterprise. Cost standards will act as measures and gauges: but only if scientifically developed.

Purposes of Costing.

To have full understanding of how far standard costing meets the requirements of industrial control, the main basic purposes of costing must be agreed.

1. To provide the sales organization with information in the form most useful for price fixing.

2. To provide analytical control over the whole activities of a concern in such a way that administration and management have a clear picture of efficiency in terms of cost.

The sales organization requires to know, usually in advance of actual production, the cost of a product not only

in total but analysed into constituents of variability and of margin. It requires to know how costs will rise or fall in inverse ratio to amount of output.

Cost control aims at the presentation of those facts which will prove of most service in securing economies and eliminating waste. The true value of cost control is measured by its utility. It endeavours to keep a close and detailed check on all activities of manufacturing and selling, but the cost of the check must be consistent with the derived utility. The economic law of Diminishing Returns may be aptly cited here.

Standard Costing.

There is no connection whatever between standard costing and standardized costing. The latter term, for which another name is uniform costing, refers to systems which have been formulated for various industries in order that costs may be examined on a comparable basis. A uniform costing system may utilize the principles and methods of standard costing, but not necessarily so. Standard costing can be more clearly, but not so tersely, defined as costing by standards.

Simply expressed, standard costing is a method of ascertaining how much costs should be, and analysing the causes of variations between how much they are and how much they should be.

Alternatively, standard costing is a scientific method of developing a comprehensive series of cost standards to cover the activities of a business, of comparing actual costs against cost standards in such a way that the causes of variation are revealed in full detail, and of combining the variations to form a complete statement of profit and loss.

Standard costing does find actual costs, but not the cost of individual articles and batches. The actual costs which it ascertains are those of processes and functions. It concentrates upon showing *how much*, *where*, and *why* actual

costs are in excess of cost standards. The other methods of costing, i.e. those not using standards, tend to finish when actual costs are found. Although *how much*, *where*, and *why* are undeniable objectives of standard costing, not every application can immediately attain all three of them. Frequently, the *why* objective is not gained. Yet it is the most important one. If costing is to exercise true control, it must know and state the exact location and reason for excess cost.

The practice of standard costing resolves into—

1. The preparation of cost standards.
2. The mechanism of accounting with cost standards.

Cost Standards.

There is probably more misuse of the term "standard" than any used in the costing vocabulary. A standard means a definite unit of measurement, something tangible and accurate. It can be described as a criterion established by scientific investigation. A cost standard, therefore, must be established by scientific investigation. Otherwise it is not really a standard.

A cost standard is an accurately developed measure of the cost of performing specified work under certain stated conditions.

Cost standards should not be based upon normal or average costs. They are, in a sense, model costs, and are intended to serve as objectives for attainment. Records of previous performance, unless qualified by sufficiency of detail with regard to methods and conditions, are of no assistance in developing standards. Obviously, cost standards must be adjusted for use in calculating sale prices. The methods for bringing cost standards into alignment for the purpose of price fixing constitute a part of the mechanism of accounting. The reason for this adjustment in level is that actual costs in total are inevitably in excess of standard. Standards sometimes will be attained but more often will not. The scientific conception of a standard must never

be forsaken if complete and accurate control is to be maintained. Therefore, for price fixing, cost standards must be increased by appropriate increments to cover a reasonable proportion of the difference between actual and standard costs.

If the definition of a cost standard be examined, the possibility of dual variation becomes apparent. A cost standard is developed as applicable under certain stated conditions.

Thus variations from cost standards may be occasioned by—

1. Alteration in conditions.
2. Relative in efficiency measured against the standards.

This raises a most important point. Although the standard of performance which measures efficiency must be a model one, the "certain stated conditions" must be those which may be reasonably operative. Broadly, "certain stated conditions" are those factors which must be stabilized in theory before a cost standard can be developed. An elementary example will suffice. Before the hourly running cost of a machine can be developed, the number of hours likely to be spent on productive work must be forecasted. This forecast becomes a "certain stated condition." However, it is neither based upon ideal conditions, nor is it intended to serve as a model. Expectation, preferably derived by analysis, governs its formulation. Previous, average, and normal conditions must be considered. These "certain stated conditions" are predetermined in advance.

Restated, a cost standard is an accurately developed measure of the cost of performing specified work under predetermined conditions. The measure of cost is developed as a model attainable in practice by highly efficient performance and without any regard to past achievement. The predetermined conditions, on the contrary, are not those which can occur under most favourable circumstances, but those which are likely to be operative during the future

time under consideration; in which case the past may be a guide to the future.

The development of cost standards by scientific investigation has been stressed. In theory, it may seem a platitude. In practice, it means the creation of functions which can satisfactorily deal with the analysis of every activity of a business and the gradual building up of performance standards. The research includes manufacturing, sales, and finance in all their ramifications. The scope of such work is immense, and its evolutionary character must always be borne in mind. Like all functions, the duties may be carried out by a specialist staff or they may devolve upon individuals as part-time work. The essentials are knowledge of objective and co-ordination of effort.

Cost Estimate and Cost Standard.

Standard costing undoubtedly originated through the comparison of actual costs with estimates. As estimating became increasingly scientific and accurate, the possibilities of eliminating much of the detailed cost finding, and of controlling costs of production in bulk, were visualized. Unfortunately, there was perhaps a tendency to cut down cost finding before estimating had really found its level. On this account, standard costing has been criticized as having faults and disadvantages which were due not to any inherent defects in principles or general method, but to the weakness and ineffectiveness of individual applications. Advanced practice in standard costing has emerged through scientific reconciliation of actual costs with estimates, but in doing so the technique has been completely revolutionized. The estimate has become the cost standard, and a complicated mechanism of accounting now indicates, in minute detail, locations and causes of variations.

A cost standard, however, does differ fundamentally from a cost estimate. A scientifically prepared standard is a fact, always providing that efficiency of performance prevails,

and that predetermined conditions are existent. On the other hand, a cost estimate is not prepared entirely upon a factual basis, and rather depends upon the law of averages to see it through. An estimate does not differentiate between basic cost and permissible variation, but takes an overall figure which experience in the past has proved to be approximately correct. Preparation differs both with regard to conception of the basis of computation and to accuracy and sufficiency of available data. While cost estimates were of great value in the evolution of standard costing, and are still likely to be of equal value in certain industries, the progressive adoption of cost standards seems inevitable on account of the continued expansion of scientific research. The latter methods provide the data essential for converting cost estimates into cost standards.

In an historical sense, there seems to be three definite stages of improvement before the scientific cost standard can be developed.

Every commercial firm must have some idea of production cost before work is actually commenced. However vague and approximate that idea may be, it constitutes an approach towards a cost standard. All manufacturing enterprise can be divided into two broad groups: production to order, and production for stock. Production to order, which includes contract and jobbing, obviously must always be covered by an estimate of cost, as the work will usually be secured by quotation only. Production for stock permits preliminary manufacture before the price is fixed, and, therefore, actual costs of trial batches or lots are available. The interesting point is that, in this first stage, production to order estimating is usually far more detailed than the preliminary costing of production for stock, though, as an overall figure, it may not be so accurate.

A stage of improvement occurs when production for stock tends to abandon its preliminary costing of trial batches and to ascertain how much costs should be. It is, thus,

amplifying the methods which production to order originally used but, whereas the latter is compelled to estimate, in advance, and often without comparable data, production for stock only deserts preliminary cost finding for methods of cost estimating when actual or comparable measurement can be practised. This change in policy is made possible by sympathetic co-operation of works management, closer touch between costs and technical functions, introduction of production research, use of administrative budgets, and so forth.

The third stage is the gradual emergence of the scientific cost standard, which should require revision only on account of deliberate changes in manufacturing methods, of alterations in the agreed conditions upon which the standards were based, or of definite changes in wage and price levels.

Evolution from cost estimate to cost standard is entirely dependent upon the mental attitude and outlook of each firm and industry. Cost accountancy is not foisting a new system upon industry, but, on the contrary, is being compelled to adjust its technique to the more searching requirements of modern management.

Scientific Management.

Events after the first Great War accelerated the change in managerial methods, the necessity for which had already become apparent. Mechanization, specialization, and mass production were well advanced before the need for a revolution in methods of control became apparent. Ideas of scientific organization had been already orginated by F. W. Taylor in the U.S.A., and were penetrating into Great Britain. The Wars gave an immense impetus to large-scale production, which, as it was soon realized, could not be managed by existing methods and functions of control without great losses and inefficiency. Slow and gradual appreciation of the scientific method as the means

of handling complex problems is now more and more perceptible. Taylor expressed this scientific attitude as "that complete mental revolution which recognizes as essential the substitution of exact scientific investigation and knowledge for the old opinion or judgment."

The management which accepts, as many now do, this attitude as fundamentally necessary for controlling and guiding its increasingly complicated industrial machine cannot fail to make demands upon its costing function which cannot be met unless that function itself has adopted scientific thought and method.

Scientific management has given birth to many specialist functions previously unknown to industry. Their advent has deeply influenced the structure of control. There is a definite tendency for an individual to control a certain functional activity in all the departments of an organization rather than an individual to control all the activities in a certain department. This functional organization intensifies specialization and co-ordination, and alone necessitates reconstruction of normal costing mechanism. Again, apart from reorganization of managerial responsibility, certain research functions have been created as auxiliary to administrative control. Market research and forecasting may be mentioned as examples. Not only does the high standard of their technique profoundly influence costing but the wealth of valuable information made available is of such a nature as to open out entirely new fields of investigation and control. The improved technique of any one functior reacts most favourably through the whole organization.

Rationalization has progressively influenced cost accountancy through its demand for comparable costs. In the promotion of combination with a view to shutting down the more inefficient plants, the rationalizing agency must base its conclusions upon potential producing efficiency rather than upon actual operating efficiency or upon existing financial conditions. The provision of such information

calls for close collaboration between specialists in costing and in production engineering. This instance of co-operation is but a single instance of liason. The necessity for very close and harmonious contact is becoming increasingly evident.

The effecting of close liason between, or even compounding of, two elements such as cost accountancy and industrial engineering will be difficult in many cases, but, unless the problems are squarely faced and settled, cost accountancy will fail to meet the demands of modern industry. An essential corollary to scientific management is the necessity for each of its functions to adopt the scientific attitude and to keep in phase, or step, with the entire organization. Therefore, cost accountancy must make good certain inevitable and inherent deficiencies in its equipment by utilizing, or absorbing, characteristics from the allied function of industrial engineering. Although any lack of adjustment must perforce be temporary and of short duration, the trend of practical organization in the future is not well defined. The only certainty is that methods of cost accountancy are now undergoing revolutionary changes. Whether, as the integral function of an organization, costing will expand or contract its sphere of influence must necessarily depend upon the mental elasticity and technical adaptability exercised upon it.

Some Principles of Standard Costing Practice.

The practice of standard costing is guided by a number of principles. Three of the most important are—

1. Grouping and allocation of costs against responsible authority.

2. Separation of the cost of idleness, i.e. unused capacity for production.

3. General alignment within the organization.

The accounting system should be designed in such a way that individual efficiency should be reflected in terms of

cost. This principle holds good throughout the organization. The sales manager is responsible for execution of sales policy, the plant engineer for freedom of machinery from breakdown, and the machine operator for the output of his machine. Responsibilities are limited within boundaries set by factors which individuals can personally control. There is everywhere a definite and well connected chain of responsibility through which losses and inefficiency can be filtered until located against a controlling authority. To include any costs irrelative to the sphere of influence in any report or account is clearly useless. If a manager or supervisor is aware that only those excess costs for which he is directly responsible are included in his cost returns, he will have as definite an objective, although perhaps not as great an incentive, as the piece worker aiming to earn a certain hourly rate. He will know that success is the result of his own efforts, and that failure is not caused by some factors outside his field of control. Also, superior authority will be in possession of facts which adjudge performance without bias or necessity for adjustment.

Separation of the cost of maintaining unused manufacturing capacity from the cost of maintaining manufacturing capacity actually in productive operation fulfils two important purposes—

1. To supply the administrative authority with full information regarding the cost of manufacturing idleness due to shortage of orders. Analysis under headings of departments and products must be made in order that consideration can be given to the necessity for changes in sales policy and prices.

2. To differentiate clearly between those excess costs which are within the control of the works organization and those which are not.

A distinction must be drawn between unused manufacturing capacity and wasted capacity during manufacture. Unused capacity refers to plant and facilities which cannot

be operated owing to shortage of sales. Wasted capacity refers to plant and facilities which stand idle on account of causes within the control of some part of the works organization. The cost of wasted capacity is always an inefficiency charge against manufacturing, while the cost of unused capacity may or may not be an inefficiency charge against sales. This elimination of cost of idleness from the cost of manufacturing proper is entirely a matter of costing analysis, and does not signify any definite attitude towards its regard as a charge against profits. The ultimate incorporation of the cost of idleness in the overall manufacturing cost can only be considered in conjunction with the relative levels of actual, predetermined, and maximum output, with sale prices, with conditions of trade, and with other factors.

The development of standard costing must be in progressive alignment with the state of organization and of standardization existing in the particular works. While the scope of control is always limited by the economical aspect, restriction can also occur on one hand from the extent of its actual utilization by management, and, on the other, from the degree of sufficiency of basic data. To prepare information which is neither appreciated nor used is sheer waste. The capacity to supply information is governed by the availability of performance standards from which cost standards can be developed. The amount of information presented to management should always be slightly in excess of that actually called for, but never sufficient to give mental indigestion. Undoubtedly one of the merits of standard costing is that elasticity of mechanism which is so invaluable when analysing costs and compiling information for reports. Detail and complication are justified not by proof of informative value but by the economies effected by their use. Until responsible authority commences to think of production and costs in terms of standards, progress will necessarily be slow.

Advantages.

The case for standard costing does not rest merely upon a weighing of "pros" and "cons." Any decision will be made rather on the acceptance of its fundamental concept—as stated on page 1—and of its principles, on the result of situations caused within the works, or on account of pressure exerted by outside circumstances. The adoption of standard costs, in their most scientific form, is not a matter for arbitrary decision. It is more often enforced by the evolution of industrial organization and carried out by gradual infiltration.

Advantages, however, may be considered under three headings: accuracy promptitude, and economy.

Accuracy is obtained by the use of scientific method in developing standards and by the analytical control of actual costs against these standards. Measurement in this way permits location of weak spots without the endless gropings and searchings which take place when there are no standards against which actual costs can be compared. Under ordinary methods of job and lot costing, each actual cost contains hidden losses not reasonably and fairly chargeable against that particular job or lot. While such losses are liable to occur in any manufacturing organization, and while they must be liquidated in actual costs, there is no valid reason for their inclusion in the cost of any particular job. For example, take the use of highly paid operators upon work which could be as well and quickly done by lower paid operators. In job costing, the cost of that job will be high, but not on account of any cause peculiar to itself. In standard costing, the excess costs of using too highly paid labour would be collected for each department, and would be the responsibility of the individual controlling the labour distribution departmentally or throughout the works. It is maintained that the inclusion of losses of this description in job and lot costs is conducive to inaccuracies which render comparisons impossible unless each cost is

examined and adjusted in detail. Yet the value of comparisons between like jobs is advanced as one of the principal advantages of job and lot costing. Standard costing analyses and transfers elsewhere, as a matter of routine, all costs extraneous to any particular work or function. For tendering and price-fixing purposes the superiority of cost standards over actual job and lot costs is undeniable, always providing that the basic standards have been scientifically prepared.

Promptitude in the issue of information is most essential for cost control. Waste and leakage can only be kept at a minimum if detected immediately. Standard costing is especially organized with a view to carrying this into effect. As measures of performance are laid down for all productive work, for material consumption, and, in fact, for all activities in a business, amounts of losses are shown clearly and quickly by comparing levels of actual and standard performance. There are three other favourable points—

1. As standard costing controls performance only and does not collect costs of particular products and jobs, the bulk of calculations and balancing usually associated with costing systems is entirely unnecessary. Certain costs, such as labour, can be prepared daily without any difficulty. In fact, this procedure can be extended to complete process cost.

2. The mechanism of standard costing reveals the location and cause of excess costs without the necessity for analysis and inquiry. Cost figures are presented in an easily understandable form to those whose duty it is to act upon such information.

3. The cost of losses and inefficiencies is analysed and allocated against the individuals who are responsible for them. This direct charge should lead to immediate action.

The economical side of standard costing has particular appeal. Not only is better value received but better value

for less money. Standard costing should be far less expensive to operate than any ordinary job costing system. This contention is based upon two facts—

1. The bulk of the work of preparing standards is carried out by other functions of the organization. In fact, the development of scientific standards will be restricted if certain functions are absent from the organization. This may lead to an apparent increase in the cost of costing. Viewed logically in the light of modern industrial tendencies, the presence of these functions is necessary to the balanced progress of any manufacturing organization. If the costing function undertakes certain of their duties, then value is being rendered to the organization over and above that of costing. Such functions are labour measurement, material specification, sales forecasting, and so forth. While all of these supply basic data for cost standards, they will have been originated for their own specific and concrete purposes. They are valuable investments and pay their own way. Provision of basic data for costing is only one of their secondary purposes. Primarily the costing function has to collect basic standards from other functions, to translate basic into cost standards, and generally to co-operate in the dissemination of informative matter relative to standards. Costing, as a function, is responsible for the formulation of cost standards in terms of £ s. d.

2. The cost of collecting and sorting actual costs is considerably lower than if either job or lot costing is practised. There is far less detailed analysis and allocation of actual direct labour and material costs. In some cases these actual costs will be handled by functions responsible for labour control and for material control. The work and cost of costing will then be even less onerous.

Enough has been said with reference to the economical side of standard costing for it to be evident that the economy is almost entirely dependent upon logical and co-operative development of functions within an organization. Also,

while the costing function may contract in size and cost of maintenance, it will gain correspondingly in importance and true value by a considerable expansion in scope, knowledge, and control.

Fundamentals for Success.

Standard costing must generally commence from small beginnings and advance its technique gradually. To say arbitrarily what form these small beginnings should take would be unwise. A far more clean cut approach is to determine the essential fundamentals for successful operation of standard costs upon scientific lines. They can be summarized—

1. The use of scientific methods of analysis and synthesis for progressively investigating all activities of manufacturing and selling for the purpose of developing standards. For specific mention are—

(*a*) Materials.

(*b*) Labour and methods of work.

(*c*) Productive plant and machinery.

(*d*) Services auxiliary to production.

(*e*) Sales and markets.

2. The organization of the accounting mechanism upon well defined lines, which will include the following—

(*a*) The accounts to be built round the structure of managerial organization in order that responsibility for cost can be allocated against executive authority.

(*b*) The cost of idleness (i.e. the cost of maintaining that part of productive capacity which is unused on account of sales requirements failing to meet expectations) to be prepared.

(*c*) The issue of cost reports concisely, promptly, and containing only information of direct and essential interest.

3. An organization which, individually and corporatively, thinks and calculates in terms of standards.

Emphasis must be placed upon the necessity for scientific

and accurate standards. Otherwise, cost variation will include bias caused by incorrect standards. For 100 per cent effectiveness it should be necessary to adjust standards only on account of revised manufacturing processes, of changes in predetermined conditions, or of wage and price changes. Stated differently, an accurate standard should never need alteration, but only redevelopment.

Terminology.

In order to convey definite and recurring meanings without either ambiguity or frequent explanation, a terminology must be recognized. It is not laid down with any arbitrary or didactic intention. Several of the terms are defined in accordance with their generally accepted meaning; others have a defined meaning specially applicable to standard costing only.

Production Centre. A recognized centre of manufacturing activity carrying out productive operations: production centres can be classified into work points, machines, and processes.

Work Point. A definite position or station occupied by an operator on hand work; the bench vice of a fitter or the gas connection for a solderer might be distinguishing characteristics of a work point.

Machine. A unit of manufacturing plant, engaged upon a stage of intermittent or continuous production; the unit of plant may perform a number of successive operations on one article, or it may carry out a single operation on a sequence of similar articles, or it may form a link in a continuous chain of machines handling one bulk product.

Process. A manufacturing lay-out consisting of a series of machines and (or) work points in which the material fed into the first machine undergoes several stages of fabrication before being delivered from the last machine in the series.

Operation. A cycle of productive work carried out by hand or machine.

Product. The article or commodity turned out by the plant and passed over to the sales organization for disposal; may be used in its general sense of *product class* to cover output of similar type, but differing in size, form, and so forth, or to refer in its more limited meaning of *unit product* to a definite article of certain size, form, and composition.

Function. Some kind or form of specialized work which may be effected, either independently or by making contacts throughout an organization.

Functional Management. That form of industrial control in which an individual is responsible for each recognized function; an executive specializes in and performs certain specific duties throughout all departments in a plant rather than a variety of duties in one department.

Departmental Management. That form of industrial control in which an executive is responsible for all, or most, of the functions in his particular department; an executive controls a number of fractional functions instead of, as in functional management, one complete function.

Administration. The division of business control which decides policy and is responsible for the general guidance and direction of an industrial enterprise; administration formulates and directs

Management. The division of business control which carries out policies laid down by the administration; management acts and executes.

CHAPTER II

INTRODUCTION TO TECHNIQUE

THE necessity for scientific method has been emphasized. But the connection between accountancy and science is not immediately obvious. The direction of approach is from science to accountancy. Standard costing involves three clear and distinct stages, of which two are scientific and one accounting—

1. Measurement—scientific
2. Synthesis—scientific.
3. Control—accounting.

Whether or not the function of costing includes all the three stages is immaterial from this aspect. The essential is that the organization shall make provision for their practice in the most conjunctive manner.

Measurement.

There must be progressive advance in the analysis and measurement of every feature of productive and sales activity. Some are more easily measurable than others. But a common denominator can be found for the evaluation of any activity provided that the method of analysis is sound. The investigation of a business or industrial problem should not differ in principle from that of chemical or engineering research. The application of such methods to specific industrial activities is varied and complex. However, from the costing standpoint, results—not the means of ascertaining them—are the primary consideration. Requirements can be classified—

(*a*) **Materials.** Research aims at the specification of quantity and quality standards. Before the standard cost of any article can be developed, it is necessary to know,

with accuracy, the amount and kind of material which should be used in its manufacture. The kind and form will be decided by a comparison of relative values in conjunction with their effects upon manufacturing methods. Comparative suitability and availability of substitutes are important points. Investigations must be made into the minimum sizes and quantities which can be economically used and into the permissibility of losses. Recovery of by-products and reclaimed waste also must be a subject of inquiry.

(*b*) **Labour and Methods of Work.** This branch of industrial research is the best known. Not only are time and work standards most necessary for economically utilizing labour, but, as overheads are mainly a function of time, they constitute one of the basic factors in distributing the latter through work point, machine, and process rates. The study of indirect work is equally important to that of direct work. The subject resolves itself into three distinct parts—

1. Analysis of jobs in order to ascertain their relative worth and the required types of workers.
2. Study of methods and conditions in order to determine the best and most economical way of doing work.
3. Measurement of productive effort in order to develop standards of performance.

The methods of study, however, for all three are allied and very closely connected.

(*c*) **Productive Plant and Machinery.** Research into potential output capacities becomes increasingly important with the accelerated adoption of machinery. On account of high capitalization costs and operating rates, inefficient utilization of machinery may be an immense source of loss. While labour may be responsible for much of this inefficiency, an appreciable amount is due to several other causes. Unless machine and plant capabilities are studied both individually and in relation to each, effective utilization cannot be expressed in terms of performance standards. The suitability and limitations of available machinery must be investigated

not only with a view to the selection of the best lay-out and process but also of economical alternatives. Analysis of productive capacity can rarely be too detailed. This subject profoundly influences selling prices, capitalization, and general business policy. Plant utilization can be made really effective only by the co-ordination of sales policy with potential capacity for output.

Of almost equal importance to knowledge concerning output capacity is knowledge of how much service the plant should consume during the production of the output. Space, buildings, heat, light, electricity, transport, special process supplies, and so forth are utilized or absorbed by productive plant. Operating conditions must be carefully studied in order to measure economical and effective use of services by productive plant and to develop standards against which actual service absorption can be compared.

(*d*) **Services Auxiliary to Production.** It is as necessary to analyse and measure the services which feed and supply productive plant as it is to study the use made of them by the same plant. These services cover all manufacturing activities which render definite aid to human effort, machine, or process engaged on direct production. Services may be interpreted to include not only the supply of something concrete but also the rather more intangible factors, such as management and supervision. There is no essential difference between the supply of electric power and of supervision when the effectiveness of the activities which aid and serve production centres are under consideration. Both play an essential part in the manufacture of a product, both are separable from the actual use of productive machinery, and both can be analysed and measured. Take the supply of steam. The capacity and operating conditions of all steam raising plant and the lay-out of distribution must be carefully studied in order that a clear conception of balance between supply and demand can be maintained and in order that sufficiency of information be available

for calculating performance standards applicable under varying loads.

Services must be investigated and measured at their origin, and not at their points of delivery, if clean-cut issues are to be secured. The primary objective of a service is to supply all legitimate demands in an economical manner. Analysis and study of their elements should provide basic data for developing standards capable of separating and evaluating the results of lack of demand, waste by consumers, and inefficient supply.

(*e*) **Sales and Markets.** The entire activities of selling must be examined with the same scrutiny as those of manufacturing. One aim is to evolve units of measurement by which performance can be evaluated and by which the effects of departures from policies and forecasts can be computed. The activities of selling can be divided into certain groups, each of which has some common link with the amount of sales volume. The sales output also needs to be analysed into classes which will most clearly represent the incidence and variability of selling costs. Analysis of sales output follows the lines of kind of product or of territorial division or of a combination of both product and territorial division. Study of the connection between the cost of the various selling activities and the worth of the returns in sales volume is invaluable, particularly when carried out under classifications of product and territory. Without analysis and measurement of elements such work cannot be satisfactorily performed.

Selling costs must also be studied in conjunction with market analysis with a view to arriving at a series of ratios which will express the trend of increased sales which may be expected from increased selling efforts. This is particularly necessary in the equation of the cost of increased selling efforts against the cost of maintaining unused productive capacity.

Market research covers a very comprehensive field of

investigation into the potentialities and possibilities for the disposal of the output of commodities and products. It endeavours to answer four problems—

(*a*) What products are needed?

(*b*) Where the products are required?

(*c*) What quantity is likely to be demanded?

(*d*) How the products can be most economically distributed?

Although these problems do concern the whole industry to which a firm is attached, of primary importance to the individual is a reasonably accurate determination of the likely demand for its products.

Market research assists the forecasting of volume and kind of sales. As a definite connection between sales, output, and utilization of productive capacity is evident, and as manufacturing cost standards as a whole are based upon a predetermined level of utilization, market research constitutes a very necessary link in the chain.

Research in the above five forms provides exact quantitative knowledge for several purposes. It is not suggested that their uses for costing will alone justify application. What is emphasized, however, is that costing practice must avail itself of every facility for measurement and analysis which the research functions in manufacturing and selling can provide. Equally in their absence, if the costing function can prove the formation of certain research functions to be a profitable investment, so much the better.

Synthesis.

The results of analysis and measurement enable performance and cost standards to be synthetically developed. By performance standards is meant the expression of values in terms of time, quantity, percentages, and similar units. When performance standards are converted into terms of money, they become cost standards. The ultimate aim of cost synthesis is to develop a standard cost for each size and

type of sales product. There are, however, several intermediate stages of cost standards: for example, the hourly standard cost for running a machine. The number of articles per hour which the machine should produce would be a performance standard for that operation and machine. Standard costs for individual products are evolved by manipulating and summating both performance and cost standards.

The standard cost for a sales product must be comprehensive, i.e. an "all-in" cost. In the definition of a cost standard, its model and objective nature was emphasized. A cost standard must be basic and difficult of attainment if it shall efficiently function as a criteria of real, and not merely relative, performance. Inefficiency, waste, unavoidable losses, and so forth must occur, and, consequently, actual costs will exceed basic cost standards. These excess costs, within limits, are legitimate constituents of an "all-in" cost. There is complete justification for this treatment. If cost standards are stringent, and to be a real measure of performance they must be, excess costs are inevitable. But a limited provision only must be allowed in the "all-in" standard cost. The excess cost allowance can be determined by adjudging an equitable percentage upon basic cost standards. This percentage can be termed an "inefficiency allowance," and will differ between department and department or even between machine and machine. Obviously, in practice, one machine may be more liable than another to inefficiency and excess costs owing to some inherent defects or to situation. While these charges are actually constituents of the cost of production, for control purposes they must be shown as costs in excess of standard in order that there shall be an urge towards their reduction.

Control.

In order to make full use of the standards, there must be an accounting mechanism which will methodically evaluate

the achievements of departments, services, processes, and other activities in terms of cost. The system must endeavour to distribute and allocate costs in such a way that an executive can be held responsible for those cuts which he can actually control, and for those alone. The form, or chain, of mànagerial organization does not, in any way, affect this principle of cost control. It is immaterial whether the organization is built on line, line and staff, or functional bases. For every fraction of cost which is incurred there must be some managerial or supervisory authority which can be held responsible for its expenditure. For cost control to be really effective the system of accounts must follow the lines of the managerial organization.

Cost control, however, must do more than appraise individual executive efficiency. The total activities of the business are covered comprehensively by cost standards and accounts. Periodically, when actual costs are compared against cost standards, each account will show the difference as a balance. The sum of these balances can be coordinated into master accounts, or statements, which will provide higher management with a clear and analytical picture of manufacturing and sales performance In addition, the final summary serves as an accurate profit and loss statement.

Statements and ratios are frequently used instead of accounts. The balance or difference between actual and standard is known as cost variation. When actual cost exceeds standard, the loss is known as excess cost.

By centralization, cost control shows the overall efficiency of the entire organization and its activities in terms of cost.

By decentralization, it shows the real individual efficiency of the most minor executive in terms of cost.

In any industrial concern, costs are separable into two divisions: the cost of making and the cost of selling. The line of demarcation between them is clear and definite.

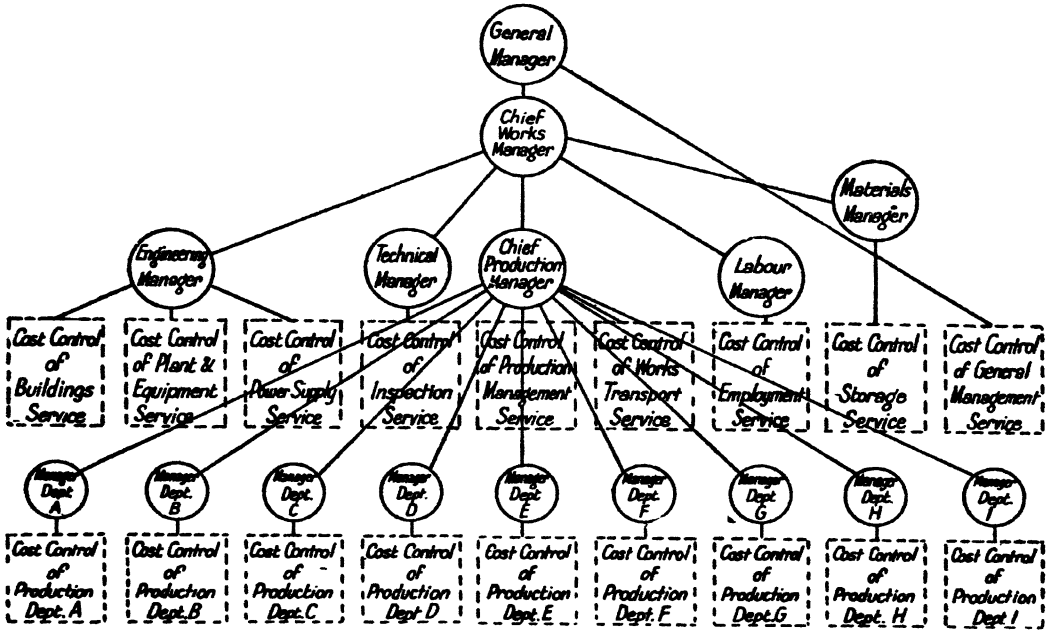


FIG. 1. CHART SHOWING CONNECTION BETWEEN MANAGERIAL RESPONSIBILITY AND COST CONTROL IN A TYPICAL MANUFACTURING PLANT WITH SEMI-FUNCTIONALIZED ORGANIZATION

Indirect costs cover that bulk of expenditure known as overhead, oncost, burden, or service. They will be conceived from points of principle and method as the expense of maintaining and operating facilities for the supply of services to production centres.

Indirect costs are collected from diverse sources and analysed into the separate costs of running the various services for making and selling. In the case of manufacturing, the charging of these service or overhead costs to the product is made on a basis of consumption of service by the producing machinery and operators. If, however, there is no call for service, much of the cost still occurs owing to the fact that it must be maintained in readiness to supply.

Direct costs, thus, differ from indirect costs in that when production stops the cost ceases. Direct cost is not involved where any question of maintenance in readiness for production is concerned. By a stoppage of production is meant, of course, a deliberate cessation of work, and not breakdowns and hindrances. The distinction is not dogmatic, but there must be some ruling principle of differentiation. This solution, however, does seem to satisfy standard costing. Taking a simple illustration, if a man operates a machine producing finished articles from raw material, the wages of the operator and the cost of the raw material are direct, while the remaining costs of manufacturing are indirect. For, if the machine ceases producing, the operator is not required, and no material is consumed, but all the services—such as power, buildings, supervision, and so forth—must be maintained, some partially, and some wholly, until the machine again produces. Certain difficulties must arise with this arbitrary division, particularly in connection with supply and transport operators, but, so long as definite practice is laid down and adhered to in each works, the narrow range of possible deviation will ensure fairly standard and comparable procedure.

The exclusion of labour from service cost is based on its assumed mobility within the works. If labour can be moved economically from job to job, and if a surplus over and above a reasonable reserve is maintained, the wages of such a surplus are excess expenditure from the costing standpoint. They may be accepted as policy cost, but not as a labour charge to a job or process. Direct cost, as a factor, must be such that is clearly separable from the work of the machine or process.

The terms "direct" and "indirect," it is contended, are confusing and misleading. In substitution, labour cost may be used instead of direct labour, material cost instead of direct material, and service instead of indirect charges or overheads. Indirect labour does convey an accepted meaning, but when analysed into classes there emerges a definite number of services by which it aids production. Here, again, "service labour" seems a far more suitable term than "indirect labour."

This comprehension of direct and service cost concerns manufacturing only. Selling costs are indirect in character, and the activities of selling are constituted in the form of services.

Basis of Cost Incidence on the Product.

Costs must be distributed through channels which are related to supply of services, and their incidence must be in due proportion to their use.

Apart from materials, manufacturing costs are applied at the various stages where work is done. The machinery and facilities for production are scheduled into processes, machines, and work points, for each of which hourly running costs are calculated. Each product must pass through a number of operations and processes. With full details of methods and output, labour and service cost standards can be developed.

Manufacturing Costs.

1. Materials: includes adjustment for loss, waste, by-products, etc.
2. Labour: based on time and wages at the various scheduled—
   (*a*) Work points.
   (*b*) Machines.
   (*c*) Processes.
3. Overheads: based on time and charges at the various scheduled—
   (*a*) Work points.
   (*b*) Machines.
   (*c*) Processes.

   and upon (*d*) Materials

Sales Costs.

1. Warehousing.
2. Packing.
3. Transport.
4. Advertising.
5. Management.
6. Representation.

These divisions are suggestive only. Their bases of incidence upon products may differ and will be contingent upon the particular conditions.

From the above, it will be visualized that costs are distributed against products only through recognized outlets. The amount of manufacturing labour and overheads passing from these outlets varies with time. Consequently, costs standards per running hour are developed for each work point, machine, and process. Sales cost does not vary, however, according to time, and several bases of allocation can be used. A preliminary distribution of sales cost between classes of products and geographical areas, followed by allocation upon the most equitable bases to suit the circumstances, constitutes a sound procedure.

Unit and Batch Costs.

Standard costs are prepared upon two alternative lay-outs. The distinction is necessitated by differences in products and methods of manufacture. The alternatives are not necessarily separable between plant and plant or between department and department. In fact, they may occur side by side.

For unit costing, individual articles or units of production

must become recognizable at the early stages of manufacture.

CASE. Assume a number of articles to be machined and assembled against specific orders. Each assembly includes three types of components—*A*, *B*, *C*—manufactured in the works, and four types—*D*, *E*, *F*, *G*—purchased from outside suppliers.

Standard Cost for Component A—

	s.	d.	s.	d.
Materials:				
4 lb. "Alpha" at 1s. per lb.	4	–		
Less ½ lb. Swarf at 4d. per lb.		2		
			3	10
Labour:				
1st operation—30 min. at 1s. 3d. per hour		7½		
2nd operation—15 min. at 8d. per hour		2		
3rd operation—5 min. at 9d. per hour		0½		
				10½
Overhead:				
1st operation—30 min. at machine rate of 2s.	1	–		
2nd operation—15 min. at machine rate of 3s.		9		
3rd operation—5 min. at work point rate 1s. 3d.		1½		
			1	10½
			6	6½

STANDARD COST = 6s. 6½d. per unit.

Standard Cost for Component B—

	s.	d.	s.	d.
Material:				
2 lb. "Beta" at 2s. 6d. per lb.	5	–		
Less ½ lb. of Swarf at 2d. per lb.		1		
			4	11
Labour:				
1st operation—10 min. at 1s. per hour		2		
2nd operation—20 min. at 1s. 3d. per hour		5		
3rd operation—10 min. at 1s. per hour		2		
4th operation—60 min. at 1s. 6d. per hour	1	6		
			2	3
Overhead:				
1st operation—10 min. at machine rate of 1s. 9d.		3½		
2nd operation—20 min. at machine rate of 2s.		8		
3rd operation—10 min. at machine rate of 2s. 6d.		5		
4th operation—60 min. at work point of 1s. 3d.	1	3		
			2	7½
			9	9½

STANDARD COST = 9s. 9½d. per unit.

Standard Cost for Component C—

	s. d.	s. d.
Material:		
¼ lb. "Delta" at 6d. per lb. . . .	3	3
Labour:		
1st operation—30 min. at 1s. 3d. per hour .	7½	
2nd operation—10 min. at 6d. per hour .	1	
3rd operation—40 min. at 6d. per hour .	4	
4th operation—10 min. at 1s. 6d. per hour .	3	
		1 3½
Overhead:		
1st operation—30 min. at machine rate of 2s.	1 –	
2nd operation—10 min. at machine rate of 3s.	6	
3rd operation—40 min. at machine rate of 1s. 9d.	1 2	
4th operation—10 min. at work point of 1s. 3d.	2½	
		2 10½
		4 5

STANDARD COST = 4s. 5d. per unit.

Standard Manufacturing Cost for Complete Assembly—

	s. d.	£ s. d.
Material:		
Component A— 1 unit at 6s. 6½d. . .	6 6½	
Component B— 2 units at 9s. 9½d. . .	19 7	
Component C— 2 units at 4s. 5d. . .	8 10	
Component D— 1 unit at 7s. 6d. . .	7 6	
Component E— 2 units at 1s. . .	2 –	
Component F— 4 units at 3d. . .	1 –	
Component G—12 units at 1d. . .	1 –	
		2 6 5½
Labour:		
Assembling—2 hr. at 1s. 3d. per hour	2 6	
		2 6
Overhead:		
Assembling—2 hr. at work point rate of 1s. 8d.	3 4	3 4
		£2 12 3½

STANDARD MANUFACTURING COST = £2 12s. 3½d. per assembly.

Standard Sales Cost for Complete Assembly—

	s. d.
Administration Sales Management at 1% on Standard Manufacturing Cost	6½
Advertising at 2% on Standard Manufacturing Cost .	1 –½
Representation at 10% on Standard Manufacturing Cost	5 3
Warehousing at 3d. per assembly	3
Packing Dispatch at 1s. per assembly	1 –
Transport at 2s. 3d. per assembly	2 3
	10 3½

STANDARD SALES COST = 10s. 3½d. per assembly.

TOTAL "ALL-IN" STANDARD COST—

	£	s.	d.
Manufacturing . . .	2	12	3½
Sales.		10	3½
	£3	2	7½

For batch costing, individual articles or units of production may not be recognizable throughout manufacture or not until the last stages.

CASE. Assume a product *X* to be converted (i.e. mixed) from raw materials, passed through three stages of preparation, packed into containers, and marketed.

	Theoretical Yield	Standard Waste	Standard Spoilt	Standard Yield	Standard Recoveries
	%	%	%	%	%
1. Conversion . . .	100	3	1	96	0
2. First Preparation . .	100	3	2	95	2
3. Second Preparation . .	100	1	1	98	0
4. Third Preparation . .	100	9·6	0·2	90·2	9·4

Conversion—

	£	s.	d.	£	s.	d.
Materials:						
72 lb. constituent "A" at 9s. 4d. cwt. .		6	–			
171 lb. constituent "B" at 74s. 8d. cwt. .	5	14	–			
210 lb. constituent "C" at 18s. 8d. cwt.	1	15	–			
68 lb. constituent "D" at 56s. cwt. .	1	14	–			
				9	9	–
521 lb. to yield 500 lb. converted.						
Labour:						
7 hr. at 1s. 4d.		9	4			
12 hr. at 1s..		12	–			
				1	1	4
Overhead:						
4 hr. process rate at 15s. 6d. . .	3	2	–			
				3	2	–
				£13	12	4

Therefore, 521 lb. raw materials produce a standard yield of 500 lb. at a cost of £13 12s. 4d., which gives a standard cost of 6·54d. per lb.

First Preparation—

	£	s.	d.
Materials:			
500 lb. from conversion stage at 6·54 per lb. . .	13	12	4
Labour:			
2 hr. at 1s. 6d.		3	–
Overhead:			
1 hr. at process rate 25s.	1	5	–
	15	–	4
Less 10 lb. by-product at 6d. per lb. . .		5	–
	£14	15	4

Therefore, 500 lb. converted material produce a standard yield of 475 lb. at a cumulative cost of £14 15s. 4d., which gives a standard cost of 7·46d. per lb.

Second Preparation—

	s.	d.	£	s.	d.
Materials:					
475 lb. from first preparation at 7·46d. per lb. .			14	15	4
Labour:					
4 hr. at 1s. 9d.	7	–			
8 hr. at 1s..	8	–			
				15	–
Overhead:					
8 hr. process rate at 7s. 6d.			3	–	–
			£18	10	4

Therefore 475 lb. from first preparation produce a standard yield of 465·5 lb. at a cumulative cost of £18 10s. 4d., which gives a standard cost of 9·55d. per lb.

Third Preparation—

	£	s.	d.
Materials:			
465·5 lb. from second preparation at 9·55d. per lb. .	18	10	4
Labour:			
2 hr. at 1s. 6d.		3	–
Overhead:			
2 hr. process rate at 10s.	1	–	–
	£19	13	4
Less 44 lb. by-product at 4d. per lb. . . .		14	8
	£18	18	8

Therefore 465·5 lb. from second preparation produces a standard yield of 420 lb. at a cumulative cost of 10·82d. per lb.

Packing into Containers—	d.	d.
Materials:		
2 lb. from third preparation at 10·82	21·6	
Container and packing materials	2·5	
		24·1
Labour:		
5 min. at 6d. per hour	·5	·5
Overhead:		
5 min. work point rate at 2s. per hour	2·0	2·0
		26·6

Therefore product *X* packed in 2 lb. containers has a standard cumulative cost of 26·4d. per container.

Sales—	d.
Warehousing at 6d. per cwt. of product	·053
Packing Dispatch at 2d. per cwt. of product	·018
Transport at 1s.	·107
Sales Administration at 2% on standard manufacturing cost	·528
Selling (includes management, representation, and advertising) at 15% on standard manufacturing cost	3·960

Therefore the standard cost for the sale of each 2 lb. container is 4·666d.

Summary—

The "All-in" standard cost for a 2-lb. container of product *X*—

	d.
Manufacturing	26·60
Sales	4·67
Total	31·27

Manufacturing Cost Standards	Cost Standard per Lb.	Cumulative Standard Cost per Lb.
Conversion—	d.	d.
Material	4·54	
Labour	·51	
Overheads	1·49	6·54
First Preparation—		
Material	6·88	
Labour	·08	
Overheads	·63	7·46
Second Preparation—		
Material	7·61	
Labour	·39	
Overheads	1·55	9·55
Third Preparation—		
Material	10·58	
Labour	·09	
Overheads	·57	10·82

	Cost Standard for 2 lb. Container	Cumulating Value of 2 lb Container
	d.	*d.*
Packing: Material . . .	24·1	
Labour . . .	·50	
Overheads . . .	2·00	26·6

Sales Cost Standards	Cost Standard for 2 lb. Container
	d.
Warehousing	·053
Dispatch.	·018
Transport	·107
Selling	3·960
Administration . . .	·528

Note. Costs have been expressed in pence per lb. for illustrative purposes only. Shillings per cwt. or per 100 lbs. will often prove more accurate and more convenient. The use of calculating machines will permit calculation to at least the two places of decimals necessary to secure reasonable accuracy.

In very many cases, a combination of both methods must be used. The standard cost of a sales product, however, will generally incline definitely towards one of the alternative lay-outs. For example, although the preparation in bulk of a patent food comes under batch costing, the packing into containers is costed in terms of units. In general, therefore, where unit and batch costs are included, the one which assumes preponderance will be accepted as normal for the plant or the product.

Predetermined Plant Utilization.

Standard costs are developed upon a predetermined measure of plant utilization. A definite number of producing hours for each work point, machine, and process must

be forecasted as "predetermined conditions" for the future periods to which the standard costs will be applied. Taking each case, if the forecasted number of hours is expressed as a percentage of the total normal working hours of the plant over the same period, an individual measure of plant utilization is derived. If the measure of plant utilization for all the work points, machines, and processes are summated on a weighted scale, an overall measure of utilization for the entire plant can be deduced.

An evolutionary method of forecasting plant utilization, however, is possible only when the expected volume of output also has been forecasted in detail. Sales and output budgets, then, are necessary. In addition, manufacturing methods and performances must have been specified and scheduled in order that the producing hours for each work point, machine, and process may be individually predetermined.

As budgetary forecasting is inapplicable at the less advanced stages of organization, and is unsuitable in certain industries and enterprises which can adopt standard costing, a more arbitrary method of predetermining the measure of plant utilization must be used. Instead of forecasting output and tracing back through scheduled manufacturing methods and performances to the work points, machines, and processes, the latter are individually and relatively considered without reference to any definite variety and volume of output, but with regard only to reasonable expectations of activity. By this method, individual measures of plant utilization may be predetermined in accordance with previous experience and existing business trends. Arbitrary predetermination is particularly applicable to those concerns which supply the requirements of other manufacturers and which accordingly cannot prepare sales and output budgets owing to ignorance of kind and type of their customers' potential requirements. At the same time, concerns which manufacture on jobbing and contract work

can use standard costs with equal effect by means of this arbitrary predetermination of plant utilization.

Relations Between Plant Utilization, Manufacturing Efficiency, and Cost.

The mechanism of cost control must be framed in such a way that any failure to attain the predetermined level of plant utilization, on account of unfulfilled sales demand, can be evaluated in terms of cost. Plant utilization, whether budgeted or arbitrary, is based on manufacturing performance standards. If manufacturing efficiency falls below standard performance, actual producing hours will be in excess of the standard hours (known as effective hours) for the output. When calculating the cost of failure to reach the predetermined measure of utilization, the difference between predetermined and effective producing hours must be taken as the basis. The variation between actual and effective producing hours causes excess cost for which manufacturing inefficiency is responsible. The elementary principles can be algebraically expressed.

Let x = standard cost per running hour of a machine.

a = actual hours taken in producing a certain output.

b = standard hours allowed for producing the same output.

c = predetermined hours for the period during which the output was produced.

Then: Cost of failure to attain predetermined plant utilization on account of shortage of work. $= x(c-a)$

Cost of manufacturing inefficiency $= x(a-b)$

Total excess cost $= x(c-b)$.

Plant utilization affects costs in that overhead or service costs do not fluctuate in direct proportion with volume of

output. Of special import is the contrast between ratios of fall in total cost and contraction in volume of output. If overhead charges can be expressed in cost per unit of output, then costs will increase progressively with any decrease in volume of output.

There is a range of different variabilities which govern the relative connection between overhead costs and output.

1. Fixed charges, which are incurred whether the plant is working or idle.

2. Charges which are incurred when the plant is prepared for manufacture but is not actually producing.

3. Charges which are incurred when the plant as a whole is partially producing, i.e. some departments working and others idle.

4. Charges which are incurred when a department is producing at either full or part capacity.

5. Charges which vary proportionately or nearly so with the volume of output.

Guided by this range of cost variability, cost control may be framed in such a structure that losses due to unused capacity and bad utilization can always be evaluated.

Plant Utilization and Productive Capacity.

Plant utilization expresses a measure of achievement while productive capacity signifies a measure of potentiality. Before plant utilization can be predetermined, the potential productive capacity of the entire plant must be known. Each unit of plant must be considered, not only individually, but, whenever possible, in connected relation to the whole. In many cases, particularly where plant utilization is arbitrarily predetermined, connection between individual machines and processes cannot be established. Productive capacity should be based upon normal working hours without regard, in the preliminary stages, to overtime or to additional shifts. For balancing a lack of productive capacity in certain processes or departments, overtime or

extra shifts may sometimes be included in the predetermined utilization.

A clear distinction must be drawn between the following terms—

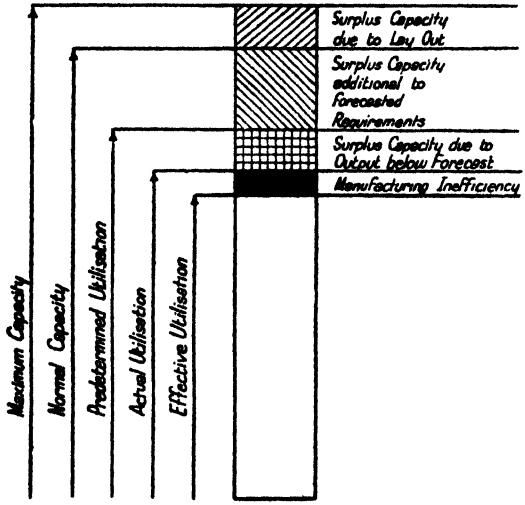
1. Maximum productive capacity.
2. Normal productive capacity.
3. Predetermined utilization.
4. Actual utilization.
5. Effective utilization.

Maximum productive capacity is based on a conception of each unit of plant manufacturing independently without restriction or hindrance of any sort. Thus, a theoretical potential is established for each work point, machine, and process. A complete summation for the plant provides a measure of maximum productive capacity irrespective of practical restrictions imposed by lack of balance and other such causes.

Normal productive capacity is an assessment of the output which can be realized in practice. Referring to an entire plant it signifies that due consideration has been given to conditions of balanced output, to necessity for periodical shut downs of individual machines, and to other restrictions which affect productivity when the whole plant is conceived as a self-contained and inter-dependent unit. Normal capacity does, however, imply 100 per cent effectiveness. It includes no provision for manufacturing inefficiencies and breakdowns. Normal productive capacity establishes the maximum output which can be turned out during normal working hours, and provides invaluable information for selling and administrative purposes.

Predetermined utilization is the level of activity forecasted in advance for some future period of time. It is determined either by budgetary or by arbitrary methods, whichever better suits circumstances. The activity of each work point, machine, and process is individually predetermined in producing hours. This information is used for the

development of hourly standard cost rates. Predetermined utilization of manufacturing plant provides the foundation for standard costing, and is essential to its comprehensive application. There must be some reasonable margin between



PLANT WORKING HOURS PER ANNUM

Maximum Capacity	2400
Normal Capacity	2200
Predetermined Utilisation	1800
Actual Utilisation	1600
Effective Utilisation	1500

GRAPHICAL PRESENTATION OF PRODUCTIVE CAPACITY AND PLANT UTILISATION.

FIG. 2.

normal capacity and predetermined utilization on account of inefficiencies and breakdowns which render the output given by normal capacity unlikely of achievement under practical working conditions. If sales demand necessitates an output above pre-determined level based on normal

working hours, and if additional machinery and facilities of the required type will not be made available, overtime and extra shifts must be considered for inclusion.

Actual plant utilization represents the amount of time occupied in manufacturing, inclusive of extra time caused by inefficiencies and hindrances. It refers to the number of hours during which actual manufacturing is being carried out or during which labour and services are standing by in readiness to produce. Time, irrespective of output, is the sole consideration.

Effective plant utilization gauges how fully the plant is occupied, output being converted into producing hours on the basis of manufacture being carried out at an efficiency equal to the performance standards. If manufacturing was carried out without inefficiency or breakdown, actual and effective utilization would be coincident. Consequently, their difference measures the departure from effectiveness of plant utilization.

CHAPTER III

COST VARIATION

SCIENTIFIC cost control is based on continuous and methodical comparison of actual costs against standards by which the location, cause, and responsibility for excess cost is shown up.

Location refers to the situation of the loss in the physical sense: at which machine or process. Cause involves the source or reason for the excess cost: in what kind or form. Responsibility attaches the excess cost to some executive individual.

There is fundamental necessity for clean cut classification of location, cause, and responsibility in order that cost control shall work smoothly. Each individual case must be framed on its special requirements. Cost control must be built around the system of managerial organization. Therefore, full scope is given to the employment of those means which will best analyse and allocate excess cost with consistency.

Responsibility for cost can be conveniently divided into certain primary divisions which are equally applicable to any type of organization or business—

1. Administrative control.
2. Sales control.
3. Production control.
4. Technical control
5. Purchases control.
6. Service control.

Causes of excess cost can be stated in rather greater detail of analysis, when considered from the broad and generally applicable aspect, than can responsibility for their incurrence. The summary on pages 52, 53, and 54 is capable

of amplification or modification to suit the majority of requirements.

Excess costs can also be segregated into two groups—

1. Cost of plant idleness owing to failure of sales demand to provide sufficient work for the occupation of the plant at the predetermined measure of utilization.

2. Cost of inefficiency, which includes all excess costs other than those caused by plant idleness.

The cost of plant idleness covers not only the loss involved in maintaining machinery of the directly productive type while not being utilized but also the proportionate amount of auxiliary plant and services which supply work points, machines, and processes. The analysis of service costs at their source of incidence is a most important feature of cost control of variations or deviations from standard.

General Administrative Cost Responsibility.

If administration be interpreted as the business control which formulates policies and guides the general destinies of an enterprise, the financial results of such policies can sometimes be reflected within the costing framework. The greater part of administrative responsibility cannot, obviously, be measured. The results of certain deliberate moves and financial restrictions, however, can often be determined.

First, the amount and cost of plant idleness will, in varying degrees, be the result of policy determination. All decisions with regard to budgeted volume and kind of sales, price fixing, and sanctioned expenditure on sales promotion and publicity rest with general administration. Plant idleness is also caused by selling inefficiency and difficult trading conditions. While assessment cannot be exact, it may be conceded that the cost of plant idleness is the joint responsibility of the general administrative and selling functions. Profit analysis provides a most important guide to the financial results of price-fixing policy.

The principle of this discrimination can be further

illustrated by a consideration of the responsibilities of the buying function. Buying of materials is governed by the dictates of administrative policy. To what extent buying shall be in advance of requirements can be laid down for the guidance of the executive buyer provided that prices are reasonably stabilized. Standard costs are based on such a formulated policy. If there is any tendency towards abnormal fluctuations in market prices, the desirability of buying ahead of requirements will be fully explored. Any decision which involves abnormal financial commitments must be authorized by the general administration of the enterprise, and, consequently, the latter must also be jointly responsible with the buying executive for the profits or losses which result. The efficiency of the buying function must be adjudged, however, by factors which it can directly influence. Primarily, cost control differentiates between administering—or directing—and managing—or executing. Therefore, the loss or gain which occurs from either advanced or retarded buying must be regarded as administrative responsibility. The buying executive is responsible only for carrying out general and specially adjusted policies.

General administration decides and lays down the policy to be followed by management in dealing with the problems of labour and industrial relations. Conceivably, the trend of this policy will influence the actual cost of production. It may be decided that every attempt shall be made to maintain the working strength at a constant level. As output can rarely be scheduled and produced at a rate which will absorb the fixed available amount of labour, there tends to be a permanent surplus which cannot be employed on fully effective work. Inevitably, this policy then must cause an excess cost over and above the basic cost of the output. A very important point is that, if such a policy is followed, planning of output and effective labour utilization must be carried out with method and in detail

if this form of excess labour cost is to be maintained at a minimum.

Sales Cost Responsibility.

The selling function contributes towards excess cost from directions which are not always obvious. Four causes may be mentioned. The excess costs of the first two often may be separable only by arbitrary assessment.

1. Joint responsibility with general administration for cost of plant idleness on account of causes other than those of general trade depression and selling inefficiency. Although general administration is primarily responsible for sales policy, the sales management acts in an advisory and consultative capacity, and, therefore, may be partly answerable.

2. Failure to obtain that volume of sales which might be expected when full allowance has been made for adverse trade conditions and sales policy. This loss can be termed inefficient selling.

N.B. Not only do the above causes result in losses on account of plant idleness but also involve excess costs due to unabsorbed sales cost. Sales cost does not contract in proportion with volume of sales. Therefore, actual sales costs in terms of output will exceed the standard cost by a determinable amount.

3. Actual selling costs may exceed the amount set as standard for obtaining the predetermined volume of sales. In effect, a certain amount of expenditure is budgeted as permissible for a certain specified sales volume. This budget has been analytically developed with full consideration to kind of expenditure, geographical and product requirements, and other factors. Any expenditure over and above the budgeted standard is excess cost unless adequately compensated for by increases in sales volume.

4. Failure of the sales function to maintain a steady demand for all types and sizes of output results in manufacturing losses on account of the necessity for producing

in small batches or lots. Frequent set-ups and changes of machines and processes are sources of loss which can be evaluated as excess cost. Economical batch sizes can be scientifically calculated by means of a technique which gives due weight to two such influential factors as stock investment and wastage, and rate of decrease of unit cost with increase of batch size.

Cost Responsibility of Production Control.

Production management involves two different and distinct groups of activities. One deals with the planning and arranging of work and the other with its execution and supervision. Whether or not these activities are functionally separate in an organization, they must actually be performed. The fact that one and the same individual carries out composite duties does not affect the issue. Every effort must be made to control cost on functional lines. Evidence of weakness may be revealed which was entirely unsuspected. Cost responsibility can be filtered from the chief authority down to the lowest minor executive, provided that planning and executing are recognized as distinct entities of production, even though they may not exist as separate functions each in the charge of individuals.

Amongst the causes of excess cost are–

1. **Materials.** Standards specifying the quantity and kind of material, yield, permissible waste, by-products, and other limiting factors have been set for each type and size of output. Certain potentialities for loss are under the control of production executives, who, in consequence, must be held responsible for excess cost due to such contributory causes. For example, in general, provided that material and equipment are satisfactory, spoilt work is mainly caused by the inefficient work of an individual operator or team. The excess cost of the spoilt work can be evaluated and shown as a definite chain of responsibility from the individual operator, supervisor, manager, to the chief production manager.

2. **Output Inefficiency Within the Control of the Operators.** Output will sometimes fall below standard on account of deliberate restriction or some other cause definitely attributable to labour inefficiency. This category does not include failures to reach standard output on account of lack of training or unsuitability for the job. The excess cost includes not only that of labour directly employed on production but also of overhead charges for the extra time spent at work points, machines, and processes.

3. **Output Inefficiency Within the Control of the Operators but Outside their Responsibility.** Output will sometimes fail to reach standard on account of operators being insufficiently skilled, untrained, or in some other way unsuitably adjusted to the particular work. While all facilities may be available for the production of standard output, limitations of the available labour prevent its attainment. Here, again, excess cost includes both labour and overheads.

4. **Output Inefficiency Outside the Control of the Operators.** Hindrances and breakdowns frequently cause temporary cessations to the flow of production. Work points, machines, and processes compulsorily cease work for intervals owing to lack of supplies, instructions, work, and other essentials. The responsibility for losses included under this category may lie with either the planning or the executive side of production management. On the other hand, losses due to breakdowns are the responsibility of supply services. Again, the excess cost includes both labour and overheads.

5. **Use of Too Highly Rated Operators.** A certain grade of labour is specified as standard for each job, and the wage rate of the specified grade is used for developing the particular cost standard. If labour is not distributed effectively there will be a tendency for the use of operators whose rates are above those specified. This signifies a surplus of certain grades or bad distribution of those available. The more likely explanation is that unmethodical distribution of

labour has fostered a belief in the necessity for a surplus. Unless general administration directs the maintenance of a surplus for policy purposes, or unless the distribution of labour is dealt with by a special function—thus becoming a service—the excess cost must be regarded as the responsibility of the planning side of production management.

6. **Use of Production Methods Alternative to and Less Efficient than those Specified as Standard.** Cost standards are based on the use of specified machines and methods for the performance of work. If less suitable machines and methods are used, there will be excess cost. The reasons for the departure from standard procedure decide the allocation of responsibility. Often the loss is due to planning defects or even to the complete absence of effective planning.

7. **Excessive Use of Services.** Each work point, machine, and process is allotted a measured proportion of each service which supplies its needs. This allocation is expressed in terms of quantity and cost per running hour. If more than the standard hourly amount is consumed, then excessive use is being made of service facilities. This loss must be regarded as the responsibility of production executives if machines and facilities are in efficient working condition.

8. **Inefficient Set-ups and Sub-standard Batch Quantities.** Every change of operation and job involves a constant cost, which requires to be spread over the amount of output produced between the two set-ups. The shorter the run, the smaller the output, and the higher the cost. Cost standards are based on economical lots and batches predetermined in advance as capable of realization. Short runs and small quantities may be caused by ineffective planning or by lack of sales demand. Performance standards are determined for the work of setting up and making changes. Inefficiency, with resulting excess cost, is the responsibility of the production executives.

9. **Overtime.** The excess cost of overtime includes only the additional payment, over and above the normal hourly rate, made to labour. Production management can be held responsible only for the overtime necessitated by failures in the arranging or executing of work. The predetermined plant utilization may possibly include provision for a certain amount of overtime on account of some particular machines having insufficient capacity for output to produce the required volume during ordinary working hours. In this instance overtime cannot be regarded as an excess cost. Again, overtime undertaken to expedite completion in advance of schedule, although an excess cost, is not the onus of production management.

Technical Cost Responsibility.

In every manufacturing plant, there exist functions, not perhaps individually separate and distinct, which are responsible for the design, specification, quality, and general constitution of the products. Their influence increases in accordance with the preponderance of chemical change in the manufacturing processes. If manufacturing involve physical changes only, technical cost responsibility does not assume large proportions. Amongst reasons for excess cost are—

1. Waste, spoilage, and low yields. Where technical processes are involved, standard percentages will have been determined as measures of performance. If yields are lower than standard, or waste and spoilage higher than standard, excess cost must ensue. The responsibility may lie with either production or technical control, or with both.

2. Alternative and substitute materials may be used instead of those laid down in standard specifications. Technical authority alone can authorize any such changes which, in consequence, if deliberate and not enforced by stock shortage, must be its own responsibility. In some cases, deliberate substitution may cause actual cost to be lower than standard.

Service Cost Responsibility.

Services comprehend the entire field of activities which supply production and technical control with the necessary facilities for manufacturing. The buying and material service provides and issues material. The labour service supplies labour. The engineering service maintains machinery and equipment in efficient working condition. The works transport service moves materials and work-in-progress. Other services provide requirements according to the special needs of the plant and industry. As previously stated, even though such functions are not always distinguishable, they do exist in every organization in so far that their duties are performed. The aim is to analyse functional services, define the individuals responsible for their control, and to assess their efficiency in terms of cost. This project, although ambitious, does define a guiding principle for treating overhead costs. No longer must they be regarded as a mass of costs, having no connected relation to output, to be distributed by an overall apportionment, but rather as being the expense of providing certain definite needs in measurable quantities. If these needs are visualized as functional services, it is only one step farther to conceive an individual control for each of their activities.

Take the generation of steam for process and heating purposes as a typical service in a plant. The cost standard will be expressed in pence per thousand pounds of steam supplied to consumers. This cost standard will have been developed on the basis of a predetermined demand for steam and of a reasonable and attainable measure of generating efficiency. If demand does not meet expectations, as actual cost cannot decrease uniformly with supply of steam, the actual cost per pound of steam will exceed the standard cost, even although the standard of generating efficiency is maintained. This excess cost on account of failure in demand is not the responsibility of the executive in charge of steam generation. On

the other hand, any failure to maintain the standard efficiency of generation lies within his sphere of influence, and the resulting excess cost must, therefore, be his own responsibility.

The principle defined by this illustration holds good for all services. The executive in control can be held responsible only for excess cost due to actual inefficiency of supply. In consequence, costs are adjusted to eliminate the bias caused by any variation in demand.

Service cost responsibility includes other potential sources of loss. For example, the cost of wasted time and capacity owing to machine breakdowns, of lost output due to equipment defects, and of any other similar interferences with the steady flow of production are debited against the engineering service. Again, hindrances to production on account of material shortage may sometimes be due to oversight on the part of the buying and material service. These instances afford some idea of the objective principles which guide analysis of cost variation and responsibility.

CLASSIFICATION OF MANUFACTURING EXCESS COST

Constituent Costs	Cause	Responsibility
Manufacturing Overheads	On account of actual sales demand failing to provide sufficient volume of output for the attainment of the predetermined level of plant utilization	Administration and Sales
Sales Overheads	On account of actual sales being of insufficient volume to absorb the budgetted amount of expenditure on selling services	Administration and Sales
Sales Overheads	On account of actual cost of selling services being in excess of the budgetted amount	Sales

CLASSIFICATION OF MANUFACTURING EXCESS COST—(*contd.*)

Constituent Costs	Cause	Responsibility
Materials	On account of actual purchase prices being in excess of standard	Administration and Buying
Materials	On account of the use of materials alternative to those specified as standard	Technical (if deliberate): Buying and Material Service (if unavoidable)
Materials, Labour, and Manufacturing Overheads	On account of material consumption being in excess of standard: inclusive of low yields, excessive waste and defectives, and other causes controlled by standards of permissibility	Technical and Production
Labour and Manufacturing Overheads	On account of failure of operators, machines, and processes to produce standard output due to causes within the control of the operators	Production
Labour and Manufacturing Overheads	On account of failure of operators, machines, and processes to produce standard output due to causes outside the control of the operators: use of unskilled, untrained, or otherwise unsuitable operators	Production and Labour Service
Labour and Manufacturing Overheads	On account of failure of operators, machines, and processes to produce standard output due to causes outside the control of the operators: for example, waiting for materials, instructions, supplies, and so forth	Production
Labour and Manufacturing Overheads	On account of the use of manufacturing methods and machines alternative to and less efficient than those specified as standard	Production

CLASSIFICATION OF MANUFACTURING EXCESS COST—(*contd.*)

CONSTITUENT COSTS	CAUSE	RESPONSIBILITY
Labour	On account of the use of operators with wage rates in excess of those specified as standard for the work upon which they are engaged	Production and Labour Service
Labour and Manufacturing Overheads	On account of failure to produce in economical quantities, i e. short runs, frequent set-ups, unbalanced production between processes, and similar departures from standard	Sales and Production
Manufacturing Overheads	On account of operators, machines, and processes, consuming amounts of service in excess of standard: for example, fuel, steam, indirect labour, sundry supplies, and so forth	Production
Manufacturing Overheads	On account of inefficient operation of service and feeder departments: including electric supply, maintenance, inspection, and so forth	Services
Labour	On account of overtime caused by factors within the control of the organization: does not include overtime due to insufficient productive capacity over some reasonable period of time	Sales and Production
Labour	On account of existing surplus of operators over and above most economical requirements of the plant	Administration and Labour Service

CHAPTER IV

LABOUR COST STANDARDS

PERFORMANCE standards are essential to the development of labour cost standards. Not only does this necessity involve the study and measurement of optimum human productive capacity, but also of the potential and related capacities of machines and processes. These same performance standards are also used for ascertaining the quantum of overhead costs justifiably chargeable against output. In addition, the work of individual jobs must be investigated and appraised in order that definite grades of operators and wage rates may be specified as standard for each case.

Scientific development must follow logical lines—

1. Study and classification of all work points, machines, and processes.

2. Analysis of each job and specification of most suitable grade of operator for carrying out the work, giving due consideration to physical demands, skill, experience, responsibility, and other influential factors.

3. Study and measurement of each operation, whether by hand or machine, and derivation of performance—or output—standards.

4. The conjunctive use of performance standards and specified wage rates for the development of labour cost standards.

This procedure, however, is influenced and guided by many considerations, both general and special. The industry, the plant, the organization, the basis of wage relativity, the existence of payment by results, all have their effect. The possible variability in individual output is very wide. As, with the majority of incentive systems, labour costs do not fluctuate in direct proportion with output, the

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reasonably accurate determination of average individual output is most important.

Scientific Labour Standards.

To appreciate fully the necessity for this searching and detailed analysis and measurement, comparison can be made with two other alternatives, both of which are in general use for setting cost standards. Neither, however, can be called scientific.

1. Cost standards are sometimes set from estimates given by managers and foremen or from the actual costs of similar jobs or lots. The disadvantages of both these methods are only too apparent. While they may have some use for price-fixing purposes, they are almost valueless for exercising cost control.

2. Cost standards are also set from data supplied by an established estimating department. If piecework or bonus systems are operated, the rate-fixing staff will set rates from experience, calculations, or arbitrary methods. This is a stage of improvement, but, so long as analysis and measurement are not practised, this method cannot be accepted as scientific.

3. Only when cost standards are developed from the results of organized research into manufacturing operations and processes can they be termed scientific. A definite technique is involved. Each job is broken down into small elements, each of which is examined, measured, and then combined into performance standards. This research is comprehensive. It deals with machines, methods, and workers. Every aspect of each problem must be considered before time and output standards can be developed. The human factor requires careful attention. Job analysis and selection of operators are as essential as the study of machines and methods. It is useless to provide facilities and to develop standards if the human element is not capable of their performance owing to lack of training or unsuitability.

Production research is not necessarily connected with piecework or bonus systems. It provides accurate data for the development of performance standards which may be equally well applied to work at ordinary hourly rates as to work on one or other of the many incentive systems. The level of requirements should, of course, be adjusted into relative alignment. For the efficient and economical conduct of industry, standards of measurement are an essential need. The level of attainment and the means of its achievement are matters of individual business policy.

Scientific cost standards are composed of two constituents: the basic standard and the inefficiency allowance. The basic standard signifies the model cost for a particular plant. The inefficiency allowance sets a standard of permissible failure. For practice must admit of many causes of inability to reach such a difficult goal. The sum of the two constituents gives the cost at which output should be produced, and this must be accepted for price-fixing purposes. There is very good reason for the development of dual standards. If a standard is to appraise or measure real efficiency, it must represent the same level at all times, conditions, and circumstances, i.e. the best utilization of available productive machines and processes. These requirements are fulfilled by the conception of a standard based upon 100 per cent effectiveness for the plant. On the other hand, it is equally necessary to have some secondary or local level of efficiency which will act as an attainable objective. The difference between the two levels gives the inefficiency allowance. There are several factors which cause the difference in levels to vary considerably between various jobs, processes, departments, and plants, even provided methods and lay-out were identical—a situation easy to visualize in theory but rarely accomplished in practice. They include special liability of some machines to breakdowns, difficulties in obtaining experienced operators, and

all difficulties accepted as inevitable at the time and circumstance. In addition, the inefficiency allowance includes provision for an amount of waiting time, failures to produce standard output, and other losses considered as reasonable for particular conditions and organization.

Performance Standards.

There must be some equating link between a unit of output and the amount of labour which should be incorporated in its production. Time is the most generally accepted measure of labour. Of late, however, a technique of measuring labour in terms of points has arisen. Both have particular import when considering the connection between potential and actual machine output in relation to overhead costs.

In the development of performance standards, each operation or job must be dealt with individually and with due attention to its peculiarities. The following factors must receive consideration—

1. Whether work is to be performed under day work conditions or under some incentive method.
2. Whether work is by hand or by machine.
3. Whether output is free or limited.
4. Whether work is carried out by an individual or by a group or team of operators.

Day Work and Payment by Results.

First, contrast the differences between production under day work and under incentive conditions. Although measurement can give performance standards, they are necessarily relative to levels of payment. For example, a normal output may be expected in return for the hourly rate of pay. But the normal output in practice will be lower under day work than when some incentive is offered. After all, this is quite reasonable. Therefore, cost standards must be treated in accordance with actual practical conditions and not upon any theoretical basis of expectation. Cost standards have

no relation whatever to ideal conditions or output levels. The basic cost standard implies 100 per cent effectiveness under conditions of equilibrium between labour cost and output which have been established in the plant in question. Measurement is, however, subject to no such restrictions. Simply expressed, this means that, even although measurement proves that an operator of average skill can produce 120 articles per hour, if an output of seventy per hour is accepted as an equitable day work production the latter amount will constitute the performance standard. This example does, of course, apply only to repetitive work, where output may be limited by agreements with labour. It cannot apply to varied and diverse output, and is intended merely to illustrate the complete interdependence of performance standards and of measured potentialities for output in relation to labour. It should be particularly noted as referring to labour only. The potential capacity of plant, machines, and processes must always be treated as potential output for the purpose of developing output standards. The amount of labour, however, required to man the machines and processes must be governed by the dictates of the existing situation: methods of wage payment, working and environmental conditions, and other factors.

Under methods of payment by results, the problem assumes a totally different aspect. There must be some closer connection between measured potentiality for output and that actually obtainable. Taking piecework as an example, unless deliberate restriction exists, the average actual output of operators should approximately coincide with the measured potentiality of an average operator. Some complex problems may be presented in the translation of performance standards into terms of cost if incentive payments do not vary in direct proportion to output. As this last condition is fulfilled only by piecework with non-guaranteed hourly rates, which method is now tending to

go out of favour, the development of labour cost standards does generally require careful treatment.

Hand and Machine Work.

Potential output is limited by factors other than human effort. It can be restricted by speed of machines and processes—as imposed by engineering or technical considerations—or by lack of balance in the flow of work in sequence between operations and processes—as governed by the relative productive capacities. Where output is entirely carried out by human effort, however, it may equally be well restricted by this last-mentioned factor of lack of balance.

Manufacturing activities, viewed from the aspect of potential output, can primarily be separated under the two broad divisions of hand and of machine or process work. By handwork is meant only those operations which are performed by human effort without the aid of plant and machines. Machine work includes all operations and processes carried out with the aid of plant and machines.

The output of handwork can be regarded as unrestricted only if the limit is imposed by the skill and speed of the individual operator. The output by machine or process depends upon the degree of restriction, which obviously varies between total and nil. Restriction can be conveniently classified as follows—

1. **Complete Restriction.** Where output is entirely dependent upon speed of machine or process: this condition presupposes the presence of sufficient labour to operate and supply at constant and fixed speeds. Output cannot be increased by human effort over and above a known maximum productive capacity.

2. **Partial Restriction.** Where output is partially dependent upon the speed of machine or process: here output is only in a certain degree restricted by limitations of

machine or process. Output can be increased by human effort to an extent which depends upon the proportion of machine operation at constant speed to the proportion which can vary with the speed of manual performance.

3. **Unrestricted.** Where output is entirely dependent upon the speed of manual performance of operators working upon machines and processes: this category is almost identical with conditions of handwork, excepting that power-driven machines are used instead of hand tools and appliances.

When developing labour standards for machine work of the first two categories, the potential output must be determined, and then the required number of operators be decided. In contrast, with regard to handwork and machine work of the third category, output can only be considered in direct connection with the labour involved in production: there is no restriction imposed by speed of machine or process, and the work is akin to unrestricted manual effort. The only limitation may be lack of balance in flow of work.

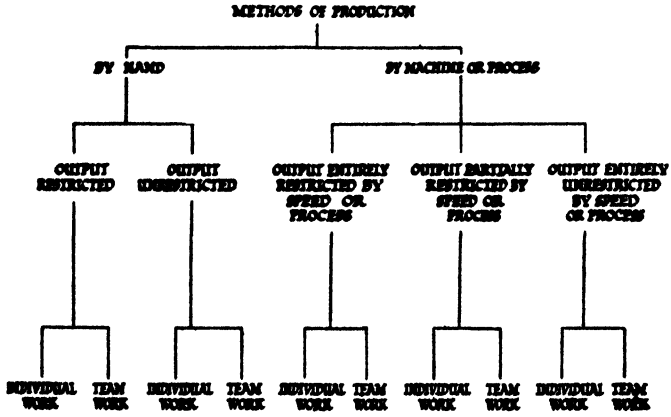


CHART SHOWING ANALYSIS OF FACTORS WHICH INFLUENCE PERFORMANCE STANDARDS

FIG. 3

Limitations to Output on Account of Causes other than Machine and Process Speeds.

These causes include only those accepted by production management as unavoidable and due to practical difficulties imposed by plant lay-out, division of labour, and sequence of work. They refer only to planned and premeditated failures to secure maximum output from operator and machine. They do not include delays and hindrances in the execution of work.

For example, under conditions of continuous production, certain machines in the chain may necessarily be working full time, but producing considerably below their maximum potential capacity. This serves as a simple illustration of restricted machine output on account of reasons entirely outside the control of the operators.

Again, in the case of handwork, a chain of operators may be assembling components, each operator performing some definite part of the assembly which is passed along until completed at the end of the chain. To ensure that each operator has the same amount of work to do is impossible. Therefore, not only is the total output of the assembly chain limited by the speed of the slowest operator, but also the relative amount of work done by an individual operator depends upon his position in the chain. Assuming that all the operators in the chain are capable and willing to perform approximately the same amount of work, total output is governed by the relative individual output upon the most difficult job in the chain. This last, then, is the key, and must provide the base for developing a performance standard for the assembly chain.

Individual and Team Work.

Frequently, performance standards must be determined for groups of operators whose work is both intermixed and interchangeable. In such cases, the work and duties of individuals may or may not be distinguishable. Where a

number of operators are manning a machine or process, they obviously constitute a team. The existence of team work upon hand or manual work is largely a question of production methods. Work can often be organized upon either individual or team lines. Study and circumstances decide selection of alternative. Even with the aid of measurement, there may be some difficulty in developing performance standards for teams engaged on handwork. Teams working as crews of machines and processes do not present so difficult a problem, as performance standards are mainly based on engineering and technical factors.

Payment by Results and Cost Standards.

Performance and output are indissolubly connected with methods of remuneration. While there is essential need for accurate knowledge of productive capacities of operators and machines, their actual realization is the practical consideration. Payment by results not only affects the level of performance and the cost standards, but also influences the degree of their attainment. Incentive payment offers a definite inducement to production, and failures to reach standards are far less likely than if operators are paid at hourly rates only. Payment by results dictates labour cost standards. There are, however, different bases of alignment for particular systems and methods. Cost standards cannot precede those used for incentive purposes. The latter act as the foundation for basic cost standards against which losses and inefficiencies can be controlled.

In Great Britain the four most important methods of incentive payments are—

1. Piecework.
2. Premium bonus.
3. Point method.
4. Collective bonus.

Piecework.

At first sight, piecework would seem automatically to give a labour cost standard. There are, however, several

objections to its unqualified acceptance. Conditions of piecework vary in different industries and plants. Some points affecting the issue—

1. Are hourly rates of pay guaranteed to the operators irrespective of output, or are they paid entirely on output without any guarantee of hourly or daily pay?

2. Are operators credited with any hindrances due to causes outside their control at their basic hourly rates of pay or at some lower rate of pay, or are they completely penalized by any such hindrances?

Only when hourly rates are not guaranteed and hindrance allowances not granted can piecework rates be accepted without adjustment as cost standards. Otherwise provision must be made for wages paid from which there is no effective return. In those instances where one or both are guaranteed, the cost standard includes the piecework rate as the basic standard and an inefficiency allowance to cover a reasonable proportion of losses. Another point requiring special treatment is the existence of different piecework rates for identical jobs. This anomaly occurs when both men and girls are performing certain work. If this alternative suits the management, they may set higher piecework prices for the men, but not in proportion to the difference in their respective hourly rates. A similar point arises when journeymen and apprentices work on the same jobs. The apprentice will generally receive a lower piecework price, but not in proportion to his wages. There is justification for this treatment in some cases, particularly where craftsmanship or machines are concerned, for it may be assumed that the lower-paid operators will use manufacturing facilities for a longer period per unit of output and also in other ways incur greater overhead costs. In other cases, however, the lower-paid operator may actually be the faster producer. The solution of the problem is job analysis. The work must be analysed with a view to the selection of the most suitable type of operator—in regard

to sex, experience, skill, and other qualifications—and a piecework price set on this assumption. This job analysis and piecework price forms a basis for the standard cost. If operators of a less suitable grade are employed on the particular work, the consequent loss will be shown up as excess cost.

Even when hourly rates are not guaranteed, losses will occur in the event of low individual productivity. Although operators receive only the amount of wages earned at piecework prices, their presence at work points or machines involves overhead costs which are a factor of time. Thus, as each hour may represent a definite charge for overheads, low productivity by an operator during that hour means that actual costs are relatively higher. Where machinery is concerned, this point is specially important. Therefore, there is every necessity to control labour performance and cost even in those cases where labour cost is directly proportional to output.

The disadvantages of piecework systems which neither guarantee wage rates nor permit the claim of hindrance time must be evident. They do not safeguard the workers from adverse circumstances outside their control, nor do they confer any moral obligation for the production of a definite output. To allow for hindrances in the piecework price means that the latter must tend towards ease or difficulty, as the amount of this non-productive time cannot be predicted with reasonable accuracy. Only in very straightforward and repetitive work, where hindrances are negligible, are non-guaranteed wage rates suitable and fair to worker and employer. Again, if wage rates are guaranteed, a worker can be expected to produce an output equivalent in value to his daily pay. This tends to secure effective utilization of machinery. In those plants which use piecework as a wage incentive system, in order to secure both economical production and scientific cost control, there is every argument in support of a guaranteed

hourly rate of pay and the grant of time allowances to cover unavoidable hindrances.

Premium Bonus.

The principles underlying this method of incentive payment are well known. The Halsey and the Rowan systems, both of which originated in, and are mainly confined to, the engineering and allied industries, are the best known examples. Hourly rates of pay are guaranteed. All premium bonus systems have a common basis in that standard bonus times are set for individual jobs and operations, and the workers are paid premium on time saved upon this standard bonus time. There is a possibility here of misinterpretation of meanings. Standard bonus times are not identical with standard performance times, although they may have a definite mathematical relation to each other. The standard bonus time is comparatively easy of attainment. The standard performance time, on the contrary, represents first-class performance by proper grade workers under good conditions. For developing cost standards under circumstances where premium bonus systems are used, both times are necessary. The standard performance time—derived from knowledge, calculation, or study—is used as the basis for setting the standard bonus time. The ratio of difference depends entirely upon the methods used in determining the standard performance times. If detailed study and measurement are applied, the ratio will be wider than if the rate-fixing technique is more superficial. Generally speaking, premium bonus is particularly good when the less advanced methods of rate-fixing are used. The sharing of savings between employer and workers permits the setting of generous standard bonus times, owing to the fact that any resulting inaccuracies will be "damped down." This is in striking contrast to piecework, where inaccurate rate-fixing can prove very costly. From the production and incentive standpoints, premium bonus has the very

great advantage that it can have limited effect without detailed measurement. But, from the strictly economical aspect, concealed losses and inefficiencies can occur, control is not 100 per cent effective, and there is no indicated level of actual efficiency unless performance standards are developed by scientific study.

In the Halsey system the worker's premium is 50 per cent of the time saved (i.e. difference between actual time taken and standard bonus time) at his hourly rate of pay. In the Rowan system the worker is paid as premium an equal percentage upon his hourly rate to that which the time saved bears to the standard bonus time.

It should be specially noted that premium is calculated upon each job or operation. This is in contradistinction to some other systems which work out premium over the day's work, i.e. failure to reach premium earning output on one job is offset against premium earned on other jobs during the same day. There is, therefore, a greater tendency in the aggregate for actual cost to exceed standard when premium is calculated for each job than when taken over the day's work.

The Point Method.

The two best known applications of this method are the Bedaux and the Haynes Manit. Instead of expressing bonus standards in terms of time, they are evaluated in points. Standards are set only after very careful study and measurement. Points are comparable in value between job and job and between department and department. In the Bedaux method the point is a unit of work known as the *B*. Bedaux aims at measuring human effort and expressing it in terms of units of work. A *B* has been defined as the normal amount of work which can be done in one minute—partly work and partly relaxation.

Hourly rates of pay are guaranteed, and premium is calculated over the day's work. Sixty points per hour are

required from each operator before premium becomes due. An operator of average skill and free of restrictions should earn eighty points per hour. All time lost through unavoidable delays and hindrances are credited to operators at one point per minute.

Under Bedaux, direct operators are paid for the total number of *B's* earned each day in excess of sixty per hour, each of these *B's* being regarded as equivalent to a premium minute. The daily premium is calculated upon these premium minutes, credit being usually given at the rate of seventy-five per cent of the operator's hourly wage. Indirect workers, including supervisors, are also paid premium, the amount depending upon the cost effectiveness at which their department is working.

Although the point method automatically provides performance standards, they may not be immediately available in the form necessary for the development of cost standards. If the conception of a scientific cost standard, however, is borne in mind, and individual consideration given to each instance of restriction imposed by speeds of machine and process, sequence of work, and other limitations, the point method can provide a very sound basis for developing cost standards.

Collective Bonus.

By collective bonus is meant not an incentive method for a machine team or a group of hand operators, but a comprehensive system to embrace an entire department or plant. Its relative merits and demerits are of no immediate concern. Generalizing, a collective bonus system operates by determining a standard output and a corresponding standard wage equivalent for the plant, and by the payment of bonus to the workers upon the basis of some agreed proportion of any savings on the standard wage equivalent. Unless output can be expressed in terms of some simple unit, the scheme involves differential valuation of output.

The variations in collective bonus schemes are many. Fortunately, from the aspect of standard costing, they have one general similarity. Bonus is paid as a percentage on actual wages, and usually in direct proportion to related savings and output.

The operation of collective bonus schemes is facilitated by standard costing methods in that the cost standards provide an accurate foundation upon which the collective bonus formulae can be based. Collective bonus differs from other incentive methods in so far that it does not, owing to its broader scope, naturally precede the development of cost standards. On the contrary, as stated, it rather tends to follow them.

Wage Rates and Cost Standards.

The medium of conversion between performance and cost standards is the hourly wage rate or its equivalent. Three methods, not necessarily alternative to each other, may be specially mentioned:

1. Piecework price: with or without guaranteed hourly rate.

2. Hourly rate paid to grade of operator selected as suitable for the work by job analysis, by arbitrary stipulation, or by labour agreement.

3. Flat hourly rate obtained by taking an average in group, department, or plant.

Whichever method, however, is used, the grade of operator selected as standard for the work should always be specified.

In the first instance, the problem will be approached on the assumption that piecework prices are already set and have not been synthetically developed on scientific lines. Translation into labour cost standards is not quite such a clear issue as it appears. Piecework prices must be analysed into constituents, and, in some circumstances, be increased by a determined percentage. The addition, and its amount,

depends upon the scope of the piecework price and whether the hourly rate of pay is guaranteed. Does the piecework price embrace an allowance for waiting and unavoidable delays, or is the worker entitled to claim credit for such time? In the former case, unless such records are kept, although not used for calculating earnings, control is much hampered and obstructed. The essential principle to be fulfilled is that the labour cost standard shall include a basic cost and an inefficiency allowance. The entire structure of control by cost variation is built upon recognition of a standard of effectiveness plus a permissible deviation in terms of time. The cost of using plant, machinery, service, and almost every manufacturing activity is governed by factors of time, and such facilities are also utilized by labour in terms of time. Therefore, piecework prices must be resolved into factors of time and earnings. If hourly wage rates have not already been agreed, they must be standardized artificially for costing purposes.

Artificial base rates establish a link between time and money when piecework prices with non-guaranteed hourly pay are being translated into cost standards.

The second method—the use of specified wage rate of the selected grade of operator—can be used for daywork and for incentive systems, such as premium bonus. To obtain basic cost under daywork conditions, the appropriate wage rate is used in conjunction with the performance standard. With an incentive system, the performance standard will be some level at which premium is earned. In consequence, the basic cost will include the amount of hourly wages and premium payable if output is produced in accordance with the performance standard. Both wages and premium in this basic cost are calculated at the specified hourly rate for the job. The inefficiency allowance also has the same basis. Fundamentally, therefore, as standards, there is no difference between the cost standard and specified hourly rate and that

developed from the piecework price with guaranteed hourly rate. When actual cost enters into question, however, piecework will tend to yield less excess cost. Under daywork and premium bonus, if a higher paid operator than specified does a job, there will be excess cost on this account. But, under piecework, whatever grade of operator does a job, the remuneration and labour cost will, in most cases, be the same. This comparison can be accepted as generally applicable, although there are some exceptions. For example, even under daywork, if an operator does a lower grade job, he may revert to that rate of pay. Again, under piecework, the prices may vary according to the grade of operator who carries out the work, e.g. a girl may receive a lower piecework price than a man for the same job.

The third method of developing a cost standard from the factors of performance time and labour remuneration is by the application of a flat hourly rate instead of the hourly rate specified for the particular job. Flat rates may be determined for special groups, processes, departments, or plants. A flat rate is calculated from a weighted average of the hourly rates of the operators included in the range covered by the flat rate. The relative proportions of various grades of operators, and correspondingly hourly rates, used for calculating the flat rate, will depend upon the prevailing circumstances. In some cases, it may be preferable to use a standard personnel as the basis of computation, while in others an average normal personnel may be more suitable. Although they offer some advantage in simplified costing routine, their main claim to merit is that, in practice, more consistent accuracy is given by their use than by the specified rates used individually. Certain conditions undeniably favour flat rates; but, speaking generally, simplification is secured at the expense of accurate control. An instance of where they may successfully be applied is a department or plant employing operators at

different wage rates upon work which may be done with equal efficiency by any of the different grades. Obviously, chance decides the operators which carry out the various work. A flat rate clearly meets such circumstances. While the foregoing illustration was an extreme case, several others having a similar tendency might be cited. Again, in practice, although some control is lost, flat rates may be preferable in cases where labour forms a very small proportion compared with overhead cost or where labour is freely interchanged between jobs. Control, however, can be tightened at any time by increasing the number of flat rates, and by controlling over smaller groups or narrower classifications of labour.

Cost Standards for Set Ups and Changes.

As machines and processes may lose considerable amounts of potential producing time on account of inefficient setting of machines or by the occurrence of an excessive number of changes of work, standards must be developed. Set-up standards may be determined by two alternative methods, the selection depending upon the ranges of variation in set-up times and in the number of running hours per set up for each particular machine.

1. If the variations in each set-up cost is comparatively small, or if the average is consistently steady, then a standard cost for a set up may be developed. When the average number of running hours per set up is reasonably uniform over a period, then set-up costs can be expressed as standard set-up costs per running hour for each machine or group of machines.

2. But, in the majority of instances, there is consistency neither in setting time nor in number of running hours per set up. In which case a standard set-up cost may be required for each operation or process, and the quantity of output produced in a lot or batch be determined in order to obtain a standard set-up cost per unit of output.

Not only must the performance time of a set up be determined, but also the wage rates of the operators concerned. Sometimes the operator or the team who normally work the machine may be required to assist the setters up, sometimes they may do the job themselves, and sometimes they can neither assist in the set up nor be found alternative work while the change is being made. All these factors must be considered and weighted when standard set-up costs are being developed.

CHAPTER V

MATERIAL COST STANDARDS

As a comprehensive term, materials embrace not only the externally purchased raw and semi-prepared materials which are transformed during manufacture and components obtained from outside suppliers, but it also refers to bulk goods which have already undergone one or more processes of preparation, and to parts which have been partially or entirely completed within the plant. The finished product of one operation or process forms the raw material for the next one in the manufacturing sequence. All charges are made at standard prices, which, in the case of materials and parts completely or semi-finished in the plant itself, coincide with their standard costs. Therefore, in reference to materials, standard price and standard cost are equal in value, but not synonymous in meaning. The standard cost of an article signifies its value after manufacture, while the standard price expresses its chargeable cost if issued for further processing or assembling.

The foregoing conception of "materials" in its comprehensive sense is specially applicable to material cost standards. As a specific term, material cost must always refer only to the value of supplies from outside sources. On the other hand, material cost standards—where the product of one process is the raw material of the next, and where machines are assembled from manufactured components—may sometimes be preferably expressed in the wider sense.

Unit and Batch Costs.

Material costing by standards can be carried out in two alternative ways. A convenient distinction between them is that one, the batch method, is more applicable when output is not easily identifiable in units, while the other, the

unit method, can be used when units of output are distinguishable numerically. There can be no arbitrary demarcation. Generally speaking, where output can be numerically recorded cost standards are developed in terms of units; but where output is recorded in bulk, either by weight or volume, cost standards are developed for batch quantities.

Unit costing may be instanced as being practised at plants which machine metal components, assemble parts into machines, make knitted wear and garments, or carry out other analogous work. On the other hand, batch costing is suitable for use at chemical manufacturing, smelting, biscuit making, soap manufacturing, and similar plants. These examples only illustrate the predominance of one or the other method in a particular sphere. Both must almost inevitably be used when dealing with the products of any plant.

Where batch costing is used for the operations and processes of manufacturing, the final stages of preparation and packing can probably be more suitably treated by unit costing. Again, a machine shop—using unit costs—may be supplied with castings made by an allied foundry department where metal melting is subject to batch costing.

In the unit method, a material cost standard is derived from a specified quantity of specified materials at standard prices, with rebate for a specified quantity of surplus material at standard values, the calculations being made in terms of units of output.

In the batch method, a material cost standard is based upon a specified yield of processed material from a specified quantity of specified materials in accordance with a specified formula, with rebate for a specified quantity of by-products at standard values, the calculations being made in terms of weight or volume.

In both cases all specified data is obtained from standard material specifications. Therefore, specified and standard are synonymous terms in these definitions. Rebates and

yields involve full consideration of the permissibility of loss, waste, spoilage, and surplus. Allowances for all sources of material loss must be determined and accepted as standard for effective manufacturing under the predetermined conditions. Included in this conception of material loss are spoilage and defective work. It will be apparent that, as the cost of material includes its share of cost incurred prior to entering another process, these allowances must cover a considerable proportion of labour and overhead costs expended on manufacture before the stage of loss or rejection is reached.

Material losses and recoveries can be broadly placed in three categories—

1. Waste.
2. Spoilage and defective work.
3. Surplus and by-products.

This division, although capable of amplification, serves as a basis of analysis and of illustration, and shows how provision for the various contingencies is made in the material cost standard.

Standard Price.

Each variety of material—whether in raw, semi-fabricated, or finished condition—purchased from outside sources of supply must be given a standard price per unit of quantity for every grade, form, and size in which it exists.

These standard prices are revised periodically; the interval depends upon conditions peculiar to the industry, plant, materials, policy, and markets. It is essential, however, that there be consistency of treatment for the different materials, both with regard to general level of standard prices and to the procedure for their periodic revision.

Standard prices include all delivery, freight, and transport charges outside the boundaries of the plant. Prices are then on a strictly comparable basis, and cost control is facilitated.

Material cost standards are based upon standard prices for all material obtained from sources outside the plant and upon standard costs for all material converted or fabricated within the plant. Transferred material, work-in-progress, and output in stock are all valued at standard cost. Actual costs can, if desired at any time, be assessed within limits of accuracy by means of ratios for the various classifications of similar materials.

There will often be considerable discrepancies between actual purchase prices and the standard prices used for developing cost standards. This variation may preferably be controlled at time of purchase through a Purchases Cost Variation Account. When balanced, such an account will show either a gain or a loss on standard prices. The use of standard prices should reduce stores records and accounting, being particularly advantageous in cases where kinds of materials are numerous and issues are small in value.

Standard Specifications and Formulae.

Standard prices must, however, be associated with tangible quality standards. The necessity is evident. Actual prices vary with quality, and, unless quality requirements are standardized in writing, there is no means of reconciling actual and standard prices with the assurance that they are comparable. Not only must quality be specified by the responsible technicians, and purchases made against their instructions, but every care must be taken to ensure that all incoming material is in accordance with the specifications. Before being accepted into stores, all purchases should be inspected with special regard to all points covered by the technical specifications. A material specification must deal with every possible departure from relevant requirements, and should include not only details of size, form, kind, and constituents, but also of physical and chemical tests to be met, of inadmissibility of defects, and every other contingent condition.

Akin to the standard quality specification is the standard formula. In many manufacturing processes, products are evolved from constituent materials in certain definite proportions. When specified, the relative amounts of constituent materials are in the nature of a formula. Each material cited in the formula is covered by its individual quality specification. Thus the formula and specification are closely linked. The formula is based upon certain requirements from its constituents which the specification codifies.

Standard Quantity and Yield.

In the unit method of material costing, a standard quantity is the gross amount of a particular material necessary for making a product. The total of the standard amounts are incorporated in a quantity specification. The quantity specification also deals with any surplus or residues which may be expected.

Various other names, such as material schedule and bill of quantity, are sometimes given to quantity specification. It states full details of the standard quantities of the various kinds, forms, grades, and sizes of materials required for incorporation in a product. The quantities are gross and are each in accordance with a standard quality specification.

Standard yield applies particularly to the batch method of costing. It can be defined as the amount of finished product which should result from the processing of specified quantities of materials, and may be expressed as a percentage. Calculations for standard yield must be based on the use of relative quantities of materials in proportion to the standard formula and on the use of materials whose qualities are in accordance with the standard specifications.

Standard Allowance for Waste.

Material losses and recoveries have been categorized into three groups. One of these groups includes all those losses which can be termed waste. Some of the latter can

be accepted as legitimate cost for which provision must be made, while others must be regarded as excess cost.

In the unit method, waste refers to usage of material in excess of standard quantity. This cannot be accepted as legitimate cost, and is consequently not covered by an allowance. The standard quantity includes sufficient material for effective production without undue waste. If any material is spoilt by defective work or some similar cause, the loss comes under another category. Thus, in the unit method, there is no allowance for excess usage of material. A frequent cause of excess is the use of oversize materials on account of the sizes, specified as standard, being out of stock or otherwise unavailable.

In the batch method, waste is the adverse difference between standard yield and actual yield. This again is a source of unjustifiable loss and must be accepted as excess cost. The standard yield is calculated on lines which permit practical attainment, providing that the level of productive efficiency is reasonably high. Standard yield does include a small margin for contingency losses and thus differs from theoretical yield, which is the maximum calculated amount which could be obtained from the materials issued for processing. The margin for loss, then, is the difference between theoretical yield and standard yield.

Standard Allowance for Spoilt and Defective Work.

This category includes all loss sustained through the production of work which, at any stage of progress, fails to reach the required standard of product quality. A certain amount of spoilt and defective work is unavoidable under the best of conditions and most effective manufacture. The permissible proportion obviously must depend upon the peculiarities of the product, the method of production, and other variable factors.

A standard allowance is made to cover the cost of spoilt

and defective work. How and where this allowance shall have incidence for control purposes must be decided according to the particular circumstances. The basis of charge for the standard allowances may be product, department, process, plant, or any other convenient factor which may influence the permissible proportion.

Consideration must also be given to the value of rejected products. Sometimes they may be rectified at small cost. In almost every case they have a disposal value. Except in special instances, the returns from the value of rectified work at standard cost and of the scrap at standard price may be offset against the cost of spoilt and defective work. The balancing of standard costs of defective and spoilt work—less the credits for rectifications and scrap—against the standard allowances can be facilitated by the use of ratios.

Standard Recoveries for Surplus and Residues.

In both the unit and batch methods, the gross issue of materials at the commencement of an operation or process will usually produce a net finished product plus a surplus amount of material. This latter includes all classes of material covered by the general terms—by-products, surplus, residue, and so forth—in addition to specific descriptions peculiar to an industry. Standard recoveries must be calculated and expressed in quantity and in price. Failure to recover sufficient material to meet the standard involves waste and, consequently, excess cost.

In the unit method the standard recovery is expressed in terms of a single article. Whether given for the finished article only or whether analysed at each operation or stage of manufacture depends upon the duration and complexity of the work and upon the value of the materials. If the materials are sufficiently expensive and the constituent amounts vary in quantity between each stage of manufacture, then valuation of work in progress may necessitate

the determination of the standard quantity of material in any article at each operation, and, possibly, the corresponding standard recovery.

In the batch method the standard recovery can be stated as a percentage. It is calculated from the standard formula. There must be a definite connection between standard quantities, yield, and recoveries. In cases where all chemical and allied processes are involved, there will exist a theoretical basis against which standards can be determined.

Standard recoveries, as well as standard yields, include a margin for loss. They must be capable of being reached under predetermined conditions, and with a reasonably high standard of manufacturing and technical efficiency. If this margin is exceeded, the actual recovery of surplus and residues will be less than standard, and excess cost will occur.

CHAPTER VI

OVERHEAD COST STANDARDS

OVERHEAD costs can no longer be regarded as a mass of indirect charges without any connected relationship with performance and output, and which can be liquidated only through flat rates and percentages. On the contrary, overheads should be definitely related to the actual performance of specific services for the facilitation of production or to the maintenance of these specific services in a state of preparation for the supply of facilities. Within the activities of a plant are discernible a number of facilities, which, although possibly owned and maintained by the plant, could equally well be supplied from an outside source. An extension of this reasoning can easily conceive all the facilities as being provided by outside suppliers. While this analogy holds good for analytical purposes, however, it goes no farther. If facilities were actually thus obtained, cost would be in exact proportion to the amount of service consumed. In practice, of course, facilities must be frequently maintained in preparation for use. But facilities can be likened to services maintained for the purposes of production and consumed as required. Overhead costs are the expenses of maintaining and supplying these services. Consequently, they can be charged to output upon differential terms, which are as far as possible accurately related to value rendered.

Returning to the analogy between services supplied within the plant and from outside sources, the evident difference from the costing standpoint is that, in the former case, the expense of maintaining services in preparation for use only must be borne by the plant, while in the latter the charge against the plant is made in accordance with

amount consumed. Consequently, in order to calculate the bases of service charges, the amount of demand for service in relation to the maintained potentialities for supply must be the primary consideration. Here connection is made with productive capacity and plant utilization. Demand for service is indissolubly linked with output requirements from the plant and with potential capacity for the supply of service. To develop service cost standards, budgets must be prepared for the supply of those quantities of service which the plant will require when working at the predetermined measure of plant utilization.

Services.

Arbitrary definition cannot be made of the services into which production facilities are resolved. While certain services are common to all plants, others are either peculiar to individual circumstances or depend upon the development of functional organization. The primary conception of a service is that it might be rendered by an outside supplier. This is merely preliminary to the visualizing of a service as being in charge of an executive responsible for its efficiency. One fundamental of cost control is individual responsibility for expenditure. As a guiding principle, emphasis is thus placed on the necessity of making individual executives responsible only for those costs which they can actually control. The treatment of overhead charges as the cost of performing and maintaining specific services to production does enable their cost control to be based on individual responsibility. The cost of maintaining service in partial idleness owing to limited demand can be separated from the cost of actually performing or supplying. Although there must be an executive responsible for the working of each service, he can control, in practice, as many services as conditions necessitate. Services are functional. Control of a single service does not necessarily mean full-time work.

The principle simply implies analysis of duties and responsibilities, and their combination into a specific job. If the job is insufficient for one executive, he can be responsible for two or more. Thus, cost control of services against individual responsibility does not entail, or necessarily suggest, alterations in managerial organization. It merely stipulates a clearly defined allocation of responsibility. In most instances the number of services in a plant are so few and well demarcated that the problem does not present any difficulty

Cost responsibility may be likened to a contract for the supply of a certain quantity of service at a specified price per unit. If less than the quantity is taken, the cost per unit will rise, but the excess cost on this account cannot be accepted by the supplier of the service. On the other hand, if the cost exceeds the specified price on account of some inefficiency, then there is a loss on the contract, for which the supplier himself is liable.

Outline of Procedure for Developing Overhead Cost Standards.

The treatment of overhead costs is so interwoven with problems of plant capacity and output that the preparation of cost standards must be preceded by a full consideration of prospective conditions. Cost standards are based upon predetermined conditions, of which plant utilization is the most important. The following order of procedure, therefore, is quite logical—

1. To predetermine a measure of plant utilization for each work point, machine, and process. The predetermination may be arbitrary or may be evolved from a definite output programme based upon sales forecasts. The measures of plant utilization will be in terms of running hours.

2. To determine the quantities of services required to supply the work points, machines, and processes when working at their respective predetermined measures of utilization.

TYPICAL MANUFACTURING SERVICES

Service	Outline of Scope
Land and Buildings	The supply of all land and buildings
Productive Machinery	The supply of all machinery directly engaged in production
Auxiliary Machinery	The supply of all machinery used for purposes auxiliary to production
Tools	The supply and maintenance of all tools and equipment required for production
Power: Steam, Electric, Gas, Oil, Hydraulic, Pneumatic	The supply of all power required in the plant
Maintenance	The repairs and maintenance of all buildings, machinery, and tools
Heating	The supply of heating to all buildings
Cleaning	The maintenance of the plant in a state of cleanliness
Materials: Buying	The purchase of all materials
Storage	The receiving, storage, and issue of all materials
Works Transport	The movement of all materials within the plant
Administration and Management	The work of the administrative and managerial functions
Supervision	The work of the supervisory function
Inspection	The work of examining and inspecting the quality of production
Employment	The supply of facilities incidental to the employment of labour, i.e. training, movement, welfare, safety, and so forth

Notes

(*a*) The above list is suggestive only. The number and scope of services must actually be decided by the necessities of the particular plant. Several of the services given above can be either further subdivided or consolidated.

(*b*) The terms "supply" and "maintenance" as used above under Outline of Scope must not be taken too literally. They are merely indicative of the ground covered. The actual constituents must vary in accordance with circumstances.

3. To budget the costs for supplying the required quantities of service, with due regard both to the possible necessity for maintenance in partial idleness and to the occurrence of exceptional periodic demands. Each service budget may be visualized as a cost contract for the supply of the required quantity of service.

4. To develop hourly cost standards for work points, machines, and processes from information given by predetermined utilization, quantities of service, and cost budgets. In special instances, overhead cost standards may be developed for incidence upon materials.

5. To determine the due amount of overhead cost which should be included in the "all-in" standard cost of each product. It is derived from the hourly cost standards of the production centres, concerned in manufacture of the particular products, in conjunction with the rated performance standards. It also takes into account the overhead cost standards which may be based upon usage of materials.

The foregoing procedure is made effective by the existence of a sound technique for analysing and measuring activities, and for developing performance standards. As overhead costs are so largely a factor of time and output, the necessity will be appreciated for possessing accurate information concerning not only the potential productivities of machines and operators but also the amounts of services which are economically relative.

Predetermined Measures of Plant Utilization.

The productive capacity of a plant is classified into a number of processes, machines, and work points, each of which forms a recognizable production centre. For developing overhead cost standards, it is necessary to arrive at some agreed measure of utilization—in running hours—for each individual production centre. This predetermination may be based upon arbitrary assessment or evolved from an output programme.

If arbitrary assessment is the basis, the number of running hours for each production centre will be predetermined in accordance with normal expectations and previous experience. Prospective output is neither analysed nor scheduled in any detail. At the same time, general attention must be given to the related capacities of department and department, process and process, machine and machine, and so forth, in those cases where the nature of the output and manufacturing methods permit any balance of plant to be established. Special machinery and equipment laid down for seasonal and other intermittent work may be treated on similar lines. Arbitrary assessment, when carefully carried out, compares quite favourably with more complicated methods, and, indeed, has no alternative in many circumstances. Where manufacture depends upon contracts and direct orders, where the output is varied, where machinery is unrelated in type and function, or where manufacturing methods are not standardized, predetermination must necessarily be made by arbitrary assessment.

If an output programme forms the basis for predetermining the running hours of each production centre, production research and standardization must be well established and capable of providing detailed information concerning methods of work, potential capacities of machines and operators, and other relevant facts. The output also must be standardized in type and size. Briefly, procedure is along the following lines.

First, the output programme, which is based on sales forecasts, must give quantities, kinds, and sizes in analysed classes. Secondly, manufacturing methods and sequences must be scheduled with mention of the most suitable production centres for performing the work. Thirdly, the potential capacities in hourly output of the indicated production centres for each of the various kinds and sizes of articles must be determined for use as performance

standards. Fourthly, by means of the output programme, the production schedules, and the performance standards, a predetermined measure of utilization in running hours must be calculated for each production centre.

An output programme can be laid down with relative ease, providing that the products are standardized and that the sales demand is comparatively stable. The difficulties in arriving at output programmes increase with departure from these two conditions. If sales demand in actuality is almost an unknown quantity, then the technique of sales forecasting can provide a basis. This introduction obviously cannot be applied in many instances. Taken generally, the arbitrary method—without an output programme—must be adjudged to have the important advantages of simplicity and of broad scope. It has particular suitability in circumstances where previous records of output form a reliable guide. The case for using normal productive capacity as a basis for developing overhead cost standards is frequently advanced. It is claimed that so long as a plant is in competition with others having relatively less unused capacity and more modern equipment, that plant cannot expect to recover from its customers the cost of maintaining surplus capacity. Where competition is severe, the force of this argument cannot be denied. It is, however, but an extreme case of arbitrary predetermination, in which the predetermined measure of plant utilization coincides with the normal productive capacity.

In any case, the standard costs for producing output at full normal capacity should be available for reference purposes. The administrative and sales functions need to know the costs of producing at different levels of plant utilization as a guide for price-fixing. Such information can be provided by the use of flexible cost budgets. The business administration must decide the quantity of output which can be sold under the prospective trade

conditions. The plant will endeavour to produce this quantity of output as economically as possible and, therefore, cost standards are based upon this same output. From the standpoint of standard costing, prices are immaterial excepting in so far as their fixing may influence the predetermined level of plant utilization upon which cost standards are based. There appears to be no logical reason for using normal capacity for cost control purposes when the business administration has accepted a level lower than normal capacity as that attainable under the conditions of trade. Normal capacity has interest as a basis for computing minimum cost standards at which output can be produced by the particular plant.

The predetermined utilization must include reasonable provision for those hindrances and time losses which invariably occur in any manufacturing plant. When a machine or process stops producing, overhead cost is still being incurred. For control, the excess cost must be shown up. Yet a proportion must be accepted as legitimate for inclusion in the standard cost of a product. It is, in fact, an inefficiency allowance, for which some provision must be made in the predetermined plant utilization. Hourly overhead cost standards are developed for effective production under predetermined conditions, and, consequently, the predetermined running hours must include a reasonable margin for inefficiency. This margin varies in percentage with plant, machines, processes, and so forth, according to their special liability to hindrance.

Development of Service Standards.

Now that the prospective measure of activity for each work point, machine, and process has been expressed in terms of running hours, the required amount of services for the entire plant must be developed for the period under consideration. The quantity of service is built up both from a summation of the requirements of each

production centre and from the needs of the plant as a whole. Obviously, there are some services, or parts thereof, which vary directly with the demands made by the production centres—e.g. power and steam—while others are almost independent of such individual demand and are decided by the general activity of the plant as a whole. Again, other services do not vary in accordance with the demand from production centres. The supply of land and buildings, for example, is conceived as a service, but the quantity required does not vary in relation to the amount of use.

There are two interdependent aims in the measurement of services—

1. To compile the amount of each service which will be required to maintain the plant as a whole and to operate each production centre for its predetermined number of running hours.

2. To ascertain the quantities of the various applicable services which each production centre may be said to need or to consume during one running hour. Each service, then, must be expressed in some convenient unit of measurement which will permit equitable allocation.

Although some services receive supplies from others—e.g. the steam service includes transfers from buildings, management, and other services—the supply from each service to a production centre must be in terms of some common denominator or unit. These units vary not only with the service, but also with circumstances. Land and buildings can be in terms of square or cubic or superficial feet, electric power in kilowatts, mechanical power in horse-power, steam in pounds, personnel in numbers and grade, productive machinery in running hours, and so forth. The primary objective in predetermination of services is to ascertain quantities, analysed against production centres, in measures which have a clear and definite relationship with performance and with cost.

Budgetary Cost of Services.

In effect, a service contracts to supply to production centres at a certain price per unit. Although this price is based on the assumption that a predetermined quantity will be consumed, the price is not altered by a decreased demand from the production centres. The plant as a whole is responsible for the amount of service which is not required, i.e. it is excess cost due to unused capacity.

For each service there must be prepared a budget of the costs involved in supplying the predetermined requirements of all the production centres. As the scope of any particular service depends upon circumstances and conditions peculiar to each individual plant, the constituent costs of services cannot be comprehensively detailed.

As an example, a cost budget for the building service in a typical plant might include the following—

1. Charges for land.
2. Rent for buildings.
3. Depreciation.
4. Insurance.
5. Taxes.
6. Maintenance and repairs.
7. Heating buildings.
8. Lighting buildings.
9. Cleaning buildings.

Certain of these costs are annual charges, which are unlikely to vary. Thus, rent, depreciation, insurance, and taxes can be regarded generally as fixed expenditure. On the other hand, the last four charges may, as actual costs, vary appreciably from the budgeted figures. They are variable, and, consequently, need close control.

Again, if the plant generates its own electric power, the cost of lighting will be a transfer from the electric power service. Heating, maintenance, and cleaning also may be transfers from appropriate services or they may be charged direct to the building service. The choice of method is decided by the division of cost responsibility at the plant in question.

When completed, the total of the various cost budgets

will comprehensively cover the provision of sufficient services for maintaining and running the production centres at the predetermined measure of plant utilization. The sum of these service budgets corresponds with the overhead cost for running the plant under the same conditions.

It is now but one step further to develop costs per unit for each of the various services for the purposes of making transfers between the services and of charging service to the production centres. To develop a cost per unit of service, the budgeted cost of the service is divided by the quantity, in terms of the appropriate unit, which has been determined as necessary to meet the requirements of the production centres.

Development of Overhead Cost Standards for Production Centres.

The predetermined number of running hours for production centres will generally be based on the assumption that they must be spread uniformly over a year, accepting a year as the usual budgetary period. If production is of a seasonal or definitely incidental nature, the budgetary scheme must be adjusted to provide for the special circumstances. This refers, for example, to a plant which works for two or three months and then shuts down for the remainder of the year.

The development of cost standards per running hour is the logical consequence of regarding work points, machines, and processes as producers of output and consumers of service cost upon the basis of time.

There are, however, certain services which are not so much functions of production time as of consumed material. They can usually be collected as a material service. A cost budget is prepared and overhead cost standards developed in terms of suitable units for application to material handled or consumed. This special treatment of material service costs is not always necessary. Choice of

method must depend upon conditions operative in the particular plant.

If all the production centres worked for their predetermined number of running hours, the total overhead cost earned must equal the sum total of the service cost budgets—less the material service if based as a charge on materials.

Overhead Cost Standards and Product Standard Costs.

The product or "all-in" standard cost states how much each product should cost. Overhead costs constitute a large proportion of the total, and one which is ever increasing with the accelerated trend towards mechanization and specialization. The due amount of overhead costs for inclusion is calculated from the standard hourly outputs of the production centres in connection with their hourly overhead cost standards. Also, of course, any necessary addition is made for the due amount of the cost of any service charged on materials. For each kind and size of article produced for sale, then, the standard cost will show the overhead cost earned—or, it can be said, value produced—at each class of production centre through which the article in question should pass when following the most economical manufacturing sequence. By class of production centres is meant a number of like machines or work points, all of which are alternative to each other. Here it may be noted that any departure from the specified sequence, i.e. failure to use the most economical machines and methods, will be shown as excess cost.

Separation of Labour and Overhead Costs.

Sometimes labour costs are included with overheads to form a composite rate. This practice is rather to be deprecated. In fact, it is unsuitable for standard costing purposes. Overhead cost goes on when labour cost has ceased.

To combine them means either loss or complication of control. If a machine or process ceases to produce for a short period, say minutes, or even hours, the operator or team may also be compelled to wait, as there may be no other work immediately available. Then, admittedly, a composite rate does not interfere with control. But, far more often, the breakdown may last for hours or days, in which case labour will be transferred to other work. In these circumstances, the overhead cost is a loss, i.e. excess cost, but there is no excess labour cost. Here a composite rate would complicate control. Again, the cost of plant idleness does not include labour. It embraces only overhead costs, which are merely the monetary expression of services. Several other reasons can be advanced against the establishment of any definite unison between labour and overhead costs.

Material Service Costs.

Frequently, consumption of material service cannot equitably be connected with the running time of production centres. The material service is, in the main, concerned with storing and handling materials in both raw and semi-finished condition prior to their delivery into finished stock for sale. It should, in fact, be regarded as two services: works transport and storage. Works transport does actually supply the needs of production centres in some proportionate relation to their utilization. The amount of demand for works transport service depends upon the activity of the production centres. Therefore its cost can be incorporated in the hourly cost standards of the production centres.

On the other hand, the storage service will usually be related more closely to the actual usage of materials than to the running of machines and processes. The following are typical constituents of storage costs—

1. Charges for the use of stores buildings and equipment,

e.g. due proportion of buildings and auxiliary machinery services.

2. Insurance of materials held in storage.

3. Labour involved in receiving, handling within the stores, and issuing materials.

4. Management and supervision of stores work.

5. Services concerned in the receiving, storing, and handling of materials: e.g. electric power, refrigeration, compressed air, and so forth.

Unless the production centres are working continuously upon the same products, and are each reasonably consistent in their requirements of quantities and kinds of materials, there may be unfair distribution of cost if the storage service expenditure is treated on a basis of supply to production centres, and not as being absorbed by the materials for which the service primarily exists.

Following the conception of a service as being separable from the plant, the stores may be assumed to be located in a neighbouring building outside the boundaries. Then, logically, the charges for storage would vary with bulk and weight of materials, value, time of storage, and other similar factors, and would be based as differentials upon the various kinds, or rather classes, of materials. This stores service is assumed to contract for the reception, storage, and issue of a predetermined volume of material during the period under consideration. The differential prices charged upon the various classes of materials are obtained by equating the predetermined volume against the budgeted service costs, with due consideration to the characteristics of the classes and their influence upon cost.

Overhead Cost Standards and the Point Method.

There is now an alternative basis to running hours for the expression of overhead cost standards. They may be developed in terms of points.

As the converse of the definition on page 67, a point

may be regarded as a unit (one minute) definitely linked with the performance of a certain amount of work. Generally the cost standard will be based upon the performance of more than one point (i.e. unit of work) per minute. The fraction above unity depends upon the point hour established as performance standard, which, in turn, is decided in accordance with the governing circumstances (see page 58).

The use of points in connection with overhead costs, although somewhat of an innovation, seems to have distinct possibilities. There is no very real difference in developing standards upon a point basis than upon an hourly basis. But, for control, particularly in certain specifically favourable circumstances, the point method has several meritorious features.

Generalizing, it can be said that standard costing is based upon agreed groupings of productive processes, machines, and work points into a framework of departments. Cost control is formulated upon this framework.

The point method may be particularly suitable if—

1. A department consists of work points only (subject to limitations).

2. A department consists of a number of machines of such similarity that their running costs do not appreciably differ and always requiring approximately the same amount of manipulation and attention, irrespective of kind of output.

3. A department consists of a number of like processes whose running costs are similar and whose labour requirements do not vary with kind of output.

The subject is very involved, and problems arise immediately that there is any departure from the conditions outlined above. Obviously, if the labour points per hour —i.e. at standard performance—vary with the kind of product being manufactured at any specific machine, then the overhead cost per unit will not be uniform under all

circumstances. Again, more obviously, if the machines in a department are not of almost identical type and size, there must be a different cost per point for each machine. Unless circumstances are favourable, there is the necessity of having an overhead cost standard for each machine and for each kind of product turned out. This nullifies the advantages.

On handwork, however, where the points produced by an operator at a work point should not vary in accordance with the kind of product handled, there is no valid objection against the expression of overhead cost standards in terms of points. If, however, the hand workers are consuming services in a disproportionate manner, the method may prove unsuitable.

Stated briefly, the point method can be recommended where control can be exercised upon groups of production centres whose hourly running costs are reasonably uniform and which require a similar number of labour points per hour. But, with concessions towards approximation, the scope can be considerably extended.

CHAPTER VII

LABOUR COST CONTROL

AN examination of the causes of excess cost indicates that those for which labour itself may be deemed responsible are supplemented by many others over which it has no control whatsoever. The elimination of the latter is entirely advantageous to the enterprise in general, neither involving any adjustment or rearrangement in the existing balance between wages and output nor in any way interfering with the harmony of industrial relationship.

The Causes of Excess Cost.

1. **Failure to produce standard output due to causes within the control of operators.** Considered entirely from the standpoint of labour cost, this potential source of loss usually assumes its greatest importance when wage payment is made at hourly rates without any financial incentive. When, however, operators are running expensive machines and processes, there is every necessity to obtain maximum output during the working time in order to prevent excess overhead cost. On the other hand, if operators are not associated with machines and processes, and are working upon hand operations, this proviso does not hold good unless a department is so busy that all its work points are occupied and consequently the maximum individual output is required. Although labour cost standards are developed upon performance standards, there can be no serious reflection on any failure to attain the performance standard level, which, in keeping with the expressed conception of the meaning of a standard, presupposes production at model effectiveness. Actual performance should not, however, fall below standard performance plus an inefficiency allowance.

A performance standard refers specifically to the work of an operator as distinct from the output of a machine or process and is governed partly by the method of labour remuneration. It is based upon one hundred per cent

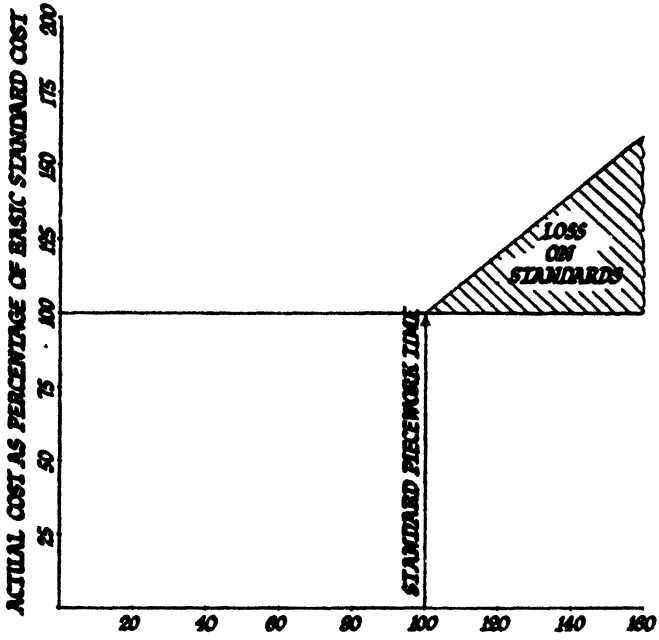


Diagram showing Fluctuations in Actual Cost with Time Taken in Performing Work under Piecework with Guaranteed Hourly Wage.

FIG. 4

effectiveness of production under the particular conditions of equilibrium existing between labour remuneration and output. Effectiveness covers skill of operator, experience at job, condition of machinery and equipment, availability of supplies, and all other contributory factors. The basic standard cost is developed from this performance standard.

For example, under day work conditions, the performance

standard for an operator may be regarded as the amount of work accepted as equivalent in value to his guaranteed rate of pay and produced under conditions which provide that he is skilled at the class of work, has had sufficient experience

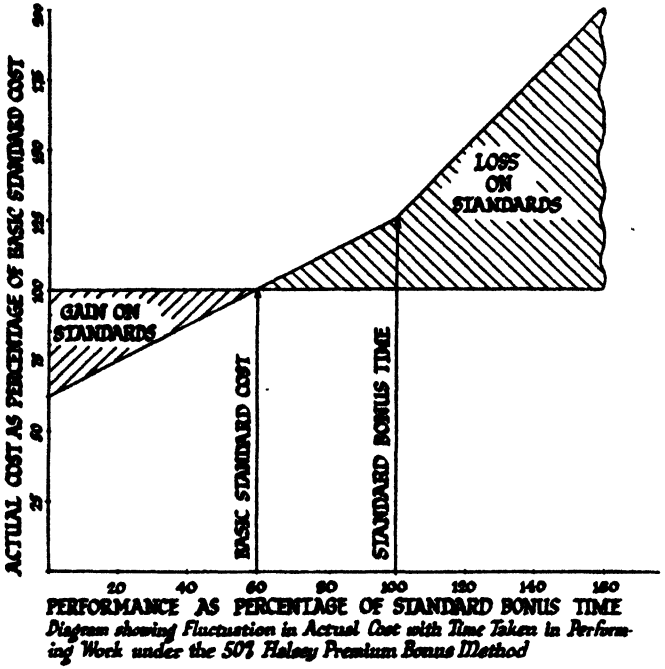


Diagram showing Fluctuation in Actual Cost with Time Taken in Performing Work under the 50% Halsey Premium Bonus Method

FIG. 5

at the particular job, has efficient equipment and suitable materials, and is entirely free from hindrances.

Even if such conditions could be maintained—an obvious impossibility in practice—actual performance would fall below standard on account of faults of the operators themselves. This excess cost comes under the classification of failure to produce standard output due to causes within the control of operators.

The inefficiency allowance—i.e. permissible variation

from basic cost standard—will include some provision for this failure to produce standard output. Obviously, the nearer the actual performance approaches to the standard performance the more effectively production is being conducted. Each plant or department can set a level

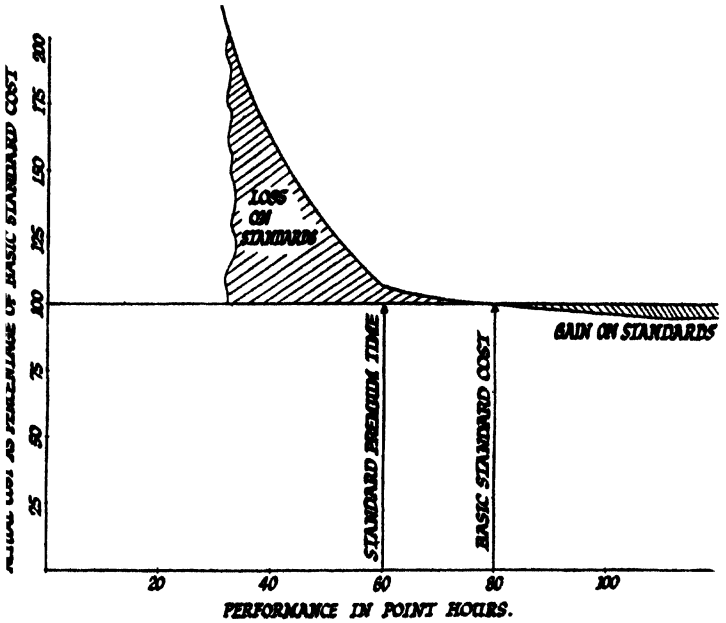


Diagram Showing Fluctuation in Actual Cost with Time Taken in Performing Work under the 75% Point Hour Method of Incentive Payment

FIG. 6

between the two limits which will form a practical index of achievement. This difference between standard output and this index will form the inefficiency allowance on account of failure of operators to produce standard output. The level of this index is decided (in plants where some form of payment by results is installed) by the extent to which operators avail themselves of the opportunity to earn premium. The average individual output of operators in

the same group or department will generally be found to be fairly constant over periods, although occasionally subject to temporary fluctuations.

In cases where economic reasons necessitate securing standard output on account of the overhead charges incurred in running costly machines and processes, some special concession other than financial incentive must be granted to operators. For example, it may be found more effective to give periods of rest and relief instead of a portion of the bonus payment.

The point being stressed is that it is not necessarily advisable to leave the securing of maximum output from expensive machines to the voluntary desire of operators to earn high premium. If such a problem does exist anywhere in a plant, it is well to remember that the overhead running costs of machines and processes usually greatly exceed the corresponding cost of operators and teams, and that it may be actual economy to increase the quota of labour.

2. **Failure to produce standard output due neither to causes within the control of the operators nor to any breakdown in the flow of production or supply of facilities.** Operators may fail to attain the level of standard performance on account of reasons other than lack of desire to make high bonus earnings, idleness, or inefficiency.

They may be insufficiently experienced at the particular work on which engaged, they may be learning to use an unfamiliar machine, they may have been advanced to another grade of job, or they may have recently been transferred from another department. All of these factors, besides several others, tend to cause a lower level of efficiency than would be existent if there were no problems of selection, training, and transference. The maintenance of excess costs of this nature at their minimum may be the duty of a special function known as the labour control or employment or personnel department. In many plants,

careful attention to such losses will not only secure economies by the reduction of excess cost, but will also give satisfaction to the operators, in so far that they will be expected only to reach standard output under conditions and upon jobs to which they are thoroughly accustomed.

3. **Failure to produce standard output due to breakdowns either in the flow of production or the supply of facilities.** Losses of this character include hindrances caused by waiting for materials, instructions, setters and adjusters, tools, repairs to machines and belts, electric power, and other similar interruptions incidental to manufacturing activities. In most cases the losses can without difficulty be analysed under their various causes if the period of each wait and its reason are recorded in every instance. While the management and supervision will be responsible for a certain proportion of these losses, the remainder, over which they cannot exercise any control, must be allocated against the functions actually responsible for their occurrence. It is axiomatic that a production department shall be charged only with such excess costs as lay within its power either to increase or decrease. Then, the amount, or rather the absence, of excess costs allocated against a department will be a real criterion of effective running on economical lines. The existence of considerable losses on account of interruptions to production may possibly indicate a necessity for changes in organization. It might suggest that economy would be effected by the institution of a planning function, or, on the contrary, it might tend to show that the existing planning was unsuitable on account of over elaboration or lack of practical knowledge. It might indicate that more methodical inspection of machines and equipment was necessary. These and many other possibilities may be revealed by analytical investigation into amounts, locations, and causes of excess cost due to interruptions to production.

4. **Failure to use operators with wage rates specified as**

standard for the work upon which they are engaged. Excess cost of this category implies that an undue proportion of higher grade operators is being employed in a department or plant. This may, however, be a temporary situation caused by the irregular occurrence of work requiring a disproportionate amount of lower-rated operators. To avoid excess cost of this nature, every effort must be made to utilize the grades of operators specified as standard for the different jobs and operations. Obviously, in practice, it is impossible to adhere with rigidity to the placement of operators in their specified grades. The aim should be to maintain a working force of operators with grades admixed in the proportion which will most economically fulfil the normal requirements of the plant and its output. There must also be, however, a proviso which stipulates the maintenance of a larger proportion of the higher grade operators to deal with unforeseen contingencies than would be needed under average conditions. This presupposes that a higher grade operator will be capable of carrying out efficiently more than one job of a lower grade. The system of wage rates adjustment between grades, sexes, ages, and other contributory factors, however, influences the problem to such an extent that any arbitrary practice on general lines is impossible. It can, however, be said that the greater the variety in job classifications and wage rates, the more economies are likely to be secured by some function empowered to regulate the employment and placement of operators. By such means, not only can a general view of potential requirements of the different grades be obtained, but the working force can be distributed throughout the plant in the most economical manner.

5. **Failure to use the methods, lay-outs, and machines specified as the standard means of manufacturing in the plant.** As the standard methods have been selected as the most economical of those available under predetermined conditions, any departure by using alternatives, however

suitable secondarily, will result in excess cost. Failure to use standard methods is mainly due to temporary excess of demand for output over productive capacity at certain production centres, which results in the transfer of the work to other production centres less economically capable of dealing with it. The causes include fluctuations in sales demand, absence of effective planning, and breakdowns in machines and equipment. Although the possible scope of departure is very wide, and can vary from a case of the manufacture of an alternative product—for which materials, lay-out, and methods differ—to a case of the use of an alternative production centre for carrying out some specified operation, the labour cost control can cover only the use of alternative methods within the limits perhaps of a department. If definite alternatives are scheduled, the losses caused by using the more costly method are outside the field of labour cost control which should deal only with any excess cost due to inefficiencies in manufacturing by an alternative method as obtained by comparing actual against standard performance for that alternative.

In a more general way, however, where alternative methods are not specified, but where standard methods cannot be used for temporary periods, the excess cost can be included under labour cost control. The fact, nevertheless, must not be lost sight of that a more costly manufacturing method will often show a lower labour cost, the adverse balance being made up on overhead charges.

6. **Failure to produce output in economical quantities, i.e. short runs of work, unbalanced processes, and other similar departures from the standard lots and batches, laid down as being the most economical under predetermined conditions of manufacture. Each change of work at a production centre entails a certain loss of output.** In processes and on machines considerable time will often be required to make a change which may include a variety of operations, such as setting, altering, and cleaning. At a work

point, a change of work will usually involve some loss of output, as benches must be cleared, tools and supplies changed, materials obtained, and instructions received. Besides these tangible losses, however, there are the psychological effects of changed work and the possibility of the operator having less immediate skill and knowledge of his fresh job. As cost standards to cover changes in work will have been developed, a comparison of the actual cost of changes against the sum total of standard cost over a corresponding period and output will show the amount of excess cost. While losses of this character are more or less inevitable if the sales demand falls below forecasted volume, there is every necessity to scrutinize them individually, as the possibility always exists that more effective planning may reduce them considerably. Conversely, if the sales demand is good there should be no tendency to incur excess cost. When lots and batches are larger than those set as standard, the proportion of changes should fall correspondingly. Therefore, in this last case, if excess cost does occur, there is every indication of some inefficiency.

7. **Failure to avoid the working of overtime when the demand for output is within the productive capacity of the plant.** Unless an order is undertaken with the promise of execution in a limited time at a special price, or unless the productive capacity, either in general or in some particular, is exceeded by the demand for output, all overtime payment must be regarded as an excess cost. The responsibility for incurrence may rest with any of the following: planning function, general production management, departmental managers and executives, material service, maintenance service, and several other functions. Equally, the responsibility may be shared between two or more of them. It is well to bear in mind that any additional cost of overtime payment may be amply compensated by a saving in overhead charges when overtime is worked on account of a long

run demand for output exceeding the potential productive capacity during normal working hours. Besides the saving in production cost, the necessity for additional plant will have been at least temporarily obviated.

8. **Failure to provide sufficient productive (i.e. profitable) employment for the working force of direct and indirect operators.** With the most efficient organization of production, and with general coincidence and agreement of actual output requirements with the forecasted output, there must be a surplus of operators for whom directly productive work cannot be found. The existence of such a surplus is essential. It forms a reserve for the supply of additional operators, for filling gaps caused by sickness and holidays, and for other similar contingencies. Every industrial enterprise, desiring to maintain harmonious relations with its employees, wishes to avoid labour turnover and to provide employment for a full working week. With this objective in view, and with the necessity for securing economical manufacture and competitive costs, the normal working force must be kept at a minimum level. The reserve of operators must as far as possible be found remunerative work about the plant. One of the principal justifications for a planning function is the organization of demand for output in such a way that, as far as possible, steady employment shall be given to the working force. Otherwise there are two costly alternatives to be faced—

1. The employment of surplus labour.
2. The existence of a high labour turnover.

The excess cost of the first alternative comes into the category now being considered, while the excess cost due to high labour turnover can be partly shown under those categories of excess cost, which refer to the failure of operators to produce standard output. A high labour turnover, however, also causes inefficiencies which cannot be analysed in terms of cost. It results in industrial disharmony, which lowers the general level of manufacturing efficiency.

Mechanism of Control.

Organization of costing method and routine must be formulated to suit the plant and its activities. There can be no arbitrary system of cost accounts for general application. Control is exercised through a series of cost statements, issued daily and (or) weekly, which show excess costs analytically and comparatively. These statements, broadly, are based on—

1. The department: indicating in detail the daily or weekly position of production centres individually or in groups. Locations and causes of all losses within the jurisdiction of departmental management and supervision are given in terms of excess cost.

2. The plant: giving a broad picture in perspective of the comparative states of efficiency in the various departments. The information should be drawn up in such a way that the chief production manager can without difficulty visualize the general position.

As much use as possible must be made of any common units of performance, such as minutes, hours, work units, and so forth. By this means, advantage can be made of ratios and percentages not only for giving clear and lucid expression to the cost information, but also for the facilitation of routine clerical work.

CHAPTER VIII

MATERIAL COST CONTROL

To be effective, the cost control of materials should be drawn up on the lines which will most clearly portray not only the amount of excess cost, but also its sources and causes. From the standpoint of direct practical utility, the two latter points are manifestly of greater importance than the former. By merely recording the existence of losses, cost accountancy can never really justify itself. Its activities must be dynamic in so far that they search out all the causes of loss and present them in the form most suitable for the plant and organization concerned.

Primarily, sources of excess cost may be classified into—

1. Price variation, due to the purchase of materials at prices in excess of those laid down as standard.

2. Usage variation, due to the actual amounts of waste and spoilage of materials and work-in-progress being in excess of those laid down as standard.

3. Variation in surplus and by-products, due to the actual recoveries being less than the amounts laid down as standard.

To give such information, control accounts must be built upon a dual formation—

1. A series of classes of like materials in which the variations in purchases cost may be shown: these deal with material excess cost before manufacture commences; and

2. A series of classes of manufacturing activities which are judged to represent the most suitable bases of returns of waste, spoilage, and recoveries; these deal with material excess costs incurred during the course of manufacture.

Price Variation.

By adjusting the actual price paid for all materials at the time of purchase to the standard price, all materials will stand in stores at a valuation of standard price, and, therefore, issues from stores may be charged at a cost equivalent to the standard purchase price. Over each period, then, there will be either a gain or loss on material purchases. In practice, for control purposes, the materials used in a plant will be classified in certain groups and the gain or loss on each group indicated periodically. This enables the actual cost of any particular kind of material to be found with approximate accuracy by imposing a correction factor upon the standard price of the material in question. This correction factor will be the ratio—

$$\frac{\text{Actual cost of all purchases}}{\text{Equivalent value at standard prices}}$$

A correction factor can be calculated for each classified group.

If market prices are lower than standard, the correction factor will be less than unity, and there will be a gain on purchases. On the other hand, if market prices exceed standard, the correction factor will be above unity and there will be a loss on purchases. The correction factor should preferably be expressed as a decimal.

The material classifications should, as far as possible, be drawn up with a view to including together in the same group all those materials which contain, in a large proportion, one common basic constituent. Then, it may be reasonably expected that the market prices of the various materials in any one group will fluctuate together in a greater or less degree according to the rise or fall in price of the basic constituent which they have in common. By basic constituent is meant some commodity, such as copper, rubber, wheat, or cotton. In practice, of course, each of these will probably be particular to one industry, and it

will be necessary to amplify the classification of material groups beyond such commodities, and to subdivide according to proportions, combinations, and stages of preparation in which they may exist.

Standard prices include all costs of delivery to the plant. By this means any specially high carriage charges on account of small orders, "rush" deliveries, and other similar causes will not only be shown up as excess cost, but, in the event of actual costs (by approximation) being required, they will be spread over all purchases included in the particular classification.

There can be no legitimate justification for including special delivery cost in the cost of the particular material on which it was incurred. Rather should it be treated as an excess cost to be charged against all the materials in the appropriate classification. Standard prices are based on the use of the most economical means of transport consistent with the buying policy, and, where considered necessary, with due allowance for a proportion of "rush" orders.

Usage Variation.

Excess cost on account of waste and spoilage can be said to be mainly attributable to—

1. Peculiarities of materials.
2. Peculiarities of process: i.e. conversion from material to product.
3. Peculiarities of product.

Therefore the control accounts can be framed upon those bases which seem to be most nearly related to the various activities of the plant. If necessary, a combination of the alternatives can be used, the appropriate one being selected in each case to suit the special circumstances. If certain materials in general use are markedly subject to waste or spoilage, it may be desirable to base control upon their usage throughout the plant. But if material loss varies

according to the process or operation through which the material goes, control should be based on the process or group of processes rather than upon the material. Again, however, losses may not be associated directly with either material or process, and they may tend to be governed by the kind of product which is being manufactured. For example, if some products are made to meet more stringent quality standards than others, the standard allowance for spoilage should be higher.

It is convenient to consider separately the unit and batch methods of material costing.

Control of Waste and Spoilage in the Unit Method.

As regards the unit method, both waste and spoilage can usually be controlled very effectively on the basis of different materials. Possibly the classification of materials used for controlling purchase variation may be suitable. Control upon a departmental basis, however, has its merits, particularly if several departments are engaged upon similar work. Interesting comparison can then be made between relative departmental efficiencies from the standpoint of economy in material usage and quality of work.

Standard loss allowances for all materials used in production are made when developing standard costs for the various products. For facilitation of calculations, these losses can often be conveniently expressed as percentages of the standard material quantities. There will, then, for each article manufactured, be a permissible loss for each constituent material used in its production. Therefore to ascertain how successfully waste and spoilage are being kept down over any given period, all that is necessary is to compare actual losses against the sum total allowances for the output produced during that period. But it is usually necessary to analyse losses more fully. Take a simple illustration.

No. 1 Department is carrying out a range of operations upon materials classified as A–B–C–D–E.

Department No. 2 is carrying out a range of different operations upon materials classified as A–B–C–D–E.

In this instance material losses can be controlled upon departments or upon material classifications. The first alternative requires two statements only, while the latter necessitates five. Again, if materials are relatively valuable, control may be exercised upon each material in both departments. Sometimes, also, the departments may be handling various ranges of products, and it may be considered preferable to ascertain losses incurred in the manufacture of each range of products

But, generally, with some exceptions, it may be said that control of material losses should be based on the department. Particularly does this apply when dealing with spoilage and defective work where knowledge of location of excess losses is most important. Spoilage is of immediate interest to supervisors and managers, and should, therefore, be analysed against departments. When necessary, losses can be further analysed between material classifications or products.

Control of Waste and Spoilage in the Batch Method.

Where the batch method of material costing is applicable, and where output can be stated in terms of percentage yields, control is very much facilitated. In contrast to the unit method, which usually deals with a large diversity of articles and operations, the batch method mainly applies to processes turning out a limited range of products in considerable quantities, the products also being of such a character that they can be expressed in common units.

Control can be exercised over—

1. Material classification; or
2. Groups of processes; or
3. Individual processes.

For preference, the individual process constitutes the most suitable basis. In practice, provided that the output is reasonably standard—a condition usually fulfilled in process manufacture—this procedure does not present any undue difficulty. If a number of production centres are each carrying out a similar process, control should be exercised upon the individual production centre in order that their relative efficiencies in material processing may be indicated. Here an important dissimilarity between unit and batch methods of material costing is illustrated. Obviously, it is impracticable to calculate material usage and losses upon the basis of the individual production centre in cases where any variety of articles is being produced. Therefore, in general, it may be said that the batch method, owing to the fact that it usually deals with processes producing on a comparatively large scale, enables far closer control to be maintained upon material usage than if the characteristics of the plant and products are such as to require the adoption of the unit method.

Factors Influencing the Control of Material Usage.

The degree of accuracy or of approximation to be followed can be decided only by considering each individual case in relation to its particular circumstances. There are certain factors which impose economic limitations upon the scope of analytical control—

1. The variety and range of products manufactured, i.e. whether they are standard or non-standard.

2. The proportion which waste bears to total material usage.

3. The comparative value of materials used, i.e. whether materials are relatively costly.

4. The difficulties involved in obtaining particulars of actual material usage at individual machines, processes, and departments.

5. The clerical cost of compiling the information.

If the variety of products manufactured is limited and if output is on a reasonably large scale, there is obviously greater necessity for, and also practicability of, maintaining a close check on actual material usage. Again, obviously, the necessity for control increases and decreases relatively with the value of the materials and the proportion which waste bears to the total material usage.

Causes of Excess Waste and Spoilage.

Of equal importance to the location of material losses is the analysis of causes. While it is often impossible to allocate excess costs with exactitude, there are certain primary causes which will form a suitable classification for analytical purposes—

1. **Equipment.** Work may be produced upon machines other than those specified for the work and which are not entirely satisfactory. Again, machines may not be maintained at their requisite state of working efficiency or there may be some defect in the supply of essential services. Inaccurate machinery is a frequent and expensive cause of defective work. In some forms of process work, breakdowns to both production and auxiliary equipment may cause heavy material losses, particularly in cases where the process is carried out in accordance with a definite time schedule.

2. **Operators and Workmanship.** There is perhaps rather a tendency to attribute an undue amount of blame in this direction. While losses may indeed be caused by carelessness, lack of skill, and incompetence, the proportion is not so considerable as frequently believed. Besides the faults committed by machine and process operators, bad setting and adjusting may also cause excess waste and defective work.

3. **Supervision.** Although operators may be directly responsible for bad work due to carelessness and other

reasons, supervision itself is not free from responsibility. Quality supervision is one of their most important duties, particularly in cases where work is being accelerated by methods of payment by results. Another cause of waste and spoilage is working to incorrect instructions given by supervisors who may themselves be in error or who may be merely passing along the mistakes of those higher in the chain of responsibility.

4. **Inspection.** Waste and defective work may sometimes be caused by the failure of the inspection department to reject work in progress at some earlier stage. It may be false economy to pass work in progress in the hope that it may turn out acceptable at the final stages. Without good reason, there should be no departure from quality standards.

5. **Conditions.** Loss on account of adverse conditions may be due to atmospheric difficulties, bad lighting, insufficient heating of buildings during cold periods, and similar causes. These sources of loss are usually not very obvious and often can be detected only by the researches of scientific observers.

6. **Materials.** The use of inferior grade materials is probably the most fruitful of all causes of loss. Their issue may be due to bad inspection of purchases before acceptance into stores, deterioration during storage, or to the intentional use of materials other than specified. The latter may either be of a lower grade or some alternative substitute which does not prove satisfactory.

CHAPTER IX

COST CONTROL OF PRODUCTION DEPARTMENTS

THE manufacturing activities of a plant can be divided into two categories, service and production. These categories are fundamental to cost control by responsibility.

Service covers the supply of facilities for production purposes.

Production covers the utilization of material, labour, and service in the course of manufacturing.

While final allocation of responsibility must be guided by the actual method of organization existing within the plant, analysis of all manufacturing activities between service and production is an essential preliminary to any careful demarcation of executive authority and responsibility. That executive authority is organized on departmental rather than on functional lines does not debar this method of approach. While the chief production manager may be responsible for the effective utilization of material, labour, and facilities, he may also be in charge of some of the service departments which provide the facilities for production. Again, although certain responsibility for production can be delegated to departmental executives, the settlement of general problems rests within the authority of the chief production manager. Consequently only those production costs which a departmental manager can directly influence should be included within the scope of his cost responsibility.

If all excess cost incurred in manufacturing which cannot be equitably charged against any individual department is analysed functionally, even although there are no executives responsible for the control of such functions, there is a possibility that the magnitude of certain of the

losses might justify the creation of functional executives. Unless actual costs are compared against accurately developed standards, there is no possible chance of knowing the amount of loss. The further analysis of the excess cost with a view to ascertaining causes will reveal where the losses are being made. It is not, however, easy to allocate responsibility for excess cost. Quite a large proportion of loss will be outside the control of departmental executives and can then only be allocated as a general production charge. If the general excess cost due to some special cause is sufficiently high, there would be concrete evidence for the necessity of the appointment of some functional executive to deal with the problem—e.g. waiting due to uneven flow of work between production centres and departments might indicate the need for organized planning.

The Production Department.

Boundaries having been set to the field of activities covered by production departments, an individual department itself can be simply defined as a group of production centres whose direct activities are controlled by a production executive. Value of output, number of operators, variety of operations, and all the many other variables are, in general, not relevant to any broad definition.

A production executive—manager or supervisor—can be held responsible only for process inefficiency and, furthermore, only that process inefficiency which lies within his power to avoid. Thus, he is responsible for any excessive use of steam for manufacturing purposes, but not for the high cost of steam due to its inefficient production. This last statement may seem a truism, but there are many systems of cost control which charge a department with its use of the various services at actual cost. The fact that steam, or any other service, costs more than it should do cannot concern the user in any way whatsoever. Again,

plant utilization is entirely outside the scope of the departmental manager. Therefore, all departmental costs are adjusted for any failure to attain the predetermined level of plant utilization before appraisal on the score of process efficiency.

Briefly, a manager is regarded as being responsible for the efficiency of production within his sphere of influence. He cannot be held responsible for losses contingent upon inefficiencies in related departments, for any failings in the supply of service, and for the inability of the sales organization to provide sufficient work for his production centres.

Department cost control, then, must cover all excess cost which comes within the scope of executive responsibility. As the sphere of influence of a departmental executive varies not only between different plants and enterprises, but also between departments within a plant itself, so those excess costs to be included for departmental control will correspondingly vary. They may, however, be grouped under four headings—

1. Excess material cost due to those losses of waste, defective work, and low recoveries of by-products for which the production executive is responsible.

2. Excess labour cost due to all those losses, the control of which comes within the duties of the production executive, e.g. output below standard, certain overtime, and other similar charges.

3. Excess overhead cost due to losses incurred by the low output of production centres on account of inefficiency or hindrances within the control of the production executive.

4. Excess service cost caused by undue use of the various facilities and services supplied to the production centres.

Under normal conditions, the manager in charge of a production department will usually be responsible for the general effectiveness of the production centres within his location. He has to utilize available labour, materials, machines, and services in the manner which will most

economically meet the output requirements. Sometimes, functional organization will relieve him of certain duties. Sometimes, on the contrary, his responsibility may stretch beyond the confines of his particular department. So long, however, as the production department is treated as a definite unit for assessing production efficiency as distinct from service efficiency, practice will be in accordance with one of the main principles of standard costing.

Production Centres and Overhead Costs.

It has been assumed that the engagement of a production centre for one hour involves one hour of labour cost and one hour of overhead cost (i.e. the sum of various services needed for one hour).

Now consider the circumstances which are likely to arise over a reasonably long period of time. A production centre may be—

1. Producing more efficiently than the performance upon which standard costs are based.
2. Producing less efficiently than the performance upon which standard costs are based.
3. Idle owing to some short and temporary hindrance.
4. Idle for some considerable period owing to breakdown.
5. Idle owing to shortage of work.

Completely ignoring labour cost, the hourly overhead standard cost will clearly not be identical in each of the cases mentioned above. In order to visualize the possibilities of variation, it is necessary again to consider how overhead costs fluctuate in relation to plant utilization and output (see page 39).

Taking the first and second cases, where the production centre is producing more or less efficiently, it is quite reasonable to assume that the hourly running cost does not differ. This reasoning is compatible with the conception of the supply of services to production centres. Suppose a production centre must turn out 100 units of output

per hour to produce at standard cost, and also assume that its standard overhead cost is 20s. per hour. Then, if the production centre turns out, say, 90 or 110 units, there should be an inappreciable difference only in overhead cost per hour in the cases both of the higher and lower output. This is, of course, a generalization only, being subject to exceptions where utilization of service bears some direct proportion to output.

The third case covers the cessation of production on account of some temporary hindrance or breakdown. Here, again, subject to exception, the overhead cost being incurred will not diminish to any appreciable extent during this cessation of work. For a short period of, say, a few hours, the supply services cannot be reduced. They must be maintained in readiness to meet requirements promptly. There are very few elements of cost in any service which will prove sensitive to a fall off in demand. Accordingly, the overhead standard cost used for calculating the cost of hindrances and breakdowns may be the same as that used in the first two cases, i.e. the basic hourly cost developed from the sales forecast, the output programme, and the cost budget. If circumstances necessitate, an hourly waiting cost could be developed.

In the fourth case, breakdown causes the production centre to be idle. The cost of idleness is governed by the position of the production centre in relation to the demand for its output and to the availability either of similar production centres or economical alternative methods of manufacturing. If the demand for output can be met easily with a low measure of plant utilization, i.e. the production centre is required to run for a comparatively few hours only, the time lost by the breakdown can probably be regained without difficulty. In which circumstances the hindrance time causes no overhead losses. But, if the breakdown necessitates the use of less economical alternatives, there is a loss due to the additional cost of manufacture. In this

instance the overhead cost of the idle production centre can be disregarded. On the contrary, however, if demand for output from the particular production centre is sufficiently large to necessitate its working as nearly full time as possible, and if also there is no suitable alternative, there will be a definite loss of overhead cost in the event of breakdown. The cost of breakdown may be assessed at the hourly basic cost or at some lower hourly cost, decision depending upon the kind and size of production centre and process, and to what extent service costs are reduced by cessation of production.

The fifth case refers to the idleness of a production centre on account of shortage of work. By shortage of work is meant any adverse difference between predetermined and actual plant utilization due to failure of the sales forecast to materialize. Overhead costs can be divided into a range of classes according to their relative tendencies to vary in proportion with output. At one end of the range is the class which includes those fixed overhead charges which are independent and invariable with output. At the other end is the class which covers any costs which should fluctuate in direct proportion with output. To absorb the overhead costs, assuming either a state of 100 per cent manufacturing effectiveness or the elimination of excess cost on this score, it will be necessary for the plant to work at its predetermined measure of activity as determined from the sales forecast. The "all-in" standard costs for the various sales products have been developed upon this hypothesis. Therefore, if the volume and variety of sales do not reach expectations, the total overhead costs cannot be recovered. The amount of the loss depends upon the extent of the difference between actual and predetermined plant utilization and upon the relative proportions and variability ratios of the overhead cost classes. The result, then, of the idleness of production centres on account of shortage of work is an amount of excess cost over which

manufacturing management has no control whatever. Strict demarcation between the excess costs of manufacturing efficiency and of low sales demand is one of the essential principles of standard costing.

The foregoing consideration of the conditions under which a production centre may be working and of their influence upon overhead costs may serve to indicate the groundwork of overhead cost control. The analysis of excess overhead cost as regards detailed method depends entirely upon the lay-out of the cost budget, classification of variable costs, organization of services, and many other factors

Illustrative Example of Evolution of Cost Responsibility.

Case. Assume that a manufacturing department contains sixty small machines, each hand-operated by a semi-skilled operative. The machines are similar in size and type.

An hourly cost rate has been computed for universal application to each machine. These machine rates are intended to cover wages, departmental overhead costs, and a proportionate share of the plant overhead costs. An hourly output of each kind and size of article processed by the machines has been determined for use as a measure of standard efficiency. Periodically, say weekly, information of actual cost under certain headings is available.

Hourly machine rate	2s. 6d.
Predetermined utilization of each machine	40 hours weekly
Total predetermined utilization for all the machines	2,400 ,,

Specimen accounts are outlined on page 124 with a view to indicating trends of changes which permit increasingly accurate observations of cost responsibility to be made available.

This cost statement affords neither any explanation of, nor guide to, the reasons for the loss.

Obviously, the first step must be the separation of cost of failure to obtain standard output from the machines and of cost of low machine utilization due to shortage of

FIRST STAGE—

Weekly Cost Control Statement

	£		£
Direct labour	100	Value of output equivalent to 1,600 machine hours at 2s. 6d. per hr.	200
Indirect labour	25		
Electric power	5		
Steam	10	Balance: loss on week's output	62
Machine maintenance	2		
Departmental overheads	30		
Plant overheads	90		
	£262		£262

work. For this purpose machine-working times, inclusive of stops and hindrances, must be recorded.

SECOND STAGE—

Actual machine hours	1,800
Machine hours in which output should be produced at standard efficiency	1,680
Machine hours at predetermined utilization	2,400

Weekly Cost Control Statement

	£		£
Direct labour	105	Value of output equivalent to 1,680 machine hours at 2s. 6d. per hr.	210
Indirect labour	30		
Electric power	6		
Steam	12	Loss due to failure to obtain standard output	15
Machine maintenance	5		
Departmental overheads	30	Loss due to low machine utilization	30
Plant overheads	90		
		Balance: unexplained loss	23
	£278		£278

Note. The loss due to failure of machines to obtain standard output during working hours is given by—

$$\text{(Actual - standard) machine hours} \times \text{machine rate}$$
$$= (1800 - 1680) \times 2\text{s. } 6\text{d.}$$
$$= £15$$

The loss due to low machine utilization on account of shortage of work is given by—

$$\text{Overhead cost} \times \left(\frac{\text{predetermined} - \text{actual}}{\text{predetermined}}\right) \text{machine hours}$$

$$= £120 \times \left(\frac{2400 - 1800}{2400}\right)$$

$$= £30$$

It will be observed that there is still an unexplained loss of £23, which is connected neither with low machine utilization due to shortage of work nor with failure of machines to obtain standard output. Clearly this loss must be due to some defect in labour utilization, and, therefore, improved control is effected by the separation of labour costs from the machine rate and by the use of a definite hourly wage rate.

Also, part of the failure of machines to produce standard output is the result of waits and hindrances for only a part of which the department is responsible. Therefore, the amounts and causes of machine-waiting time, while set up and ready for producing, must be recorded in order that responsibility for the loss can be settled.

THIRD STAGE—

Actual machine hours	2,240
Waiting hours for which department is responsible	48
Waiting hours for which department is not responsible	128
Machine hours in which output should be produced at standard efficiency	2,000
Machine hours at predetermined utilization	2,400
Hourly consolidated labour rate (1s. for direct and 3d. for service)	1s. 3d.
Hourly machine rate	1s. 3d.

The cost statements (page 126) can be constructively criticized on the following grounds if it is desired to formulate a control report for presenting to the departmental manager.

Weekly Cost Control Statement—Labour

	£		£
Direct labour	120	Value of output: equivalent to 2,000 hours at 1s. 3d. per hour	125
Service labour	24	Loss due to inefficient machine operating	4
		Losses outside the control of the operators:	
		Fault of department	3
		No fault of department	8
		Balance: other losses	4
	£144		£144

Weekly Cost Control Statement—Overheads

	£		£
Electric power	18	Value of output: equivalent to 2,000 hours at 1s. 3d. per hour	125
Steam	20	Loss due to inefficient machine operating	4
Machine maintenance	20	Losses outside the control of the operators:	
Departmental overheads	30	Fault of department	3
Plant overheads	90	No fault of department	8
		Loss due to shortage of work	10
		Balance: other losses	28
	£178		£178

(*a*) The charges for electric power, steam, and machine maintenance are made at actual cost, and, accordingly, are outside departmental scope of control: services should be controlled at their source of supply.

(*b*) Losses due to faults outside the control of the department should be transferred elsewhere. The cost of certain waiting time is an example.

(*c*) Departmental and plant overheads, with the possible exception of service labour, can be best dealt with under their appropriate service groupings.

(*d*) Losses caused by low plant utilization are no concern of the department from the standpoint of control.

The next stage outlines a cost statement which does reflect only those facts which primarily interest departmental management in so far that the excess costs indicated will react to executive control.

FOURTH STAGE—

Actual machine hours	2,224
Waiting hours for which department is responsible	64
Waiting hours for which department is not responsible	80
Machine hours in which output should be produced at standard efficiency	1,920
Machine hours at predetermined utilization	2,400

Weekly Cost Control Statement—Labour

	£		£
Direct labour	112	Value of output: equivalent to 1,920 hours at 1s. 3d. per hour	120
Service labour	30	Loss due to inefficient machine operating	10
		Losses outside the control of the operators:	
		Fault of department	4
		No fault of department	5
		Balance: other losses, such as excess service labour	3
	£142		£142

Weekly Cost Control Statement—Overheads

	£		£
Actual machine hours at 1s. 3d. per hour	139	Value of output: equivalent to 1,920 hours at 1s. 3d. per hour	120
		Loss due to inefficient machine operating	10
		Losses outside the control of the operators:	
		Fault of department	4
		No fault of department	5
	£139		£139

Note. The above example is intended to be broadly illustrative and not to represent accounting technique. It

will be noted particularly that correct relation has not been established between the excess costs of sales responsibility and of manufacturing responsibility. In practice differential machine rates should be used for costing idle and waiting time. Also some adjustment between predetermined and actual running hours would be necessary.

CHAPTER X

COST CONTROL OF THE SUPPLY OF SERVICES

THERE is a very cogent reason for the segregation of services on at least a quasi-functional basis. By this means only can cost control of the supplying and the consuming of service be secured. Excess service costs may be broadly analysed into three groups—

1. Those due to inefficiencies in supply; i.e. the responsibility of the particular function which provides the service.

2. Those due to the demand for service from the production centres being less than the predetermined amount upon which the cost standards were determined; i.e. neither the responsibility of the service nor of the production departments.

3. Those due to use of service by the production centres being in excess of the amount which they should have consumed; i.e. the responsibility of the production departments.

How the cost control of services is framed to meet these requirements has been outlined on pages 84 and 89. First, consideration is given to output and plant utilization, and predetermination of both made for the future period under review. Secondly, the quantities of each service required to supply the plant at its predetermined level of utilization are ascertained. Thirdly, a cost budget is prepared for the supply of the agreed amount of each service. Fourthly, from the cost budget and the contracted supply, a cost standard per unit of service is developed. There are, however, specific peculiarities in the treatment of individual services on account of the fact that some are almost intangible and do not conform to the general interpretation

of the meaning of "service." For example, the following, although equally to be regarded as services, have no evident similarity when considered for assessment upon a unitary basis.

1. **Power Service—Steam.** The supply of steam does fulfil the conventional idea of service. It supplies something tangible, which can be measured and "turned on" or "cut off" at will. Power supply in general can, without straining at the imagination, be accepted as a service.

2. **Maintenance Service.** Here again the work of maintaining the buildings and machinery in a state of order and efficiency can be visualized easily as a service. The determination of units and cost standards, however, does present very different problems from those involved in the treatment of power service.

3. **Works Transport Service.** The scope of such a service can be said to include all movement of material within the plant—after issue from stores until delivery to finished stock warehouse. Although movement of material can be conceived as a service, a unitary basis of translation into cost standards is not so easily derived.

4. **Warehousing Service.** Strictly this includes only the storage of finished products. In practice, however, it must be closely associated with the packing and dispatching of sales orders. Both are constituents of sales cost, and, as they serve the finished product, the service must be regarded as being consumed upon such a basis. Obviously, warehousing service does not in any way supply production centres, and cannot therefore even be indirectly connected with manufacturing.

5. **General Management Service.** This service is perhaps the most difficult to distribute. Its constituents are very varied, and they are not so obviously measurable on a unitary basis. It can be coupled with the administrative function, which, for this purpose, does not need separate consideration.

Power Service : Steam.

It is not difficult to draw an analogy between the supply of steam from outside sources and its supply from within the plant. As with every service, this constitutes a basic conception of the situation. The steam power service fulfils two definite functions: the generation of steam and its distribution to consumers. Sometimes it may be appropriate, from the costing standpoint, to regard generation and distribution as separate and distinct from each other.

Steam has several uses, e.g. for manufacturing processes, for the generation of electric supply, and for heating buildings. Each of these is made up of a number of individual consuming units. If a cost standard per 1,000 lb. consumed is developed for the supply of steam, cost control can be carried out along indicated lines. The procedure is as follows—

1. The amount of steam which should suffice to supply the requirements of the plant under the predetermined measure of utilization is calculated. Full consideration is, at the same time, given to incidence of load, peaks, and shut downs. The allowances for steam losses between boiler houses and consumers must also be made.

2. A cost budget is prepared for the supply of steam in accordance with the calculated requirements, both as regards quantity and incidence. This budget is divided into the cost of generation and the cost of distribution.

3. A standard cost per 1,000 lb. for the supply of steam is developed. If the cost of distribution is fairly considerable, and if it differs appreciably in due apportionment between the various consumers, then it may be desirable to develop separate cost standards for supply to each of the consumers. The cost standard per lb. of steam may be likened to a price per unit charged by an outside supplier. A scale of differential prices for consumers is clearly justified by the varying costs of distribution due to distance from source of generation and other causes.

Before steam requirements can be calculated with reasonable accuracy, it is first necessary to develop standards. The quantities of steam which are needed for each process per running hour, the quantities which the prime movers absorb for generating certain kilowattage, the quantities which may be used for the heating of each building, must all be measured on bases which will facilitate the assessment of steam requirements for given measures of plant utilization. Standards can be developed from the results of test runs over periods of days or weeks. Measurements are preferably made by steam meters temporarily installed for the purpose. It is necessary to ascertain how much steam each consuming unit—whether process, heating, or prime mover—will use per working hour under conditions of normal load. Steam motors, owing to their high cost, should not be permanently installed at each localized point unless the particular consuming unit uses very considerable quantities of steam. At the same time, however, it is essential to have steam meters installed at all key positions for the purpose of recording the actual amounts consumed by groups of users. All steam consumed must pass through one of these meters. The location of a key position for metering depends entirely upon lay-out of generation and distribution, situation of consumers, relative use, and other factors. It is interesting to note that, if certain types of meters are adopted, the recording instruments may be grouped in a central installation at which the readings are transmitted from the meters themselves to the recorders by electrical means. The amount of steam actually generated also must be measured by a meter at the boiler house. The difference between the steam generated—as shown by this boiler-house meter—and the sum of the amounts shown by the meters which measure distribution of steam to the consuming units represents the loss in distribution. Therefore—

1. Standard quantities per working hour for each

consuming unit are determined by using portable steam meters.

2. Actual amounts generated and consumed are measured by steam meters permanently installed at key positions.

3. Actual working hours of each consuming unit are recorded.

From these figures, accurate control can be maintained upon the distribution of steam. Waste and extravagant use should be immediately apparent, provided that the standards have been carefully determined.

The next step is the preparation of a cost budget. The constituents to be included are—

Generation.

1. Building service: covering rent, depreciation, taxes, insurance, and all similar charges connected with the land and buildings occupied by the steam-raising plant.

2. Auxiliary machinery service: covering depreciation, insurance, maintenance, and all similar charges connected with plant and machines engaged in generating steam.

3. Fuel.

4. Water.

5. Electrical power.

6. Compressed air.

7. Sundry materials.

8. Labour: stokers, labourers, and all others engaged in steam raising.

9. Management and supervision: directly connected with steam generation.

Distribution.

1. Depreciation, insurance, taxes, and maintenance of service mains—including piping, valves, meters, and all fittings—from boiler house to delivery points, and of exhausts and returns which do not form part of the consuming units being supplied.

2. Losses of steam due to condensation and other causes between boiler house and consuming units.

The cost standard per 1,000 lb. of steam generated will vary only if steam is produced in different boiler houses. On the other hand, distribution cost at the various consuming units may differ considerably on account of their location as regards distance from the boiler house and other conditions which affect the economical delivery of steam. If differential cost standards are developed for various groups of consumers, then distribution cost governs the scale, as the generation cost remains uniform to all consumers, excepting in cases where the incidence of demand from certain consumers may necessitate the charging of special prices. Obviously, each steam meter may be the basis for cost control if variation in cost of distribution is sufficient to merit use of the differential method. The number of differential cost standards is not, however, limited by the number of permanently installed steam meters.

The primary object in cost control of steam generation is to separate the excess cost of producing steam from the excess cost of using steam. The former is due to the cost per lb. being too high, while the latter is caused by the consumers using steam wastefully. High cost per lb. of steam is the responsibility of the service. Extravagant use is the responsibility of the production executives in whose departments the consuming units are situated.

Lack of demand for steam from consumers, i.e. operating boiler house below predetermined utilization, must be taken into account. The excess cost of this loss is not a manufacturing responsibility. The converse, however, may happen. The actual production of steam might be above the predetermined amount.

If the actual cost of steam generated is in excess of standard, the causes must be investigated in detail. Steam generation can be controlled so scientifically and performance registered so accurately that analysis of losses is not

difficult. The subject is very technical, however, and really deserves special attention.

Inordinate and wasteful use of steam in manufacturing processes, in generation of electricity, and in other ways is shown at the location of loss by comparing metered quantities against amounts allowed, calculated at standard, for the running hours of the consuming units over the period under consideration. The differences are excesses for which the executives in charge of the consuming units must be responsible.

COST STATEMENT FOR THE GENERATION OF STEAM

Debited with:	Credited with:
Actual cost of steam generation.	Value of steam generated: as measured at the boiler-house and extended at the standard cost per 1,000 lb. for the generation of steam.
	Loss due to demand for steam from consumers being less than the predetermined amount: as given by the difference between predetermined and actual generation and extended at a standard cost per 1,000 lb. of unused steam capacity.
	Balance:
	Loss due to inefficiencies in steam generation.

Note. The standard cost per 1,000 lb. of unused steam capacity must cover only those costs which are invariable in nature and do not tend to fluctuate in proportion with quantity of steam generated. Fuel is an example of a variable cost which would be excluded. The standard cost of unused steam capacity can be made to slide in accordance with the percentage of unused capacity.

It must be emphasized that the method of costing the generation and distribution of steam as outlined is conceived on simple and elementary conditions of supply. Although the principles given are basically sound, they will in the main be fairly difficult of application. Complexities are introduced by the necessity for crediting

certain consumers with the value of exhaust steam and hot water. These latter supply both heat and water to the boilers and consequently are debits to the cost of generation. Again, exhaust steam is frequently used for heating purposes. The problems can, however, be handled by means of engineering technique.

COST STATEMENT FOR THE DISTRIBUTION OF STEAM

Debited with:

- Actual cost of steam distribution.
- Cost of actual loss of steam between boiler house and consumers: as given by difference between amount generated and amounts consumed and extended at the standard cost per 1,000 lb. of steam generated.

Credited with:

- Value of steam distribution as measured by the consumer meters and extended at the standard cost (or costs) per 1,000 lb. of steam distributed.
- Value of permissible loss of steam in distribution: as given by taking the standard percentage allowances for loss upon the actual steam consumed and extending this standard loss at the standard cost per 1,000 lb. of steam generated.
- Loss due to demand for steam from consumers being less than the predetermined amount: as given by the difference between predetermined and actual amounts consumed and extended at the standard cost (or costs) per 1,000 lb. of steam distributed.

Balance:

- Loss due to excessive loss of steam in distribution.
- Loss due to other inefficiencies in distribution.

Maintenance Service.

The scope of this service may be said to include all the repair and maintenance work upon the buildings and machinery of the plant. A distinction must be made between repairs and maintenance. Maintenance refers to work carried out with a view to the prevention of breakdown;

it includes inspection and overhauls. Repairs, on the contrary, refer to work carried out on account of actual breakdown or cessation of use. Although the line of demarcation may not always be well defined, the distinction in meaning is reasonably clear and has special import for costing purposes. While the cost of repairs must necessarily be somewhat spasmodic and difficult to forecast, the cost of maintenance may be budgeted in advance, providing that a programme of periodic inspection and overhaul is laid down. Obviously, however, this division and method of treatment cannot be arbitrary. But, whatever the conditions governing the individual plant and its activities, there cannot be any objection against standardization of at least a part of the maintenance work.

It is an admitted fact that maintenance work is most difficult to control. On that account, and owing to its consequent costliness, there is abundant reason to search out economical methods. The problem really involves consideration of the whole question of an engineering department in a manufacturing plant. Besides repairs and maintenance, its duties include certain capital development and replacements. Whether, of course, these latter justify the existence of an engineering department larger than otherwise would be necessary is a matter of policy. But high maintenance costs will more often than not be found to synchronize with hindered capital development and slackness in repair work. This leads to the formulation of certain principles which seem to be relative to economical plant maintenance and to efficiency in the engineering department.

1. When capital extensions and additions are contemplated, the engineering department should be placed in competition with outside suppliers. If the work is carried out by the engineering department, these outside quotations can constitute standards against which actual costs can be compared.

2. As little manufacture of new equipment and spare parts as possible should be undertaken. Equipment can be more advantageously made by outside engineering firms against drawings and specifications than by the engineering department, owing to possession of better facilities and to price competition. Sufficient stocks of those machinery spare parts which are frequently required may be held in stock. When necessary, an understanding may be reached with two or three small engineering firms in the vicinity with a view to giving special expedition to the manufacture of replacement parts or to carrying out any repair work. There must, however, be no practice which will lessen promptitude in dealing with breakdowns.

3. A comprehensive system of periodic inspection and overhaul should be laid down to cover all buildings, machines, and equipment. An inspection time-table can be developed which will deal not only with the special features in each machine, but also with roofs, water service, windows, walls, and other points connected with buildings and equipment. Painting and whitewashing may be scheduled for carrying out at stated time intervals. In fact, attention to buildings and machinery can be scheduled in a manner similar to that of the lubrication of a motor vehicle.

4. The cost of overhauls and repairs must be collected and analysed against each building, machine, and unit of equipment. There are many arguments in favour of ascertaining actual costs. The cost of running machines, processes, and departments cannot be obtained, predetermined, or controlled unless this information is available in analysed form.

The repairs and maintenance service differs from most others in that there seems to be no definite unit, apart from cost, in which its work can be conveniently assessed. Some basis of alignment must necessarily be decided upon in order that comparison can be made, machine against like machine, year by year. Maintenance cost can be reasonably

expected to remain a steady annual charge for each building, machine, or other unit. Repairs, on the contrary, will fluctuate considerably, and should preferably be regarded as yearly cumulative. The cost of repair can be budgeted for, say, five years in the light of experience with the particular unit in question, and the annual budget charge taken as one-fifth of the amount. By this means, over the entire plant, the incidence of repair costs can be expected to average out approximately in accordance with the total budget, while the incidence over the five years for each individual unit of equipment should also permit comparison to be made with the budgeted cost for that time.

Although the costs of repairs are not annually comparable for any particular unit, and, consequently, cannot be standardized, there is no valid reason why a budget for the suggested period of five years cannot be accepted as a basis for an annual charge. This amount can then be used as the budgeted costs of repairs when developing hourly overhead cost standards for the production centres.

It is often desirable to express on some comparable basis both repair and maintenance costs for the various buildings, machines, and so forth. A basis which seems to offer a fairly good perspective is the illustration of each as a percentage on the replacement cost of the particular asset. It is not suggested that this method is free from criticism, but only that some relative alignment between similar units can be obtained.

Briefly, then, the two main points advanced for the treatment of the costs of repairs is that they shall be budgeted over a period of five years instead of annually, and shall also be expressed individually as percentages upon the replacement costs of the individual assets.

If there is a budgeted cost which stands as a measure of achievement, the manager in charge of repairs and maintenance will endeavour to keep his expenditure within that limit. For the individual unit—whether building or

machine—this might appear disadvantageous, as there might be a possibility of failure to maintain at proper efficiency. Therefore the annual budget for the complete plant rather than the individual unit should be the measure whose cost may be watched cumulatively over several years.

There is always a possibility that undue economy in maintenance may be offset by excess cost in other directions. The existence of a state of first-class efficiency in plant and manufacturing facilities is one of the fundamentals upon which standard costs are based. As, however, the cost of waiting time due to machine breakdown and of failure to produce standard output on account of equipment defects is regarded as an excess cost for which the engineering department is responsible, any unjustifiable economy would be immediately revealed.

Works Transport Service.

As previously stated, this service embraces all movement of material between issue from store and delivery at stock warehouse. It is inclusive of all means—whether electrical, mechanical, pneumatic, manual, or any other. It covers all stages of manufacture between raw materials and finished products, but will usually exclude service supplies, such as fuel for boiler houses.

All units of handling equipment must be scheduled for identification purposes. Each unit can then be considered in relation to the service which it is capable of rendering to the various production centres. For it is to the latter that transport service must be connected. With the exception of manual effort with or without the use of hand-propelled trolleys, works transport is fixed or at least limited in its application. Lifts, conveyors, railroads, and other permanent equipment can only supply certain sections of the plant; while, generally speaking, the scope of more flexible transport—such as electric trucks and portable hoists—has definite limits. The aim, then, is to derive

various bases upon which their service can be equitably assessed to the production centres which they supply. Primarily, the incidence of the predetermined plant utilization governs this assessment.

The connection between material handling equipment and production centres may be simple or complex in varying degrees. The most simple instance, obviously, is a handling unit permanently allocated to a definite production centre and serving that one only. An illustration of complex relationship is the case of a yard railway supplying a number of departments with materials differing widely in kind and bulk. The association between handling units and production centres is, however, quite logical. If a conveyor is laid down for the purpose of supplying a number of work points with materials, it may justifiably be linked with them. Again, electric trucks delivering castings and forgings to a machine shop are rendering service to all the production centres located in that department. Or if an overhead travelling crane assists the setting of work in a line of machines it can legitimately be linked with these machines.

That the scope of works transport or material handling is limited, however, must be stressed. It does not, for example, include a stacking hoist operating a warehouse, a sack chute in a stores, or ash-handling equipment in a boiler house. All these must be regarded as capable of being allocated to their appropriate services, viz. warehousing, storage, and steam power respectively.

The following charges are included in the cost of works transport service—

1. Building service cost to cover space occupied or obstructed by handling equipment and tracks: collected by transfer from cost of building service.

2. Depreciation and insurance upon all handling equipment: may be collected by transfer from cost of auxiliary machinery and equipment service.

3. Repairs and maintenance to all handling equipment: may be collected by transfer from cost of maintenance service.

4. Power—in any form: charged at the standard cost per unit.

5. Management and supervision: cost of whole or part time work directly connected with works transport.

6. Labour: cost of labour working upon material handling and transport.

The budgeted cost for the entire service is not built up by summarizing the individual costs of the above groups, but by considering the service for the plant as being composed of a number of constituent services and by collecting individual budgets for each of these latter. A constituent service would be linked with specific departments and production centres, and might refer to either permanent or flexible equipment. Each miniature cost budget can then be prepared in accordance with the predetermined utilization of the production centres which it serves.

The cost of the service must be allocated against the production centres on bases which as far as possible reflect the actual value rendered to them individually. If a constituent service—e.g. a conveyor, a crane, a number of hand trolley men, or some similar means of movement—be linked with one production centre, allocation is obviously simple. It is in those cases where common service is made to several production centres that the problem assumes complexities. Assessment can be made in a number of ways—

1. By arbitrary division between production centres served: particularly applicable for use where a number of similar machines or work points are concerned.

2. On a weight or bulk basis: suitable for rail and power trolley service on a large scale.

3. By some grading method: if materials handled are very varied, and if the requirements of each of the production centres are specialized to certain materials, then it

may be necessary to evaluate the kinds and types of materials on a scale of points. Apart from length of journeys, the factors which mainly influence cost of handling are weight, bulk, and shape, the particular significance of each varying with the kind of equipment.

Warehousing Service.

The custody and storage of finished stock constitutes the warehouse proper. Although the packing and dispatch of sales orders may be included under the same managerial control, for costing purposes, they must in general be treated as separate and distinct functions. The cost of warehousing is far more invariable, as a total, than that of packing and dispatch. The costs of the latter in the main are not incurred unless sales actually materialize, while the cost of warehousing cannot readily respond to changes in sales volume.

The following are constituents of warehousing cost—

1. The due share of building service cost in respect of the space occupied for warehousing.

2. The due share of auxiliary equipment service in respect of handling aids, tools, and so forth.

3. Insurance charges on stock held in warehouse.

4. Cost of labour employed in the storage and custody of stock.

5. The due share of manufacturing management service cost. Although warehousing is not associated with manufacturing for distributing cost, it is located in the plant and employs labour. Therefore, some proportion of the cost of organizing and managing must be incurred. This amount, then, is a charge against sales, and not against output.

6. Cost of power service: charged at standard cost per unit.

Warehousing service must be charged as a standard cost per article or unit sold, the standard varying if necessary with each kind, type, and size of product. Sometimes a

common unit—such as weight—may be conveniently used. The annual cost of the service is budgeted upon the predetermined sales. Therefore the problem resolves into spreading the cost budget over the expected sales, analysed under classes of products, in the most equitable manner. Amongst the factors which influence the allocation of cost between various classes of products are—

1. Bulk.
2. Weight.
3. Difficulties in handling, storing, and recording.
4. Value.

The reasons which account for the influence of these factors upon warehousing cost will be readily apparent. Bulk governs space occupied. Weight may necessitate special provision for storage. Difficulties in handling, storing, and recording include fragility, shape, atmospheric conditions, and so forth, and may cause considerable differentiation in cost owing to certain products requiring specific care. Value influences the cost of insuring stock.

General Management Service.

The cost of general management—which also may include administration—must be divisible between manufacturing and sales. For this there is clear justification. As with other services, its constituents must depend upon the particular plant and its method of organization. Broadly, they are—

1. Cost of general management and administration: salaries of officers, secretarial cost, and all other expenses, including due share of building service.

2. Cost of general office: salaries, stationery, equipment, and all other expenses, including due share of building service. Amongst general offices are—

Accountants.	Timekeeping.
Wages.	Invoice.
Costs.	Purchasing.

When the cost budget has been analytically built up under these groups, the primary divisions between manufacturing and sales can be carried out. Arbitrary assessment is the only means of dealing with the cost of management and administration. Each officer can make an estimated allocation of his time between manufacturing and sales. This will provide a sufficiently accurate basis of apportionment. The cost of the general offices can be divided without difficulty, as some are related to manufacturing and others to sales.

It will be noticed that only those closely related to commercial management are included under general offices. Manufacturing management service embraces all clerical work connected with production organization and control.

That portion of general management cost allocated to manufacturing must be distributed to the production centres, with the exception of an amount chargeable to the material service. This latter exclusion is made only if the material storage service is charged upon materials and not to production centres.

The apportionment of cost must be made first to departments, and then between the various processes, machines, and works points in each department. The cost of general management itself may be divided between departments by assessment. The cost of general offices, however, may be allocated on the basis of number of operators in a department, or rather on the expected annual total operator hours. The cost of the purchases office provides an exception in that it may be charged direct to the material storage service.

The apportionment of the departmental quota of cost between the various production centres again may be based upon operator hours.

CHAPTER XI

SALES COST STANDARDS AND CONTROL

EQUALLY searching attention requires to be concentrated on the cost of making and executing sales as on the cost of manufacturing the products offered for sale. In the past cost accounting has undoubtedly tended to use more arbitrary methods when dealing with sales cost than with manufacturing cost. To-day, however, this state of affairs can no longer exist. On one side, the increasing importance and proportionate cost of selling has caused knowledge of sales cost in analysed form to be an economic necessity to the administration of an enterprise. On the other side, collation of the essential information has been made possible by the modern developments in selling organization and methods. Not only are projects and campaigns carefully formulated in advance, but they are based on definite facts and trends. Research into selling activities is now receiving almost as much attention as the study of manufacturing efficiency.

The attention devoted to the treatment of selling cost is in the main dependent on the proportional relation which it bears to manufacturing cost. At the same time, however, there may always be special possibilities of effecting economies or some necessity for maintaining close control. Also, both the relative proportion of the various constituents of selling cost and their incidence on sales in connection with the scheme of distribution to customers possess considerable influence. The cost of selling may vary between less than 1 per cent of total cost in, for example, the case of some small and specialized plant allied to a combine and several hundred per cent of manufacturing cost in the case, say, of some large selling organization handling proprietary articles.

It can be fairly accepted that the cost of selling, as expenditure in aggregate and in detail, decides the margin between sale price and manufacturing cost, and really determines profit or loss. If the aggregate expenditure is insufficient, sales orders will be comparatively small, with consequent low level of plant utilization and high manufacturing costs. But, on the other hand, the sales expenditure may exceed an economic limit beyond which the corresponding return in increase of orders does not balance the additional cost of selling. In fact, as a generalization, the trend of sales costs is somewhat comparable with the economic laws of diminishing and increasing returns, and can be stated thus—

After a certain point an increase in the expenditure applied in making sales causes in general a *less* than proportionate increase in the amount of remunerative return.

Until a certain point an increase in the expenditure applied in making sales causes in general a *more* than proportionate increase in the amount of remunerative return.

The first is particularly important when considered in connection with problems of plant utilization. In these times the cost of selling seems to constitute an ever-increasing proportion of sale price. There is every good reason not only for giving careful attention to the incidence of sales cost on the individual product, but for ascertaining the relative effectiveness of the expenditure in its various forms and applications. The cost of making sales, the corresponding sales actually made, and the cost of distribution, all considered in reference to territorial districts, may prove most illuminating. The cost of selling and distribution in overseas markets can be effectively analysed on such lines.

The proportion of selling expenditure and the scheme of distributing products to customers decide the amount of attention and detail which may be economically devoted to the cost control of sales. Obviously, the larger the

proportion which sales cost bears to manufacturing cost the closer should the former be analysed. Again, where there exists a complex system of distribution to wholesalers, retailers, and consumers, extending over the entire home market, and possibly overseas, then there is ample justification for maintaining an intensive control on the comparative results of selling activities.

One of the primary bases for the formulation of any method of cost control is the segregation of sales cost into appropriate groups, in order to provide sources of information for the solution of such problems as the following—

1. What return for each £100 of selling cost is given by each country, area, district, or representative, bearing in mind that a comparatively high turnover does not necessarily represent the same comparable level of profits?

2. In what places increases in selling costs are likely to be followed by more than proportionate increases in sales?

3. Whether the cost of selling a certain line or type of product renders it individually unremunerative and, even so, whether it may not be profitable from a wider standpoint to continue selling it individually at a loss in order to avoid unused manufacturing capacity?

In addition to the information made available by normal costing procedure, certain key figures of great significance can be periodically abstracted.

1. Average actual cost per visit of a representative.

2. Average actual cost per order executed: includes cost of invoicing, warehousing, dispatching, and so forth.

The average actual cost per visit can be compiled for the entire sales organization and for each area. Not only are such comparable figures useful for indicating periodic changes, but also for showing relative costs between areas. Such costs must be only those incurred in the field, i.e. representatives' salaries and expenses, unless a proportionate charge is also made to cover sales office costs.

The average actual cost per order executed should

disclose any tendencies towards increase or decrease in number and size of orders, and the efficiency displayed in dealing with them. The quantities in which customers are ordering has considerable influence on cost of execution. It will be generally accepted that the cost of executing orders has but little connected relationship with amount of sales in pounds, but that it has a definite link with the number of orders handled.

The foregoing, however, does apply with force only to enterprises supplying consumers through a distribution network. With regard to plants manufacturing against specific requirements, or carrying out work of a more general nature, there can be but little significance in such key figures.

Outline of Procedure for Dealing with Sales Cost.

Although differences in methods of costing are rather wider and more pronounced in sales than in manufacturing, there are certain common lines of approach.

1. Before cost standards can be developed some objectives for achievement must be laid down. This applies to manufacturing enterprises of all kinds, types, and sizes. By scientific method or by arbitrary decision, the expectation in volume of sales must be worked out and agreed. The degree of analysis, the basis, and the units in which volume is expressed do not affect the broad principle: namely, sales volume must be estimated, forecasted, or predetermined in advance.

2. A cost budget to cover the total expenditure involved in obtaining and executing this forecasted sales volume must be prepared. The budgeted expenditure will, in the first instance, be grouped under certain recognized headings and can, in addition, be subdivided in the most convenient manner for the subsequent development of standards.

3. Sales cost standards are developed on the basis of

information given by the forecasted sales volume and its related cost budget. Not only must cost standards be developed for each individual product, but, if circumstances indicate the necessity, differential cost standards may be determined for the various geographical locations in which products are marketed.

4. By means of the cost standards the financial reaction of all departures from the forecasted sales volume can be measured. If this forecast has been built up in sufficient detail, and if actual sales are analysed on comparable lines, a comprehensive picture of the results of the entire sales activities of the enterprise will be available at the requisite periodic intervals. Not only does any departure from forecast affect the sales cost, but the amount of net profit, which also has been determined in advance. It will be noted that the following departures from sales forecast and cost budget can occur.

(*a*) Actual volume of sales differing from forecast.

(*b*) Actual variety of sales differing from forecast.

(*c*) Actual sales cost differing from budget.

These variations, broadly, can be treated upon four alternative bases of control—

1. On the single basis of the entire activities of the selling organization and of the complete range of products marketed.

2. By classifying products marketed into well demarcated ranges.

3. By dividing the markets supplied into clearly defined areas.

4. By classification and division under both products and areas.

The selection of the basis of control is governed by the analytical structure of the sales forecast and its cost budget. Obviously, cost control cannot be based on either product or geographical location unless forecast and budget have been prepared with this eventuality in view.

Forecasts and Quotas.

When forecasting the sales of any particular product, there are two different methods of approach. The volume may be estimated in bulk according to the expected influence of market trends, sales policies, and other factors, or it may be built up from the sum of prospective sales in the various territories covered by the organization. This is, of course, a very broad view of forecasting. In actual application intermediate variations and combinations must be used.

The steps in forecasting in bulk can be along the following lines. First, the total quantity of each individual product which can be reasonably expected to be sold is determined; this is in effect a broad co-ordination of consumer demand and potential plant productivity considered in relation to all the markets supplied. Secondly, the forecasted totals of the various products are allocated to the various geographical areas, and, when necessary, sub-allocated to the representatives. The allocations to areas and representatives are known as "sales quotas."

Sound methods in forecasting strike a happy mean between unduly complex detail and insufficient factual analysis. As almost every kind of product and commodity has its own peculiar problems of marketing and distribution, and as each plant may be manufacturing several products, consistency of treatment is almost impossible. Taking the problem of allocation of sales between geographical areas in those cases where a total forecast in bulk has been made, sometimes the product may be related to available statistics, which will provide indices of comparable prospective sales in the various areas. For example, the number of private motor-cars registered in each county should prove a suitable basis for determining sales quotas for certain sizes of tyres. On the other hand, if the product cannot be associated with any available statistics, then quotas must be based on past experience and performance, representatives' estimates, or some method of arbitrary estimation.

Sales quotas may be expressed in quantities or in money. As an ideal, it is preferable for each sales quota to specify its constituents in quantity, kind, and value. If, however, the products handled by a selling organization are very varied such a practice is impossible. But, in the majority of instances, products, however miscellaneous the range, can be classified into groups, each embracing products of like marketing and selling characteristics.

The sales quotas set in terms of money will be based on these classified groups. The great disadvantage to a money basis for sales quotas is that, unless the profit margin is fairly uniform for various lines in the same classification, the attention of representatives may be concentrated on the ones most easily sold, but which may carry a very low profit margin. On this account the area showing the greatest volume of sales may not be making the largest amount of profit.

Sales Cost Budget.

A distinction must be drawn between the cost of selling and of distribution. Selling includes the cost of actually making the sales. Distribution includes only the cost of handling the order and the sold product. While both are included under sales cost, they form two definite primary services. Often, of course, sales activities may be divided into more than two services for the purposes of charging against sales made and executed.

The sales cost budget may be framed upon the following groups of expenditure—

1. Administration.
2. Sales management.
3. Advertising and publicity.
4. Representation.
5. Stock warehousing.
6. Packing and dispatch.
7. Transport.

Administration includes that part of the cost of administration and general management which was deemed to be equitably apportionable against sales.

Sales management includes the cost of maintaining head and branch sales offices, of directing and organizing selling activities, and of all clerical duties connected with this work. It may also include the cost of preparing estimates and tenders.

Advertising and publicity is fairly self-explanatory. It covers all expenditure upon sales promotion apart from representation in the field, and includes the cost of exhibitions, advertising by newspaper and magazine, posters, samples, and so forth.

Representation includes all expenditure involved in making and maintaining direct contact with customers, and includes salaries, commission, and expenses of representatives and agents.

Stock warehousing refers to the cost of custody and storage of stock ready and available for sale.

Packing and dispatch covers the cost of collecting stock from the warehouse, packing into suitable containers, and generally preparing for transit.

Transport includes the cost of arranging and making deliveries to customers.

In some circumstances, the cost of design and experimental work may be regarded as a constituent of sales expenditure. This conception applies more particularly to the cost of general and recurrent work, and not either to heavy expenditure upon developing a certain product or to the cost of specialized work for an individual customer. The former, usually, will be accepted as a capital charge for liquidation over a number of years. The latter must be regarded as a constituent cost of the particular job or contract concerned.

Sales Cost Standards.

The cost budget in conjunction with the sales forecast provides the requisite information for developing sales cost standards. The basis and method of development are

governed by the detail and scope of the sales forecast, the units in which the forecast and quotas are set, the variability of cost with different products and areas, and other factors.

The budgeted sales cost must be analysed between the various classifications into which the forecast is divided. These latter may be—

(*a*) Product: under kind, type, and size.

(*b*) Market: home and foreign, subdivided into areas and countries respectively.

The actual divisions upon which sales cost and forecasted volume are connected will depend upon the same factors which influence the structure of the sales forecast itself.

There is no universal basis of incidence for sales cost, such as the producing hour in manufacturing. A comparison, perhaps, can be made with the methods used in dealing with the cost of the material service when distributed as a charge against materials in so far that the costs are allocated more directly to the products. Sales costs will in most cases have several bases of incidence upon the product. They can only approximately be allocated against products upon a single basis, such as percentage upon manufacturing cost, although this method, of necessity, will frequently be adopted.

There can, at the other extreme, be a different basis of incidence for each one of the groups in the cost budget.

The guiding principle when developing cost standards from the budget is to apportion the budgeted cost of each individual group between products and markets as far as reasonably practicable, and to treat the products and markets used as bases of apportionment as a sales classification for further subdivision of sales cost. Cost standards can be developed for the different sizes and types of products included in each sales class by equating the apportioned cost against the forecasted volume. The

development must have some common basis, such as manufacturing cost, weight, or sale price.

Therefore, the cost budget must be allocated by two methods, one consecutive to the other. First, by actual analysis of budgeted expenditure in groups, and its apportionment to classes of products and markets according to premeditated use. Secondly, through further breaking down cost against individual lines of products by means of some arbitrary method of allocation. Certain groups of sales cost are broken down by analysis far more easily than others, and, consequently, can be allocated with greater accuracy.

Bases of Incidence for the Various Groups in the Cost Budget.

In order to develop sales cost standards, the total budgeted costs must be allocated against the individual volumes of the classified products and areas given in the sales forecast.

The cost of administration and sales management can be apportioned by arbitrary estimation. Whether the allocation shall first be made on a product or a market basis must be decided by circumstances. For example, if the products marketed vary only in size and detail, it will be unnecessary to allocate between products. The budgeted cost may be divided first between home and foreign trade; and, secondly, subdivided between areas, in the case of home trade, and between countries or groups thereof in the case of foreign trade. On the other hand, if the product marketed varied considerably in kind and method of distribution, it would probably be preferable to apportion budgeted costs between product classifications immediately following division between home and overseas trade, and before subdivision between countries and areas. The cost allocations against areas and countries can be combined with cost allocations from the other groups of selling cost

for the purpose of developing sales cost standards for the various product lines included in the product and market classifications. As mentioned, this development of individual cost standards must be somewhat arbitrary. For example, supposing that, in a particular geographical area, a yearly sale of £10,000 of product "A" was forecasted, and that product "A" was marketed in a variety of sizes and qualities. Further, suppose the allocations of budgeted selling costs for all groups to be £500. Obviously, some broad method of development must be used. The manufacturing cost might be a suitable basis. If the manufacturing cost be £8,000, the selling cost will be 6·25 per cent upon manufacturing cost. Then, to ascertain a selling cost standard for any size and type of product "A" in the particular geographical area, all that is required is to take 6·25 per cent of its manufacturing standard cost.

The budgeted expenditure upon publicity and advertising can be allocated in much the same way as the cost of administration and management, excepting that actual analysis can usually be carried to a further stage in the former than the latter before arbitrary methods of breaking down the cost against areas and individual lines are necessary. Obviously, the sales organization can plan to spend their allotment of expenditure in various areas, and possibly upon certain products. This planned expenditure provides information more far reaching and relatively connected than any available for the allocation of administration costs. At the same time, however, determination of how much cost each individual line being marketed shall bear must generally be decided by some arbitrary method of allocation.

The cost of representation in the field can be analysed against areas without difficulty. But, unless the enterprise is manufacturing very different products, which necessitate individual handling by separate branches of the sales

organization, analysis of the cost of representation cannot be carried very far. In any particular area there may be a sales quota of varied products in terms of pounds, and there will be a certain budgeted representation cost. Under such circumstances the cost of representation may be arbitrarily expressed as a percentage of sale price or of manufacturing cost.

The cost of warehousing is connected solely with ranges and varieties of products. Markets do not affect the cost of stock custody unless branch warehouses are maintained in certain areas and countries, in which case their costs will be borne by the markets concerned. Warehousing cost is charged against products according to service rendered. The basis of allocation may be value, bulk, weight, or whatever other unit best assesses the service rendered.

The cost of the packing service includes a certain amount of both fixed and variable charges—such as building service, supervision, and so forth—plus the actual material and labour costs. These latter are in the nature of direct charges. For example, performance standards may be determined for packing sizes and ranges of cases, and, therefore, labour cost standards similarly can be prepared. Owing to difficulties in standardizing methods of work, cases, and routes, recourse must be made to weighted averages when determining the packing cost which should be borne by each of the varieties of products dealt with. Provided that distinction be made in any instances of special packing—such as for overseas markets or for specially fragile products—cost standards can often be developed upon bulk or weight bases, particularly if products are uniform in character.

The cost of transport—considered in relation to its incidence upon products—is governed mainly by two variables, load and distance. By load is meant the effects of differences in weight, bulk, fragility, and other factors. Distance

refers not only to actual distance delivered, but to accessibility and mode of transportation. Load is essentially a variable connected with the kind of product, while distance principally concerns the market to which delivery is being made.

The study of transport methods is very essential to the development of cost standards. The field of research is very wide and repays close investigation. Road transport costs are particularly intricate and need very special attention. If a road transport service is attached to the organization, the problem assumes proportions equivalent to the cost control of a production department. Relative performance standards must be determined for various makes of vehicles, cost standards be developed, and control maintained in the same way as if a vehicle was a production centre.

SALES COST BUDGET

	Total	Analysis under Products			Analysis under Geographical Areas						Analysis under Products and Geographical Areas																	
											Product A						Product B						Product C					
		A	B	C	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6
Forecasted Sales	£ 200,000	£ 100,000	£ 60,000	£ 40,000	£ 20,000	£ 60,000	£ 30,000	£ 10,000	£ 25,000	£ 55,000	£ 12,000	£ 30,000	£ 10,000	£ 5,000	£ 8,000	£ 15,000	£ 5,000	£ 6,000	£ 15,000	£ 4,000	£ 10,000	£ 20,000	£ 3,000	£ 4,000	£ 5,000	£ 1,000	£ 7,000	£ 20,000
Standard Manufacturing Cost	138,000	60,000	50,000	28,000	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Budgeted Sales Cost	31,070	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Administration	1,500	600	200	400	—	—	—	—	—	—	108	450	90	45	72	135	17	20	50	13	33	67	30	40	50	10	70	200
Sales Management	2,500	1,000	500	600	—	—	—	—	—	—	192	800	160	80	128	240	25	30	75	20	50	100	45	60	75	15	105	300
Publicity	12,000	10,000	—	2,000	—	—		—	—	—	1,200	5,000	1,000	500	800	1,500	—	—	—	—	—	—	150	200	250	50	350	1,000
Representation	9,000	—	—	—	900	2,160	1,350	600	1,900	1,200	624	2,377	868	642	956	533	173	95	440	173	366	228	103	128	273	86	556	459
Warehousing	2,000	350	400	250	—	—	—	—	—	—	42	175	35	17	28	53	33	40	100	27	67	133	10	25	33	7	45	115
Packing	2,500	1,000	500	400	—	—	—	—	—	—	240	800	160	80	128	240	42	50	125	34	83	166	30	40	50	10	70	200
Transport	3,500	—	—	—	700	350	200	1,000	500	800	503	186	94	50	235	312	105	17	70	333	157	176	92	17	36	50	141	312

Fig. 7. Example of Method of Analysis of Sales Cost Budget

Explanation of Methods Used in the Analysis of Sales Cost Budget.

1. *Administration* . (*a*) Total budgeted expenditure divided between Product groups by assessment.
   (*b*) Budgeted expenditure of each Product group divided between Areas in proportion to the forecasted sales in the areas.
2. *Sales Management* (*a*) Total budgeted expenditure divided between Product groups by assessment.
   (*b*) Budgeted expenditure of each Product group divided between Areas in proportion to the forecasted sales in the areas.
3. *Publicity* . . (*a*) Total expenditure obtained from sum of budgeted Product group expenditures.
   (*b*) Budgeted expenditure of each Product group divided between Areas in proportion to the forecasted sales in the areas.
4. *Representation* . (*a*) Total expenditure obtained from sum of budgeted Area expenditures.
   (*b*) Budgeted expenditure of each Area divided between the forecasted sales of the Product groups in proportions adjusted by weighting their relative difficulties: in this instance, the weightings taken were—

$$A = 3$$
$$B = 1$$
$$C = 2$$

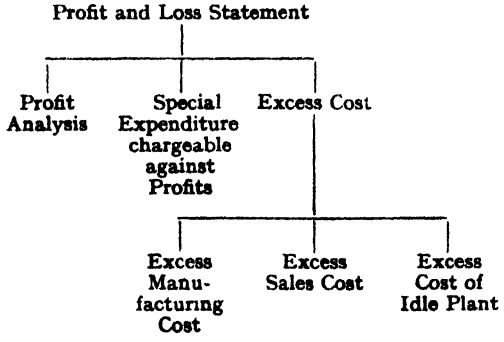
5. *Warehousing* . (*a*) Total expenditure divided between Product groups on basis of service rendered.
   (*b*) Budgeted expenditure of each Product group divided between Areas in proportion to the forecasted sales in the areas.
6. *Packing*. . . (*a*) Total expenditure obtained from sum of budgeted Product group expenditures.
   (*b*) Budgeted expenditure of each Product group divided between Areas in proportion to the forecasted sales in the areas.
7. *Transport* . . (*a*) Total expenditure obtained from the sum of budgeted Area expenditures.
   (*b*) Each budgeted Area expenditure obtained from the sum of the transport cost standards for the forecasted sales of the various Product groups in the area.

CHAPTER XII

COST SUMMARIZATION AND FINANCIAL CONTROL

THE value of costing in an industrial undertaking will be mainly judged by the worth of the final returns. They must be simple, accurate, prompt, and incisive, but yet sufficiently comprehensive and connected to provide full information of amount, location, and cause of any loss which arouses specific interest. Costs, however informative, are useless and redundant unless appreciated and understood by high authority. Cost statements, in order to receive attention, must be framed in such a way as to arouse the interest of management. But also, when interest has been aroused, there must be readily available further consecutive statements giving costs broken down in sufficient detail to reveal the required information without either waste of time or mental complexity.

The method of presentation should be the reverse of that of compilation. In the latter, costs are collected and amalgamated in order to derive a few key figures. In the former, the key figures may be expressed as a brief statement of gains and losses linked consecutively to a series of amplifying statements available for detailed reference as and when required. Such a series might be arranged thus—



COST STATEMENT

Analysis of Excess Manufacturing Cost

	Excess of Actual Cost over Basic Standard Cost		Inefficiency Allowance	Net Gain or Loss
	£	%	%	£
Materials—				
Waste and Excess Usage				
Spoilage and Defective Work				
Shortage in Recoveries of Surplus and By-products				
Purchase Price				
Labour—				
Production Inefficiency (output below standard)				
Responsibility of Operators				
Breakdowns and Hindrances in the Flow of Work				
Responsibility of Organization other than Breakdowns				
Wage Rates other than Standard				
Manufacturing Methods and Lay-outs other than Standard				
Changes and Set-ups				
Overtime				
Surplus Labour				
Overheads—				
Production Inefficiency (output below standard)				
Responsibility of Operators				
Breakdowns and Hindrances in the Flow of Work				
Responsibility of Organization other than Breakdowns				
Manufacturing Methods and Lay-outs other than Standard				
Changes and Set-ups				
Excessive Use of Services by Production Departments				
Inefficiencies in Supply of Services				

Note The outlined Cost Statement is intended to be illustrative only. The form should be drawn up to suit special requirements and can be elaborated as necessary.

"Net Gain or Loss" can be shown in at least three ways. Gains can be shown in red and losses in black, or *vice versa*. Gains can be preceded by a plus sign and losses by a negative. Gains can be inserted in one column and losses in an adjacent one. The classes of excess cost can be known by terms of recognition particular to the plant, and, in addition, by symbolic references.

FIG. 8

The profit and loss statement is based on a summarization of the various excess costs in conjunction with analyses of profits and special expenditure. The periodic interval of time covered by the statements will depend upon particular conditions and circumstances. They may be issued monthly, four weekly, fortnightly, or even weekly. In the majority of instances it will suffice if final statements are prepared either every calendar month or every four weeks.

Excess Cost Statements.

The chief debit charge in a Profit and Loss Statement obtained by standard costing is the sum total of excess costs. As a general principle, whatever the individual circumstances, excess costs can be aggregated in three groups: Manufacturing, Sales, and Plant Utilization. Each of these should form the subject of a cost statement dealing with the plant as a whole and classified causes of loss in particular. An illustrative draft of an Excess Manufacturing Cost Statement is given on page 161. These three statements give a summarized view of the general position in final terms of excess cost for the entire plant. They do not, however, show the total excess cost in each department or the distribution of any particular class of excess cost between the various departments in the plant. Therefore, to amplify the three general statements of excess cost, two series of complementary statements are necessary.

First, a statement for each classified cause of excess cost will show the amounts analysed against the departments and services. Each statement, then, is a location or departmental analysis for each classified cause of loss (see Fig. 10).

Secondly, a statement for each department and service will show in analysed form the individual amounts of excess cost due to each classified cause. Each statement, then, is a cause analysis of the excess cost incurred in the department or service (see Fig. 11).

COST STATEMENT

ANALYSIS OF EXCESS OVERHEAD COST DUE TO PLANT IDLENESS

i e. Failure to Attain the Predetermined Measure of Plant Utilization

Department or Service	Excess Cost	Plant Utilization		Net Gain or Loss
		Predetermined	Actual	
	£	%	%	£

FIG. 9. COST STATEMENT SHOWING AN ANALYSIS OF EXCESS COST CAUSED BY PLANT IDLENESS

COST STATEMENT

ANALYSIS OF EXCESS LABOUR COST DUE TO BREAKDOWNS AND HINDRANCES IN THE FLOW OF WORK

Department	Excess of Actual Cost over Basic Standard Cost		Inefficiency Allowance	Net Gain or Loss
	£	%	%	£

Notes

1. The form is illustrative only and can be extended to include a sub-analysis of cause.
2. In practice it may be convenient to include the excess overhead cost in the same statement.

FIG. 10. COST STATEMENT SHOWING AN EXCESS COST ANALYSED UNDER LOCATIONS

COST STATEMENT

ANALYSIS OF EXCESS COST IN DEPARTMENT

Cause	Excess of Actual Cost over Basic Standard Cost		Inefficiency Allowance	Net Gain or Loss
	£	%	%	£

Notes

1. This statement can include either all the excess cost in the department or only that amount for which the executive manager is directly responsible. The ruling of the form may be duplicated, one showing the total excess cost and the other the excess cost for which the department is responsible. This enables the cost effectiveness to be viewed both in general perspective and with specific reference to executive departmental responsibility.

2. Which excess costs are within departmental responsibility is decided by the type of organization, i.e. the extent of functionalization. If the organization undertaking is organized mainly on departmental lines, a large proportion of the excess cost may be adjudged to be within the control of the departmental executive.

FIG. 11. COST STATEMENT SHOWING A CAUSE ANALYSIS OF THE EXCESS COST IN A DEPARTMENT

The lay-out of the statements must depend entirely upon individual peculiarities of organization, types of product, and other governing factors. So long as a logical sequence of analyses is followed in order that the cause and location of exceptionally high excess costs can be traced, the general form will be decided principally by the type of organization and the classification of excess costs.

. There is, however, another series of cost statements which can be used in those plants whose organization is sufficiently functionalized. Excess manufacturing costs can be analysed under such headings as—

1. Material responsibility.
2. Process responsibility.
3. Production responsibility.
4. Equipment responsibility.
5. Employment responsibility.

It will be noted that these divisions are merely functional groupings of the various classes of excess cost, and, accordingly, can be regarded as cause analyses of excess cost incurred by a function instead of in a department.

Special Expenditure Chargeable Against Profit.

There are certain charges against an undertaking which cannot legitimately be accepted for inclusion under the cost of either manufacturing or selling. Such charges must be a deduction from profits. What expenditure shall, or shall not, be accepted cannot be arbitrarily stated. It is insufficient even to generalize by defining legitimate costs as those which can be directly chargeable or which, while indirect, are even and normal to production under predetermined conditions, unless the latter includes expenditure which can be spread evenly and equitably over periods. The following may be noted as representing the types of special expenditure chargeable against profits—

1. Replacement of buildings, machinery, and other facilities for manufacturing on account of obsolescence or

some uncovered happening (this charge includes net loss only).

2. Losses due to special circumstances, such as strikes and industrial troubles, inability to secure supplies of raw materials, and plant shut down on account of failure of some outside provider of service (power or railway transport).

3. Cost of experimental and research work which cannot be recovered from customers. For example, if considerable expenditure is incurred upon unsuccessful experimenting in the manufacture of a product which is not afterwards marketed, it is questionable whether such expenditure can be regarded as legitimate cost. There does seem a distinct line of demarcation between experimental work with a view to the improvement of a product, interpreted in the collective sense, and experimental work upon a product entirely different to any other which the enterprise is marketing. While the particular product can reasonably be expected to pay for the first, no logical justification exists for the treatment of the second as a constituent of the cost of any product other than that upon which it was incurred. Therefore, if the experimental and research work does not yield results leading to the marketing of a product, it must be charged as a loss.

For purposes of preparing the profit and loss statement, assessment must be made of the periodic amount to be charged against profits. The incidence of particular charges —i.e. the length of time over which they shall be spread over—will obviously vary in accordance with financial policy.

Profit Analysis Statement.

If the sales forecast has been prepared in a comprehensive manner, a standard profit will have been determined for each different article or form of commodity sold. This standard profit will be the difference between the forecasted sale price of an article and its standard cost.

The forecast must take into account the fact that the sale price of an article, apart from alteration necessitated by market and competition, may vary according to the class of customer. Frequently sales may be made on wholesale trade and retail terms at different discounts. Again, prices may be scaled according to quantities purchased under orders and contracts. Therefore, if a sales forecast is prepared in quantities, in order to convert into £ *s.* *d.*, the sale price of each article used for conversion will often have to be determined by an average weighting of the proportions and their respective prices.

The aim of a profit analysis is to ascertain the variation in expected profits on account of actual sales not being in accordance with forecasted sales. This analysis is calculated on a standard profit basis. Disagreement between actual and forecasted sales may be due to—

1. *Volume in £ s. d.* (i.e. the money value of actual sales in aggregate may differ from the forecasted amount).

2. *Profitability* (i.e. the proportion of actual sales carrying high standard profit returns, and conversely also those carrying low profit returns, may be either more or less than forecasted.

3. *Price* (i.e. the sale prices actually obtained may differ from forecasted prices).

To clarify the matter of profit analysis, the terms may be defined—

Forecasted Sales (Quantity or Value). The amount of articles or of a commodity either in quantity or money, which has been set in advance as an objective: to convert quantity into money a forecasted price is necessary.

Forecasted Price. The average sale price of an article or commodity determined in advance as an expectation.

Standard Profit. The "bogey" profit, which would be obtained from the sale of an article, provided that all standards and forecasts were met: it is the difference between the forecasted price and the standard cost.

PROFIT ANALYSIS STATEMENT

Product	Standard Profit on				Gain or Loss Due to		
	Forecasted Sales at Forecasted Prices	Actual Sales at Profit Factor	Actual Sales at Forecasted Prices	Actual Sales at Actual Prices	Variation in Volume	Variation in Profitability	Variation in Price
	£	£	£	£	£	£	£

Net Gain (or Loss) £ . . . .

Note Profit Analysis Statements can also be made for departments or for geographical areas instead of, or in addition to, classified ranges of products

FIG. 12

Standard Profit Factor. The percentage which the standard profit bears to forecasted sales.

Actual Sales (Quantity). The amount of articles or commodity actually sold.

Actual Price. The average price actually obtained for an article or commodity.

These definitions will serve to elucidate the application and meaning of profit analysis. The formulae can be applied to the analysis of total sales, product sales, area sales, or any other desired division.

Symbol		
W	*Standard Profit on Forecasted Sales at Forecasted Prices*	This represents the total standard profit attainable if the sales forecast materializes in accordance with volume, price, and variety; it is the "bogey" profit for the sales forecast
X	*Standard Profit Factor on Value of Actual Sales* (i.e. actual quantity sales at forecasted prices)	This represents the standard profit earned if actual sales are made at forecasted prices
Y	*Standard Profit on Actual Sales (Quantity) at Forecasted Prices*	This represents the standard profit earned if actual sales are made at forecasted prices and in forecasted variety
Z	*Standard Profit on Actual Sales at Actual Prices*	This represents the standard profit actually earned from sales

From the above four key figures the profit variation on account of lack of agreement between actual and forecasted sales can be analysed under the three points of difference: volume, profitability, and price.

Using the symbols W, X, Y, Z as references to the four key figures, the profit variations can be calculated from formulae—

Variation in Standard Profit due to Volume of Sales

$$= £(W - X)$$

Variation in Standard Profit due to Profitability of Sales

$$= £(X - Y)$$

Variation in Standard Profit due to Sale Prices

$$= £(Y - Z)$$

The total variations, then, between the forecasted standard profit and the actual standard profit will be their sum—

$$£(W - X) + (X - Y) + (Y - Z) = £(W - Z)$$

Profit and Loss Statement.

The principle guiding its compilation is the rule of exceptions. It can be briefly explained in the following way—

If the forecasted output was produced at standard cost and sold at forecasted prices, the actual profit would coincide with the standard profit, provided that no special expenditure chargeable against profits was incurred.

Therefore, if the cost of exceptions plus special expenditure are balanced against the earned standard profit, the actual profit can be obtained. The example given below, with its accompanying notes, may serve to illustrate the application of this method of determining profit and loss.

PROFIT AND LOSS STATEMENT

	£		£
Net Excess Cost. (1)		Total Standard Profit (6)	
Manufacturing (2)			
Sales . . (3)			
Plant Utilization (4)			
Special Expenditure chargeable against Profits . . (5)			
Balance— Actual Profit (7)			
	£		£

References

1. The net excess cost is the total of the excess costs of manufacturing, sales, and plant utilization for the period under review.
2. The manufacturing excess cost is the total of net losses and gains given by the analysis of excess manufacturing cost.
3. The sales excess cost is the total of net losses and gains given by the analysis of excess sales cost.

4 The plant utilization excess cost is the total of net losses and gains on overhead costs given by the analysis of the cost of plant idleness

5 The special expenditure chargeable against profits is decided by assessment

6. The total standard profit corresponds to the standard profit on actual sales at actual prices (i e. symbol Z) and is obtainable from the profit analysis statement

7 The actual profit or loss is obtained by balancing the statement

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