A productivity study: measurement of productivity of manufacturing units within a company

A PRODUCTIVITY STUDY

Measurement of productivity of manufacturing units within a company.

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INTRODUCTION

The role of "productivity", in the modern industrial environment, is one of increasing importance.

Knowledge not only of profitability and efficiency, but of the means by which these are achieved, is essential to management in order that they, the managers, may make decisions based on the maximum amount of reliable and relevant data.

Productivity measurement presents to management, another, and powerful source of control information. In a multiplant company, productivity measures can serve as a supplement to the more usual comparisons of the plants' financial ratios. Despite the existence of numerous legitimate reasons for differences in productivity change among plants, periodic comparisons may have a constructive effect in that they create an awareness of the factors affecting their efficiency and keep the managers alert. These sort of comparisons when possible should also be applied to products in order to evaluate the contributions of the various products. Measures of productivity trends also tend to illustrate technical progress and the reduction of real cost per unit of output, this being a factor which largely determines a Company's final performance when operating in a competitive market, and which is probably the most important single function of productivity measurements. Further use of productivity measures can be made in the field of expense budgeting in relation to future sales forecasts or forward orders, but this requires detailed studies of all relevant input factors.

The use of productivity measurement is also possible in creating long range projections of labour, material, and capital requirements, but due consideration must be given to the impact of technological advances which may occur in the immediate future. Such projections, however, if adjusted for such eventualities could be found useful in planning future finances, personnel recruitment and training policy, and possibly purchasing strategy.

It remains to be said, after expressing the wide range of possible uses, that productivity indexes are not a complete solution in themselves. In many applications, considerable thought must be given to the basis of measurement, and what basis suits one applications may not be suitable for another, and whilst they measure changes in productive efficiency they do not measure changes affecting other aspects of management efficiency.

In view of the above, productivity estimates are only recommended as a supplementary tool, in addition to other statistical tools which are to be found in management.

In order that the above may be more fully understood and the meaning of productivity more clearly established, the following summary of the basic concepts outlines the more general procedures of productivity measurement.

Basic Concepts

The term "productivity", which has come into widespread usein recent years, has been used loosely to describe the relationship, usually in the form of a ratio, between output and any or all of the associated inputs, in real terms. The inital vagueness of this term and its lack of definition has done little to retard its use, and although it has acquired a more precise meaning with the passage of tiie, it still remains extremely broad in its application and interpretation.

It is because of the above that under any given conditions the terms used must be clearly defined in respect to that particular situation. In general however, the following elaboration of the basic concepts will help to clarify the reader's understanding of the term "Productivity". The following has been arrived at, after research through published papers (1) on the subjects many of which deal only with a narrow area of application but it is hoped that the collection of these views will serve to illustrate the breadth of the subject.

The method of measurement of productivity will differ depending on the nature or purpose of measurement, it may be that it is being used to establish National productivity, Industrial productivity , Company productivity, the productivity of a manufacturing section or of a product line. In each case the system of measurement will differ and a relevant one must be established and used. Nevertheless as in all concepts and methods of measurements, there are common characteristics, and it at these that we must first look.

Output

Output may be looked at in a number of different ways depending upon the circumstances. It may be evaluated in terms of physical units or monetary units.

In the case of a homogeneous product the use of physical units of output provides an accurate and easily used base. However, this situation is rarely encountered and in most industries, the output consists of a very wide range of products of different types and differing models. Where there is some degree of similarity in the products produced, comparability may be achieved to some extent by reducing the similar products by a system of weighting, to a notional "standard product".

In most cases, however, the product mix of a company is so hetrogeneous that they cannot be treated by either of the above methods. It then becomes necessary to reduce them to some other form of comparable and consistent unit. The most favoured unit is the monetary one, either real or notional. The usual source of this type of data is from company accounts. Such data suffers from a number of discrepancies and needs adjusting for factors of inflation, imperfection of markets and price differences caused by such arbitary factors as advertising and profits, all of which affect price.

In the view of one noted researcher (2) of productivity, inputs may be considered from two main points of view,"Resource orientated" which is concerned with the effects of productivity adjustments on the utilisation and allocation of the available supply of the resource, which may be regarded as reflecting the primary interest of the suppliers of that resource, or as reflecting

a public or Government interest in welfare of such resource suppliers.

The second is User-Orientated. Here the primary interest tends to be in the effects of productivity adjustments on the users requirement of the given resource. This is a situation with which the author wholeheartedly agrees.

An illustration of this is that the resource-orientated interest tends to be more directly concerned with changes in the quantity of labour required per unit of output, while the user-orientated interest tends to be more directly concerned with wage costs per unit of output.

In such productivity studies the main problem may thus be seen to be that of defining the terms in which the particular input under study should be measured for its comparison with some of the general measure of output. The first and perhaps easiest choice may be considered as between physical and financial terms However, further and often more searching decisions have to be made beyond this point, either as among the alternatives of physical measures or as among the various methods of financial measures. The main factors or determinants affecting such choices would appear to be the nature of the resource that is being investigated and the previous choice of resource or user-orientated approach.

The great majority of productivity studies have concentrated on the productivity of labour, and others have taken some other single input factor as the base. These studies, though providing useful information, are always open to criticism . The main source of criticism is that high productivity of the factor studied may have been produced at the expense of low productivity of other input factors.

It is possible that the resulting high productivity was so dearly bought that it has resulted in low "efficiency".
Hence it is desirable to consider all input factors or at least a number of them which appear to interact with each other.

Productivity and efficiency are often considered to be synonymous with each other but a distinction may be shown by the following:- Efficiency is "aptitude, capacity; in a word the quality of the entity whose productivity is under review (3)"

The word "efficiency" may in fact, be regarded as expressing the quality of a unit of definitely adequate productivity, but which is constantly striving to improve this productivity by conscious and successful effort on reasoned lines (4). It may thus be seen that "efficiency" embraces the idea of productivity but goes beyond it in that it expresses an aptitude or capacity. The term efficiency would not be used to mean the specific productivity of material factors such as land, new materials or power, but could be used with reference to a man, a technique or a firm, in describing any of these obtaining specified results by the applications of deliberate effort to improve productivity.

In order to proceed with an analysis of input factors that may be used in order to show overall performance, it must first be indicated what, factors exist, what role they play and how they may be measured. The main sources of input are those of Labour, Capital, Services and Materials.

Labour Input

Labour input is the most commonly used single input factor in productivity studies, and is considered one of the major economic

indicators although it suffers from the above deficiencies when used in isolation from other input factors. Labour inputs may be measured with reasonable accuracy and provide significant results, in either physical or financial terms. Physical units of measuring labour input may be either in terms of the number of wage earners or the number of man-hoors employed. Using financial terms., labour inputs might be measured in terms of wage payments. This provides two different forms of input-output relationship, the first measuring the quantity of labour required per unit of output and the second,measurement of the wage cost of producing a unit of output. This returns us once again to the concept of resource or user-orientated analysis. A further argument is put forward in support of the difference in viewpoints between resource and user-orientated studies of input factors, by Bela Gold in her publication on productivity analysis. Remembering that resource orientated studies are primarily concerned with supplier or governmental interests, it goes as follows "a concern with the utilisation of the labour force and employment prospects, tends to be accompanied by a primary interest in the effects of productivity adjustments on the quantity of labour required per unit of output, both because it bears directly on prospective employment adjustments, and beaause wage cost per unit of output do not. Specifically prospective employment may increase or decrease whether unit wage costs rise or decline. The generally greater interest of user-orientated productivity studies may be explained in a similar manner. Thus the user evaluates transformation processes in terms of the excess of financial yields over financial outlays, not of physical output yields over physical inputs.

It is virtually always possible to reduce labour requirements per unit of output. But users are interested only in those labour saving adjustments which reduce rather than increase attendant costs. Hence changes in unit labour requirements tend to be of less strategic significance for decision making by employers than changes in labour cost per unit of output (5),

The above emphasises the employers interest in reducing cost of labour required as opposed to reducing the actual number of employees or even total hours worked. But as it pointed out by Bela Gold an exception occurs when the input factor, in this case labour, is in short supply, and then the units of labour may assume a greater importance, and in fact in extreme circumstances supersede the cost factor.

These arguments are not intended to suggest that the user of the input factor is not interested in the physical quantities of that factor, but that the cost is generally of greater importance, and that although reduction of the physical quantity of labour used may be a major area of cost reduction, it does not follow that a reduction in number employed will be followed by an equal reduction in the proportion of costs or by any reduction of costs at all.

User-orientated tends to centre around and be more directly concerned with the composition as well as the quantity of the factor input requirements. This is largely because of its interests, in particular shortages or scarcity of types of labour or other input factors. This often leads to labour input measurements which are weighted. One means of so weighting man-hours is to do so by relative wage levels of different grades of labour.

In contrast to this the supplier of a resource, labour, will be more interested in labour as comprising of individual units seeking to obtain or retain employment and as such is concerned more with the actual number of wage earners employed than with man-hours worked in total.

The previous two paragraphs illustrate the difference in approach and interest between user-orientated and resource orientated studies even when both are dealing with physical units of measurement.

It may be seen from the above discussion that there is considerable interaction between physical and financial methods of measurement and that the choice between the two is not always clear. The effects of factor price changes and changed in quantity and composition create many problems, and that changes of average wage payments per unit of labour may be affected not only by overall changes in the wages of different categories of labour and in the composition of it. In the same manner changes in the labour requirements per unit of output may be attributed to changes not only in the composition of labour but in the effectiveness of the wage payment systems and incentives.

Capital Input

In the years since the ending of World War II many industries have seen dramatic increases in "Labour productivity". This has been largely due to the fact that most productivity studies have focused on the sole input factor of Labour. This has meant that increases due to new technology, management systems and the injection of large sums of capital have been shown as Labour productivity increases.

The substitution of capital for labour has played a major role in the advancement of productivity and it is in order to separate out the effects of capital injection, that it is necessary to construct capital as a separate input factor.

Capital like labour may be measured in terms of physical and financial units. Capital viewed from the physical aspect may be regarded as consisting of land, buildings, plant, machinery tools and of cash balances. Changes in capital when considered in this light may thus involve adjustments in the total volume, in relative proportions of the total accounted for by the major categories of capital goods, and in either the physical features or performance characteristics of particular units of embodied capital.

In the financial system of measurement, the capital inputs may be considered as a fund of financial values derived from different sources on various terms and distributed across the range of outlets, which may include the many sectors business activities in addition to the purely productive processes.

It has been suggested by a number of writers, on the subject of capital and productivity, that physical measurements are possible but they remain narrow and limited. Several alternatives of measuring capital in physical terms have been described by various writers (5) but these are usually either highly theoretical or of a specialised nature and applicable only under the precise situation for which they were designed.

These problems are due to the extreme hetrogenity of capital goods both in physical form and in the nature of the tasks

which they are designed to perform. Also the hetrogenity of the determinants of operating efficiency in capital goods · their potential contributions being influenced not only by the labour, materials and other physical resources entering into capital goods, but to an even greater extent by the scientific and technological advances embodied in their design. These factors all influence the measurement of physical values of capital, but as yet there appears to be no common denominator by which they may be assessed.

However, for the purposes of most productivity studies a financial measurement of capital provides a more relevant and consistent source of information, in particular when dealing with productivity from the aspect of management of an industrial unit where management are concerned with the overall effectiveness of the capital, which they allocate, is used.

For the purpose of assessing the role of capital or fixed investments in productivity adjustments, the measurement of fixed investment is usually focused on the current value of the capital facilities and equipment that constitute that investment. This normally involves a deduction from the original value of such capital investments which reflects the estimated wear and ultimate obsolescence which has accrued since that investment was made. There are several means of estimating such deductions, each of which will produce differing results. As yet there appears to be no proven nor universally accepted basis for making these estimates, each and every approach being open to criticism and significant errors from a variety of sources. The two most significant sources of error occuring due to the methods estimating

the manner in which physical deterioration occurs in the passage of time and in estimating the resultant of such deterioration on the value of the investment.

Consistency is however the keynote of such estimates and if the measurement is made in a manner which suits the institution being measured, then the resultant information would be quite adequate for checking movement through time in that institution. The main cause for concern in collecting data that is useful for comparison of adjustments in fixed investment, either between firms or for year to year movements within the firm, is the possibility of variations in the manner in which the estimated rates of deterioration are calculated, and the further possibility of changes in the time over which the value of investment is to be recovered, the pattern of recovery of the estimated loss in value, and the scrap value of the investment at the end of that period.

Fixed investments are subject fortunately to considerable attention within the accounting records of industry, and within a single firm they are subject to rate of depreciation which the management of that firm considers to be adequate to recover its costs. This means that adequate data is usually available in such a form that meaningful use can be made of them in productivity investigations. However, some adjustments may be necessary for an accurate economic analysis. The major adjustment that is required is some means of deflating fixed investments to allow for changing prices in capital goods and to make allowances for changes in quality. One reason for applying such adjustments in prices is to obtain measures on changing depreciation allowances in terms

of constant value, another is to measure changes in the real volume of the stock of capital goods.

In most companies the depreciation charges are related to the original cost of the goods which they are designed to recover This means that the total sum accrued for replacement may in many cases not equal the cost of replacement. This introduces the possibility of errors, but these may be small in comparison with those that might be introduced should it be attempted to create a system based on expected cost of 5 - 20 years in the future. In any case it is the opinion of one researcher (7) that, owing to the rapid advancement in technology it often happens that the replacement good is more productive than the old which helps to balance the difference in the recovered sum and that required for replacement.

An alternative system of analysing the value of fixed investments is that of revaluing in terms of current replacement costs, the total fixed investment each year, allowing for such factors as price changes, obsolescence, and wear and tear. The cost of such a venture would be considerable and might introduce the possibility of considerable estimating errors and inconsistency. This concept is worthy of considerable further investigation, and should a consistent system of evaluation be derived, it would be a preferable basis of measurement. At present although it is difficult to present any strong arguments for its introduction in place of current practice, should the data be available it is strongly to be recommended as an alternative basis.

Service Inputs

This category ofinput covers a wide range of managerial and technical services which are contributary to the production processes and are, in general, functions which are provided by salaried personnel. These functions may be classified into three main areas, those of policy determination, supervision and control, and technical services of various kinds. Another source of classification could be between those services in which the manpower requirements are influenced directly by productions levels and those whose manpower requirements are more closely affected by long term ghanges or adjustments in productivity levels.

It is apparent that managerial and technical services supplement the direct productive contributions of labour. materials and capital inputs. It may be noted here that managerial and technical services are not additive to the factors of labour and materials, but are integral parts of them. Managerial and technical services may be regarded as assisting the processes of production through the allocation and utilisation of other resources.

It is not possible to measure directly any of the actual contributions of managerial and technical services, efficient co-ordination of resources, reduction waste and losses, development of production methods and techniques, and many others, but it may be appreciated that these contributions are essential to an efficient and organised production process. Although, as has been stated, it is not possible to apply any form of direct measurement, it is possible to estimate the effects on the input-output relations of

changes in such services or in their policies.

The problems of measuring the quantity of managerial and technical inputs may again be viewed from the two standpoints of resource-orientated and user-orientated interests. These follow to some considerable extent the interests outlined when describing the labour input factor. Resource orientated interest being primarily concerned with the trend in requirements for managerial and technical personnel with respect to output levels. To serve such interests, the measurement of these inputs would be most appropriately stated in terms of the numbers of personnel employed. A weighting index may also be applied to the various constituent groups which comprise the total, engineers, accountants, clerical staff, secretaries etc.

User-orientated interests are also once again concerned largely with the cost of these services, managerial and technical, and with the composition of such services. Thus it may be seen that it may involve physical and financial measurements of input.

The hetrogeneous nature of functions performed by staff within a firm creates many difficulties in the measurement of various inputs. One suggested method is to consider the personnel as being comprised of two basic groups. Those involved in the decision making and creative processes and those involved in purely routing work functions, and break each of these into various sub-groups. It is considered that it is only those personnel involved directly in the processes of decision making and creative function can directly affect productivity adjustments,

but changes in the total number of persons employed within these input factors will also affect the ratios.

In the measurement of clerical staff and others of a similar nature, carrying out routine work, it is suggested that total numbers employed per unit of output would provide a valid system of measurement, and also that a similar basis may be used for the measurement of supervisory personnel. These physical systems of measurement, however, although suited to the resource-orientated studies are not always adequate from the cost approach of the user-orientated standpoint. It is because of the differences in the composition of personnel, even within routine functions, that is often of greater value to measure the input in terms of man-hours weighted by the salary level of the various sub-groups, or by direct financial measures of the input in terms of total salary outlays per unit of output.

The measurement of the remaining personnel with the managerial and technical services, presents even more difficulties. This is because physical numbers play less effect on their contributions in comparison with the special attributes and abilities required for the performance of their duties. It is the extent to which these qualities exist and their distribution that more nearly influences performance levels. Under these circumstances it is more realistic to identify the input in terms of salary than any physical criteria. However, it means that such measures can rarely be directly compared with adjustments in output, but must be considered always as contributory factors.

The above discussions of productivity is not and could not

be an exhaustive manual of instructions. It is merely an attempt to explain some of the basic concept and present methods of dealing with some of the problems encountered with when dealing with productivity measurement and comparisons.

Because of the broad range of applications of productivity studies it is not possible to dictate a rigid policy of measurement and some of the alternative systems and alternative interests have been discussed. The final choice of selection of input and output factors being left to the investigator, who will have to determine which factors to take, and in what manner they should be measured, in order to achieve the object of his investigation under his given circumstances.

THE STUDY

1. Objectives of the Study

The purpose of this paper is to investigate the possibility of establishing a number of suitable productivity measurements for use within a group of manufacturing units, manufacturing a wide range of electronics equipment and associated mechanical devices. These indexes of productivity to be of such a nature as to enable the comparison of each manufacturing unit's performance from year to year and also enable the comparison of inter-unit performance

An additional function of this investigation is to establish and record the performance of these manufacturing units over a period of five years (1964 - 1968 inclusive) with the intention of comparing the movement of a number of input factors in relation to the real output values.

An analysis of the productivity changes of the various input factors, recording where possible, any legitimate reasons for changes in productivity, which are outside the immediate control of the relevant works managers and their staff, and those changes in productivity of one factor which may be shown to be strongly influenced by changes in one or more of the other input factors.

In as far as possible, for reasons of time, and of future applicability for the company concerned, the data used will be of the type currently to be found in the company's accounting system. The use of such data will provide a more consistent and reliable source than estimates produced from outside this source. However, where data appears to be inadequate on unsuitable recommendations will be

made as to alternative forms of data required, or attention will be drawn to the limitations of the resulting indexes.

II THE COMPANY - AND ITS MANUFACTURING UNITS

The Company which is the subject of this study is a major manufacturer of electronics equipment. Its range of equipment covers a wide field, from specialised test equipment to space tracking systems, from micro-miniaturised circuits to high power transmitters from television cameras and studio equipment to computers. It includes the manufacture of many specialised components and back-up equipment.

This range of manufacture requires a great variety of managerial, technical and productions expertise, and the close co-ordination of all these functions into an integrated industrial complex.

The manufacturing facilities which are the focus of this study, cover light, medium and heavy engineering practices and involve productions processes ranging from flow-line to "one-offs". The high rate of technical advance in this type of industry requires constant re-appraisal of these facilities and the introduction of advanced production processes and control systems, many of which involve computer applications.

The Company's manufacturing facilities are divided into five main manufacturing units, each of which has separate management and accounting responsibilities. Each manufacturing unit deals with a family of products concerned with a particular area of the Company's operations. Hence, one deals largely with mechanical products, heavy engineering involved in the manufacture of aerial systems, whilst another might deal with those products in connection with aviation.

Although in general each manufacturing unit is conerned with a particular range of products, there is considerable overlap and flexibility. The range of products with which a manufacturing unit is concerned, remains however, a diverse and rapidly changing one, owing to the rapid advances being made in the science and technology of electronics and electrical engineering.

Each of the manufacturing units support a variety of service functions which indlude the functions of Engineering Services, Material services, Maintenance Services, Labour Services and Production Supervision. These being the areas which will be analysed in this study.

Engineering Services include the activities of:-

Production Planning

Production Control

Production Engineering

Inspection

Test

Work Study

Works Laboratories

and a number of other minor activities which constitute only a very small percentage of expenditure even when combined.

Material Services include the functions of:-

Purchasing

Storekeeping

Marshalling

Internal Transport

Schedulling

and again a small number of other associated activities.

Maintenance Service include the activities of:-

Repair and Maintenance of Machine tools

Repair and Maintenance of Test Gear

Repair and Maintenance of Furniture.

Repair and Maintenance of office equipment.

Cleaning.

Paint of Buildings.

Steam Raising

Removals and Re-organisation.

Labour Services include the functions of:-

Personnel Department

Administration of Fringe Benefits:-

Holiday Pay

Sick Pay etc

Welfare Department

Canteens

Medical Facilities

Training

Recruitment

The existence of identical overhead allocation codes, and the similarity in the accountancy procedures enables accurate comparisons to be made between these manufacturing units on the basis of costs.

As previously stated however, each manufacturing unit specialises in differing product ranges, and although these are similar in terms of basic construction, it will be appreciated that each has a number of special problems which are peculiar to its operations. A brief description of the activities and special functions will help

the readers appreciation of these differences.

The fifth works, Research and Development Workshops has been omitted from this study for a number of reasons and will therefore not be discussed.

CHELMSFORD WORKS

The principal equipments manufactured are:-

High powered transmitters for use in broadcasting and telecommunications.

Radar transmitter/receivers.

Colour television cameras

and associated equipment such as studio facilities and outside broadcasting facilities.

Analogue computers which necessitate the manufacture of gears to Class A standards.

Waveguide labyrinths, which involve intricate mechanical assemblies and complex precision machining.

Sheet metal work - extensive facilities exist at the Chelmsford Works, and provide for the requirements of the other works in addition to its own need.

There also exist at Chelmsford extensive facilities for full scale system testing which is often required for radar and telecommunication purposes.

In addition to these equipments and facilities the Chelmsford works also provides facilities for specialised fibreglass and other plastic products. Also there exists extensive printed board facilities. Much of the Chelmsford production consists of small

quantities or "one-offs" to special order.

BASILDON WORKS

This manufacturing unit specialises in the production of airborne equipment, designed to operate under extreme environmental conditions.

The production of closed circuit television systems is also conducted at these works and again are often required for extreme environmental conditions.

This manufacturing unit provides quantity production of printed boards and clean area assembly facilities.

WEMBLEY WORKS

This factory concentrates on the production of:-

Telecommunications receivers and Maritime equipment

The facilities of the Wembley Works are set out for batch quantity production. It has extensive machine shops and gear cutting facilities, again to Grade A classification. The gears are mainly used for the production of analogue gearboxes required for aeronautical computers.

GATESHEAD WORKS

This factory, unlike the others which are situated in close proximity to London, is located in the North of England on Tyneside. This manufacturing unit is responsible for the production of the heavier mechanical items required by the Company's products.

These items include fixed and moving aerials that are required, for telecommunications, radar and space communications.

These aerials involve constructions of up to 100 ft. in diameter, which must be capable of being positioned within minutes of arc by means of electric and hydraulic control.

The Gateshead Works has extensive facilities for the fabrication of steel and aluminium constructions.

As will have been seen from the above descriptions, the Company displays a disconcerting and hetrogeneous range of products, requiring all manner of expertise. It is this that provides one of the most difficult problems in measuring productivity, for the establishment of a sound, and comparable unit of output against which to gauge input factors is always a difficult problem and under these circumstances always open to debate and criticism.

However, one factor of the Company operations may well assist it in overcoming these problems. The manufacturing units, whose productivity it is the intention of this study to analyse, all manufacture at a "cost price" and supply product divisions who are responsible for placing orders on the manufacturing units. Profit margins are then added by the product division In consequence the problems associated with profits and selling expenses are removed from the immediate concern of the manufacturing units, and do not therefore influence productivity studies based on these units

THE STUDY

III Basis of Measurement and data collection

This paper is concerned with the investigation of productivity of a number of manufacturihg units within an electronics group. Its interest lies · n the operation of these manufacturing units only, and not with the overall company performance. As such it is the author's intention to look only at the inputs and outputs of these units, in real terms, and not with inputs from other sources on the output attributable to those inputs.

The input and output factors related to this study, the basis of measurement and some of the arguments supporting the choice of these units of measurement are presented below, and it is on this basis that the data presented by the author has been collected and analysed.

Productivity is concerned with "real inputs" and with "real output" and every attempt will be made to establish units of measurement and adjustment to obtain data which corresponds to these requirements.

The source of information for the data used, in this study of productivity, is primarily from the Company accounts and although it is possible in some cases to visualise more theoretically correct forms of data, time and future applicability of this report, demands that where possible existing sources of data be utilised and deficiencies allowed for or acknowledged.

The choice of output factor selected for the purposes of this study is the value of Works Processing Costs. This is an element of the total of production.

Within this group of manufacturing units there are several possible units in which the output factor might, be measured, and the following will briefly discuss the accounting data available.

The value of production from the manufacturing unit consists of two elements, that of Works processing cost, which represents the cost to the works of manufacturing and that of Works material costs, which represents the value of raw materials and purchased components used in manufacturing. There also exists a figure for the value of output from the works which is based on the amount of goods actually leaving the works to a product division or customer, at a pre-determined estimated value.

The prime reason for not using the value of output is that production cycle on much of the equipment produced is in excess of a year. In consequence the value of output recorded may not be a direct result of inputs for that period of time, and therefore the ratios which would result would be distorted by this lag. Also the value of output is an estimated value.

The elimination of works material cost is based on the observation that these constitute an input from another source, and in many cases is used as a separate input factor for productivity analysis. These inputs of materials and components also include other factors of profit and transport costs and when viewed on a broader scale the inclusion of materials and components costs would constitute especially in the case where one works provides another with component parts. If material costs were to be included in the

value then an increase in purchased materials or components would result in an increase in the productivity even though other inputs may have remained the same or even increased, and this would be a falsehood.

Thus i. is suggested by the author that the use of Works processing cost as the value of output, provides a source of real productive output which is directly related to the same period as the inputs and which eliminates the distortion of profits or selling expenses, and the effects of productive effort from other sources

This output factor of Work processing cost has also been chosen in preference to a measurement based on physical units of output such as units produced, or equivalent manhours, because of the wide range of products produced by this group of manufacturing units, and the variety of skills and expertise required to produce them. These factors create an extremely difficult weighting problem both from the point of view of the establishment of a "standard product" and from the multitude of grades of labour. Also it is the opinion of the author that measurements based on these units would be of little greater value, if any, than those based on the financial basis described.

All the data obtained has been adjusted, using national price indexes to provide real time comparisons of the value of production costs. The base year chosen being that of 1964 which is the starting year of this study.

The establishment of an output factor as above appears to provide a satisfactory and realistic value of output for the purposes

of productivity measurement. It reflects the actual productive effort employed, on a comparable time base, and the cost of value of output directly attributable to that productive effort. It is thus this figure of works processing cost which will be used in this analysis and all movements will be measured in relation to this value, so established, of "real output".

By thus eleminating the effects of material and components from the "real output" value it is possible also to ignore its influences on productivity so measured. If, as is sometimes required, it is necessary to compare movements of materials costs against output, this remains an easy operation as the figures are recorded separately in the Company accounts. However, in productivity studies it is often only required in order to estimate its effect of labour productivity, and if it can be eliminated this appears to simplify the problem.

The second area that requires consideration is that of establishing the methods of measuring the input factors to be considered in this paper. The choice of units of output, the pound need not necessarily influence the choice of units for input factors, as it is the ratio of input and the movement of these ratios in which we are interested.

The two input factors, considered by the author to play the most significant roles in the productivity of the manufacturing units concerned, and which is supported by most major researchers in this subject are those of:-

1. Labour
2. Capital

Labour has been a traditional basis of productivity measurement both in this country and abroad. This is because of the vonsiderable influence labour costs and effort have on the economy of any country or its industries. Labour still holds the key to the productivity of a nation and is probably the most important single factor. However, in recent years the interplay of capital has greatly affected the levels of labour performance and as some industries swing away from being labour intensige to being capital intensive, the effects will become more and more pronounced. It is because of these developments that capital justifies considerable attention in productivity analysis.

Having expressed the need for greater attention to the productivity of capital, we must now turn our attention to the problems of measuring it. Capital is somewhat more difficult to measure than other input factors, and the establishment of a realistic value for it is fraught with hazards.

Capital may be of two main types, fixed capital and working capital. In this study the cost of working capital has been excluded as it is not shown as a manufacturing cost, it is in fact shown against Head Office accounts and is not a charge to production. Land and buildings have been excluded also as these are treated similarly and because of the time factor prohibits the derivation of this data in sufficient details to satisfactory for the purposes of this analysis.

This study will therefore consider the influence of fixed capital with the exclusion of land buildings on output, in the form of a "capital productivity index". The term fixed assets

will be taken to include the following items:-

Plant and Machinery

Building Services

Test Equipment

Motor Vehicles

Furniture

Fixtures & Fittings

and Office Machinery.

The source of data for the calculation of the capital investment level is the year end accounting statements of the individual manufacturing units. The account statements provide data on the level of new investments, the sale and/or the transfer of equipment from that unit, and the level of depreciation. The value of new investments less sales and/or transfers and the amount of depreciation are adjusted for inflation in prices and are set against the base year of 1964. By so doing the nett addition or decrease in investment is added to or substracted from the previous years total of investment to provide a year end value of capital investment for that manufacturing unit. However, these are accounts figures of year end values and are relevant only to the moment in time at which they were compiled. In order to obtain a realistic value of capital investment for that year, the average capital investment must be taken not the year end values.

Having established the source and nature of the data, it must now be said that it inherantly suffers from two main sources of error, which without considerable expense and a good deal of costly effort, in order to provide more detailed and relevant information of the type suggested earlier in the paper, cannot

be accurately compensated for. It is therefore proposed to acknowledge the existence of these deficiencies and they must be borne in mind when evaluating the data which results from them.

The sources of error and the possible effects of them on the productivity index are briefly outlined below and represent the authors view of the situation under the given circumstances of this study only, althoughtsome of the points expressed may be applicable in other situations under similar circumstances.

(a) Errors due to adjustment to base period

For the purposes of this study the year 1964 has been established as the base year and all expenditure or incomes at dates after this base are adjusted, using price indexes, to give the real value in terms of the base year values, (constant price). This provides a basis on which to realistically compare movements in the capital expenditure. Unfortunately the value of capital expenditure at the base of the year consists of the cost price less depreciation (at a set rate) for all investments up to that date. Many of these investments being made at times prior to the base date. Technically all expenses prior to the base date should be adjusted to base date values in order to give a statistically correct base date value. However, this becomes a very difficult job in a Company which has been established as long as this Company being studied, changes in accountancy procedures and rates of depreciation may all affect the result.

It is thus better to accept the gross value at the base date and analyse the effect of ignoring adjustments prior to that date.

The apparent effect is to present an investment figure which is slightly low in terms of real value. This will tend to create a ratio, when calculating the productivity index which is higher than the theoretically correct ratio and will hance tend to reduce the apparent movement of the index. This error, however, is slight and decreased with additional investment and the progress of time away from the base date.

(b) Errors due to the use of depreciation figurex.

Depreciation is an accounting procedure that is used to adjust the value of fixed investment, in a attempt to recover the cost of that fixed asset over its productive life. It is normally a fixed rate of depreciation based on the initial sum invested.

This figure of depreciation which has been used inthis paper for the allowance of loss of productive capacity with age, or obsolescence, may not in fact accurately reflect or relate to the true productive capacity of the plant and equipment. This is largely due to the fact that, although an investment may be "written off" over a period of years, its productive capacity may continue to be available over a considerable further number of years. In fact, some investments that may be written off, over a short period of years through the fear of obsolescence, may indeed be be more productive after their value has been recovered than they were before

The alternative method of calculation using the previous mentioned solution, of establishing replacement values, is not liable in this situation owing to the cost of introducing and

operating such a date recovery systen, and the lack of this type of data currently available.

For these reasons the author selected the use of depreciation figure, for at least these are consistent, and over a period of time tend to reflect trends fairly accurately.

The applications of company depreciation rates tend to err on the safe side, and recover investments over a shorter period than their actual productive life. This tends to thus under-value the capital investment at any moment in time.

The effect of this on the graphs is to once again reduce the apparent movement in the index from year.

(c) Errors due to under capitalisation.

Within this group of manufacturing units there is considerable investment made, in the form of specialised test and manufacturing plant, production aids and other equipment. Not all of these investments appear to have been capitalised. This would again tend to understate the value of capital investment within the manufacturing units, with the same effect on the data as previously described.

As has been shown above the sources of error that exist all tend to understate the value of fixed capital. This situation can be allowed for in the interpretation of the resulting data, and as long as the data is of consistent nature, provides the best existing source of information.

If, in fact these errors did not exist the graphs of indexes would be slightly more pronounced but the trends would remain the

same.

The method of calculating and establishing the value of fixed assets is illustrated by the formulae shown below, as will be seen it provides the average fixed investment for the year being measured.

The equations are:-

$$C = s + a - d$$

$$A = \frac{s + c}{2}$$

$$\text{therefore } A = \frac{2s + a-d}{2}$$

Where S = opening balance for year

C = closing balance for year

D = depreciation for period adjusted to 1964 based period prices.

a = Additions or transfers of capital adjusted to 1964 base period prices

A = Average value of FIXED ASSETS for year at 1964 base period prices.

We must now return to the subject of labour input, Labour productivity has been the basis of most productivity studies, and under most economic situations provides one of the most acceptable guides as to productivity trends in general.

This study will look at the contribution of labour in three ways. It will look at the contribution provided by direct labour resources, this constitutes the direct production effort entering the products in the form of labour. It will look at the contribution

of indirect labour changes in productivity. Finally, it will look at the total contribution of all labour.

The author has again selected a financial unit of measurement (the pound) for the basis of the labour index. The cost of labour being taken as the real value of input when adjusted to 1964 base period prices. The author also considers that this is the most meaningful unit of measurement in the context of this study as it reflects directly on managements interest in the cost of production.

The use of physical units of measurment has been rejected by the author for the following reasons which will be discussed briefly below.

The use of the manhour as the basis unit of measuring productivity trends, has been rejected in the case of this study owing to the extreme difficulty of accurately weighting the relative values of the multitude of grades of the different labour skills and effort required by both of the two major sections of labour, direct labour and indirect labour. The weighting of manhours under these circumstances is not only desirable, but in order that a realistic degree of accuracy be achieved, a necessity.

The rejection of manhours weighted by the relative wage levels is on similar grounds. The weighting being only possible within very broad bands. This system also reflects the additional financial burden on the cost of overtime premiums.

As may be seen, and as was explained in the introduction to this paper, the physical methods of measuring productivity under the situations encountered in this study, where there are labour

differences not only within our manufacturing unit but, between the manufacturing units as well, are very complex and from the user-orientated point of view, far less meaningful and thus of less value to management, than the cost orientated analysis which has been suggested above. This does not mean however that physical units of measurement would be of no value to management, but it would depend on the end use to which the study was to be put and the degree of importance attached by the company to its labour levels and possibly its future requirements of certain grades of labour.

We will now proceed to discuss the input factors which this study is to consider in addition to those of labour and capital . The movement in the productivity of these next input factors are of little value on their own but are useful in providing further information on the reasons for changes in the general movement of productivity. They can also however provide some useful control data for the area related to the index.

The input factors that are to be considered within this study are limited to five of the main overhead categories of the manufacturing units or certain section of them which the author considers to be more useful or relevant to the purposes of productivity analysis.

The input factors are as follows, the order not being of any significance and not intended to represent any order of priority:-

Production Supervision

Material Services

Engineering Services

Maintenance Services

and Labour Services

The groups consisting of the functions previously defined within this paper when discussing the nature of the company and its manufacturing units.

The unit of measurement chosen here, is again the financial one and is related to only that part ofthe overhead costs that constitutes the labour changes. An exception has been made to this, in the case of maintenance overheads at the Chelmsford Works, where the material costs were available as a separate items and it was considered worth treating this separately, as it forms a major part of the overhead costs for that department. Unfortunately, these figures were not readily available for the other manufacture units, and thus, because of the time involved in recovering them, they have not been shown It is thought however, that a further survey of this area a some future date might show some interesting and useful results, as is indicated by the Chelmsford figures.

The input factor of production supervision consists of the labour charges for the staff grades of, superintendents, foremen and chargehands. The terminology used by the various works varies slightly, but the functions amd responsibilities are braadly the same. Total labour costs have been taken in preference to manhours for the same reasons as previously stated for the Labour input factor and in order to maintain uniformity of the data.

The input of material services and engineering services are also composed of the labour costs of operating these services which include those function previously listed when describing the

company actifities. The different manufacturing units again may have different structures, but the cost code groupings are largely the same and covdr the same areas of operation. It must be appreciated however that any radical changes in structures will affect the validity of the year to year movdments of the productivity indexes and must be recorded in order to analyse the true movements.

Maintenance service inputs have been treated in a similar manner as the above inputs in respect of labour costs, but as stated the material cost is of considerable interest in this instance, because maintenance requires considerable material, in various forms, in addition to administrative materials. The amount of material costs will tend to vary in a different manner to labour costs and be more dependant on the short term changes in production through-put and thus on mahhine and plant utilisation, than on the longer term changes affecting production capacity.

Labour service inputs have also been dealt with on the basis of labour costs, although, here the labour charges are normally of anindirect type of sost such as holiday pay, sick pay, training and other fringe benefits, and constitute not so much a cost of operating a service group, as a cost incurred by the employment of the total labour force.

All the costs involved in the measurement of these input factors are corrected in terms of real value to a 1964 base. The adjustements are made on the basis of price and wage indicies published by the National Institute of Economic and Social Research,

in their Economic Review Number 48 publish in May, 1969. This source was used largely because of its inclusion of 1968 figures.

The figures for the total labour costs are adjusted using a weighted combination of the hourly and weekly rate movements provide in the above review, in an attempt to compensate for the ratio of direct and indirect labour employed within the manufacturing units. The ratio used is a 2.1 ratio, which although not exact is a close approximation which is suitable for use in all four manufacturing units. Again however any major changes in this ratio would require a modified weighting index.

The above discussion suggests that a large number of statistical and conceptional errors may exist, but with due acknowledgment of them, they can be reasonably interpreted and allowed for. The problems are many, but consistency of data overcomes many possible criticisms.

The above discussion serves to illustrate the complexity of problems of measuring productivity in a complex industrial organisation, and perhaps also the indefinite state of the science of productivity measurement. This does not howver render the results of such investigations void, in fact, as long as the errors are understood and reasonably consistent they influence the trends to only a small extent and normally only affect the magnitude of the movements.

THE PRODUCTIVITY GRAPHS

The productivity graphs are divided into four groups, each relating to the performance of an individual manufacturing unit. Each group of graphs consist of seven separate graphs showing the productivity trends, of each input factor investigated in this study, over a period of five years, commencing 1964, and continuing to and including 1968. This span of years was chosen as it is the most recent period of five years for which all data required was available.

Each productivity graphs starts on the base year of 1964 with the index equal to 100. The index values for the years following the base year are calculated as shown in Part V from the data sheets shown in Part IV. The data sheets all being compiled from the company accounts.

The analysis of the graphs resulting from the compiled data will be treated in two main sections. Section (i) will look at the individual graphs of each manufacturing unit, analyse movements, where possible, of each input, factor and compare the movements of one input factor against another. Section (ii) will attempt to draw comparisons between the individual manufacturing units.

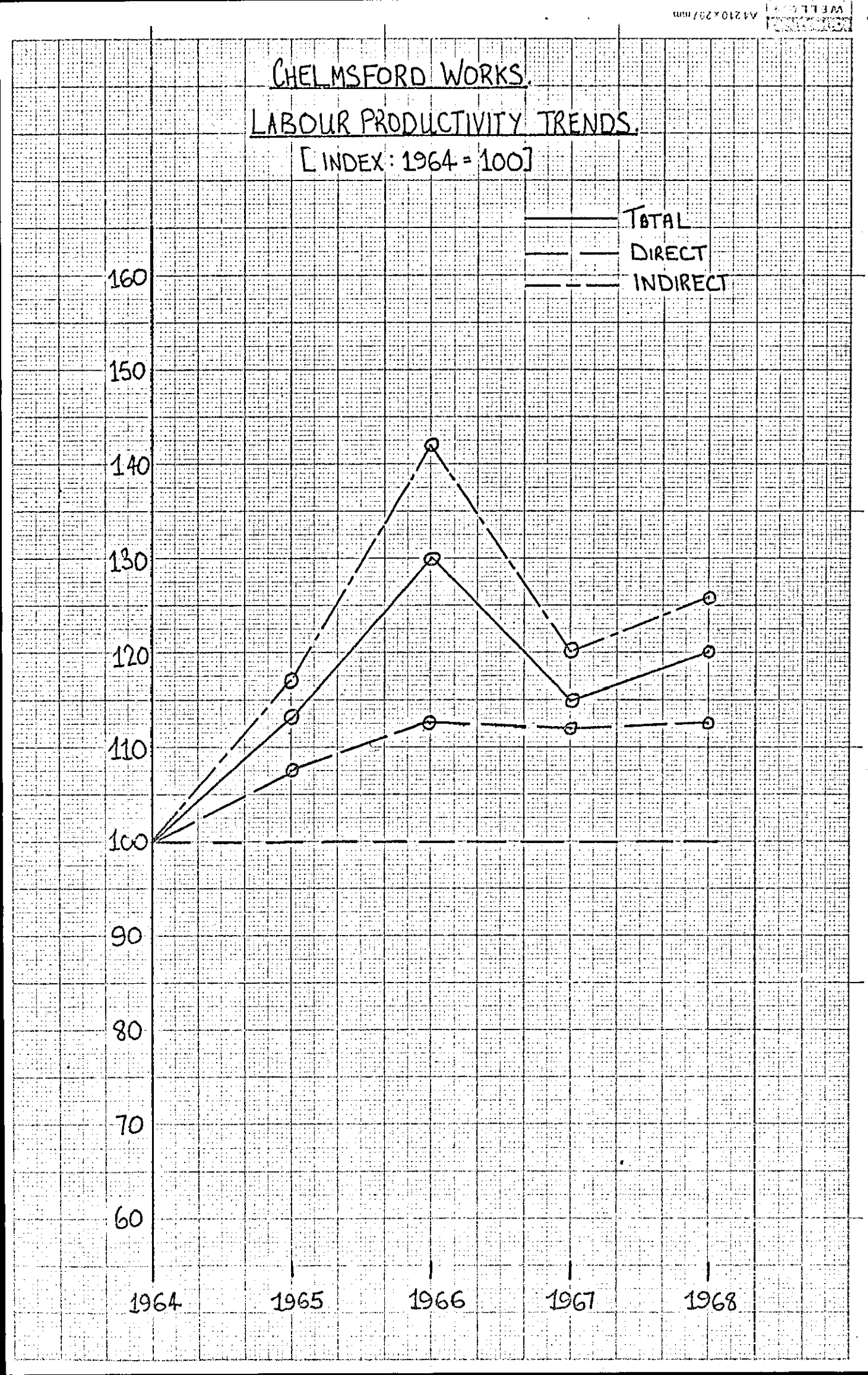
SECTION I

CHELMSFORD WORKS

CHELMSFORD WORKS.

LABOUR PRODUCTIVITY TRENDS.

[INDEX: 1964 = 100]



LABOUR PRODUCTIVITY

The trend illustrated by the labour productivity graph shows a steady upward trend with respect to direct labour productivity. The trend of indirect labour productivity has a sharp peak for the year 1966, other than this exceptional deviation the general trend is upwards, The combination of indirect and direct labour into a total labour figure reflects to some considerable extent the influence of indirect labour movements with a peak in 1966 but a general upward trend.

The magnitude of the variation in the year ending the 31st December, 1966 is difficult to explain. The dramatic increase of nearly one million pounds in the works processing costs represents a 25% increase in this cost over the 1965 value of expenditure.

Considerable investigations have been made into this situation with the following results.

The sharp deviation could be due to the combined affect of factors, which interact and in consequence make any definite statement as to the exact cause of deviation difficult. It is thought however, after consulation with the various members of the company, that the major contributions to such results are:-

(a) The year of 1966 was a 53 week accounting period in contrast t the other years considered within this study which were 52 week accounting periods. This means an additional weeks production is involved and will increase the works processing costsfor that year. It will also

increase the total labour costs for that year but not necessarily to the same extent.

(b) The overhead recovery rate for the manufacturing unit was increased in that year (1966) and resulted in a surplus recovery of approximately £250,000, which it should be noted reduces the real processing cost by that sum. To maintain comparability of the figures the works processing cost should be adjusted to allow for this.

(c) There was a possible transfer of responsibility for the works accounts to Head Office accounts in that year, which reduced the ratio of direct to indirect labour. This appears to be part of a deliberate company policy at that time to reduce or stabalize indirect labour.

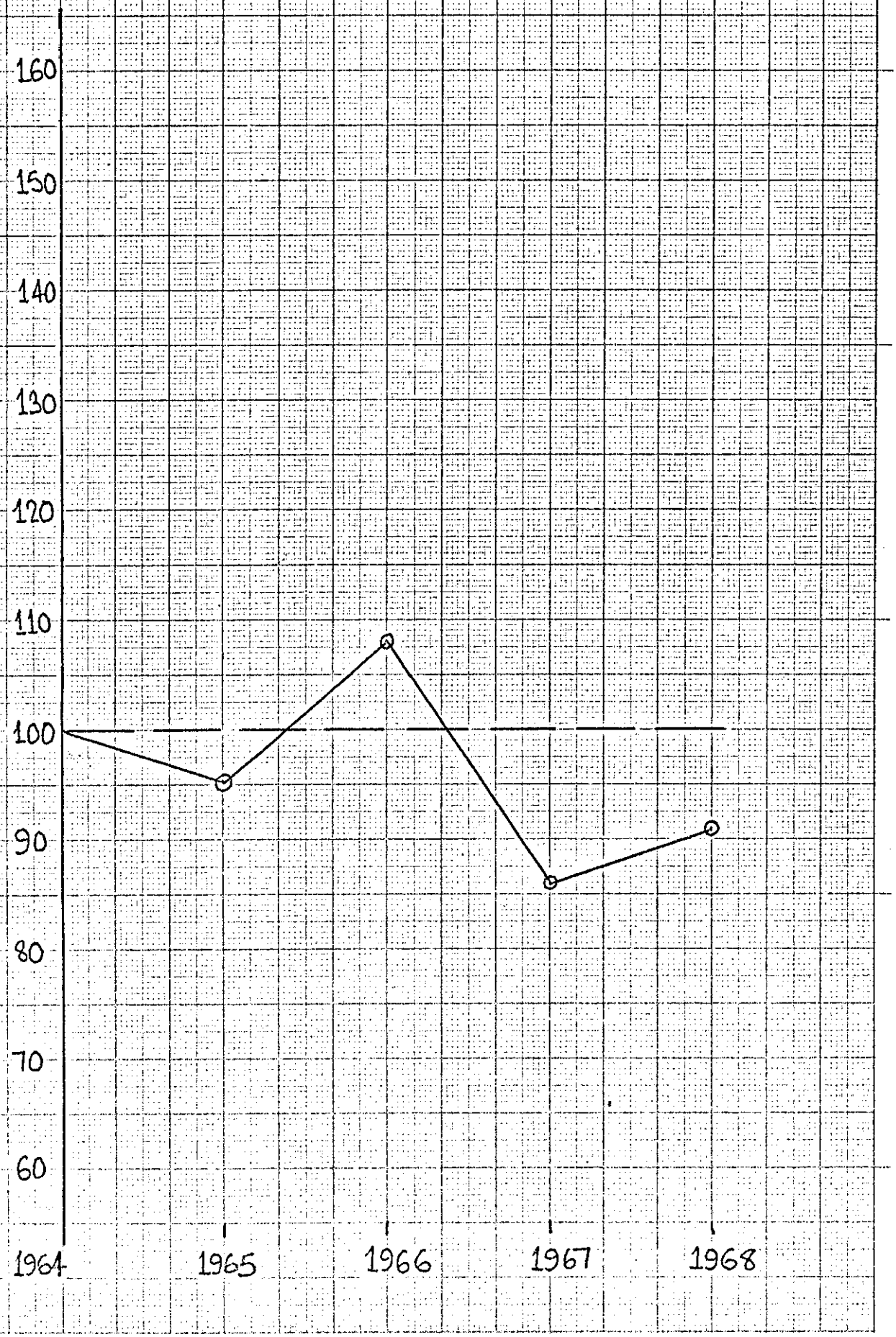
(d) A steady increase in the direct labour force enabled higher production and involved a high production spend.

(e) It may also be noted that during the two previous years there had been a considerable amount of capital investment which may have influenced the 1966 performance.

Thus it may be seen that the 1966 figures may be the results of a deliberate and determined effort by management to cut indirect expenses, whilst expanding direct labour and utilising capital expenditure of the previous year. This combined with a high activity level and the additional operating week would appear to be responsible for the exceptional increase in indirect labour productivity for that year.

CAPITAL PRODUCTIVITY TREND.

[INDEX : 1964 = 100]



CAPITAL PRODUCTIVITY

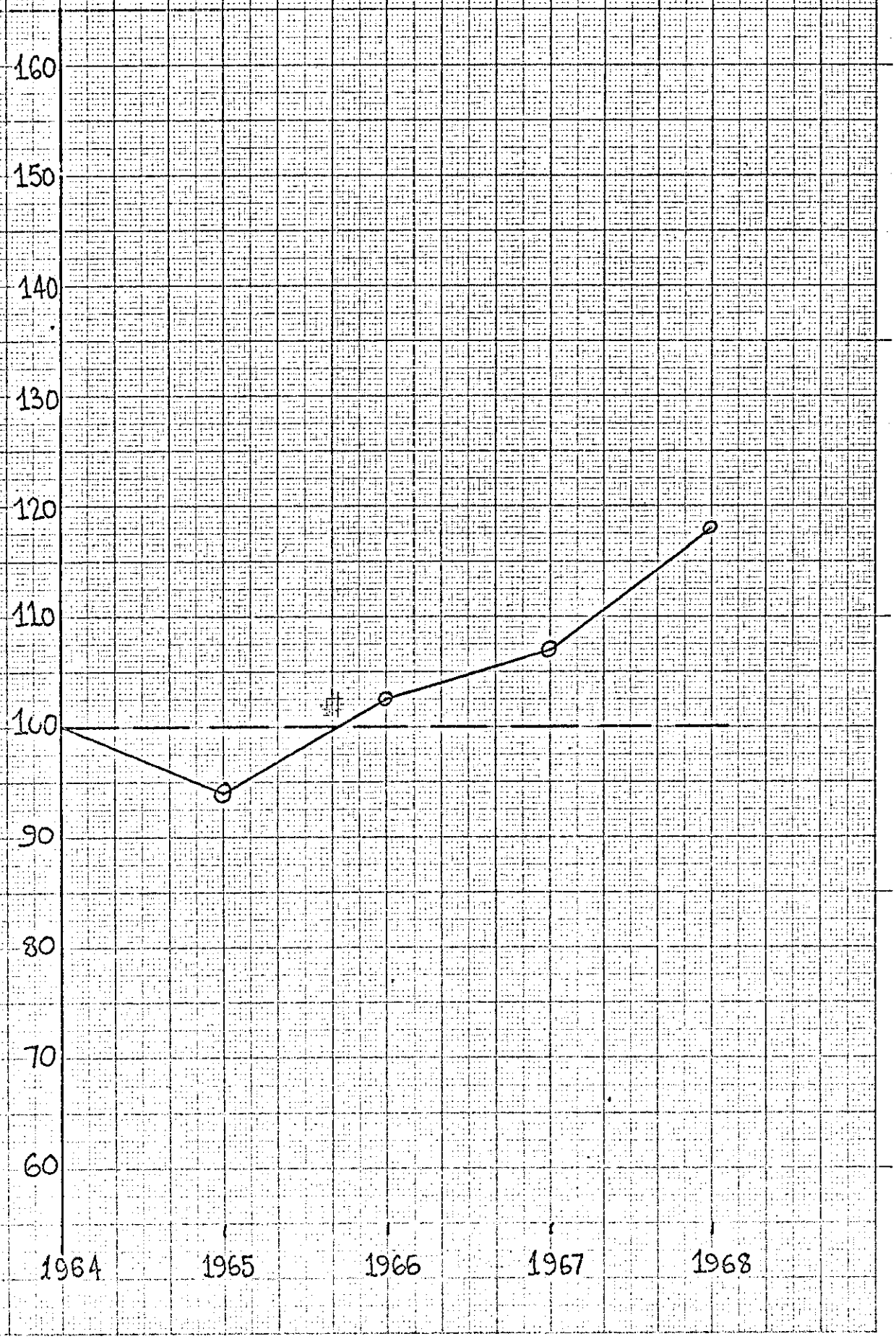
The capital productivity curve shows a general downward trend with the exception again of 1966. The reasons for this exception being the very high "Works Processing Cost" for this year and a cut back on capital expenditure also.

The general trend however, suggests that capital expenditure is occurring at a rate that exceeds the increases in output and it thus this which may be responsible for the general upward trend in labour productivity rather than the increased efficiency of the labour force itself. The slight recovery of the curve in 1968 may be largely due to the transfer of a large amount of fixed assets away from the Chelmsford works and also the general increase in output (W.r.C.)

The trend described above is indicative of the current trend of industries to substitute to some considerable extent, capital for labour.

PRODUCTION SUPERVISION PRODUCTIVITY TREND

[INDEX: 1964 = 100]



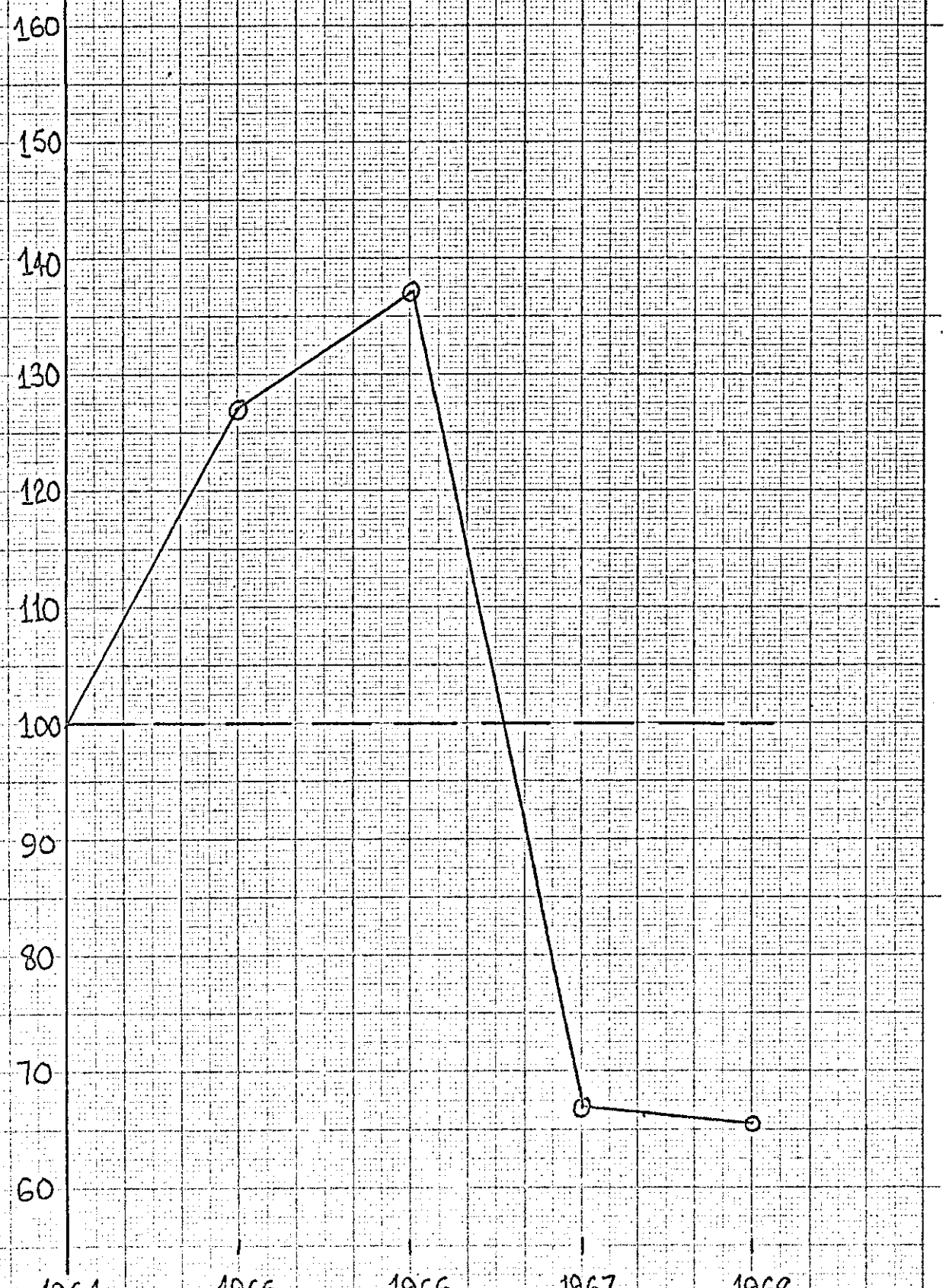
PRODUCTIVITY OF PRODUCTION SUPERVISION

The trend of this input factor, after a drop in 1965 is steadily upwards, aided by the high output (W.O.C.) in 1966 and a sharp cut back in numbers in 1967. The drop in graph for 1965 being largely due to a rapid increase in supervisory staff.

The total movement is slightly below the average for indirect labour in general but is showing a satisfactory and steady improvement.

PRODUCTIVITY OF MATERIAL SERVICES

[INDEX: 1964=100]



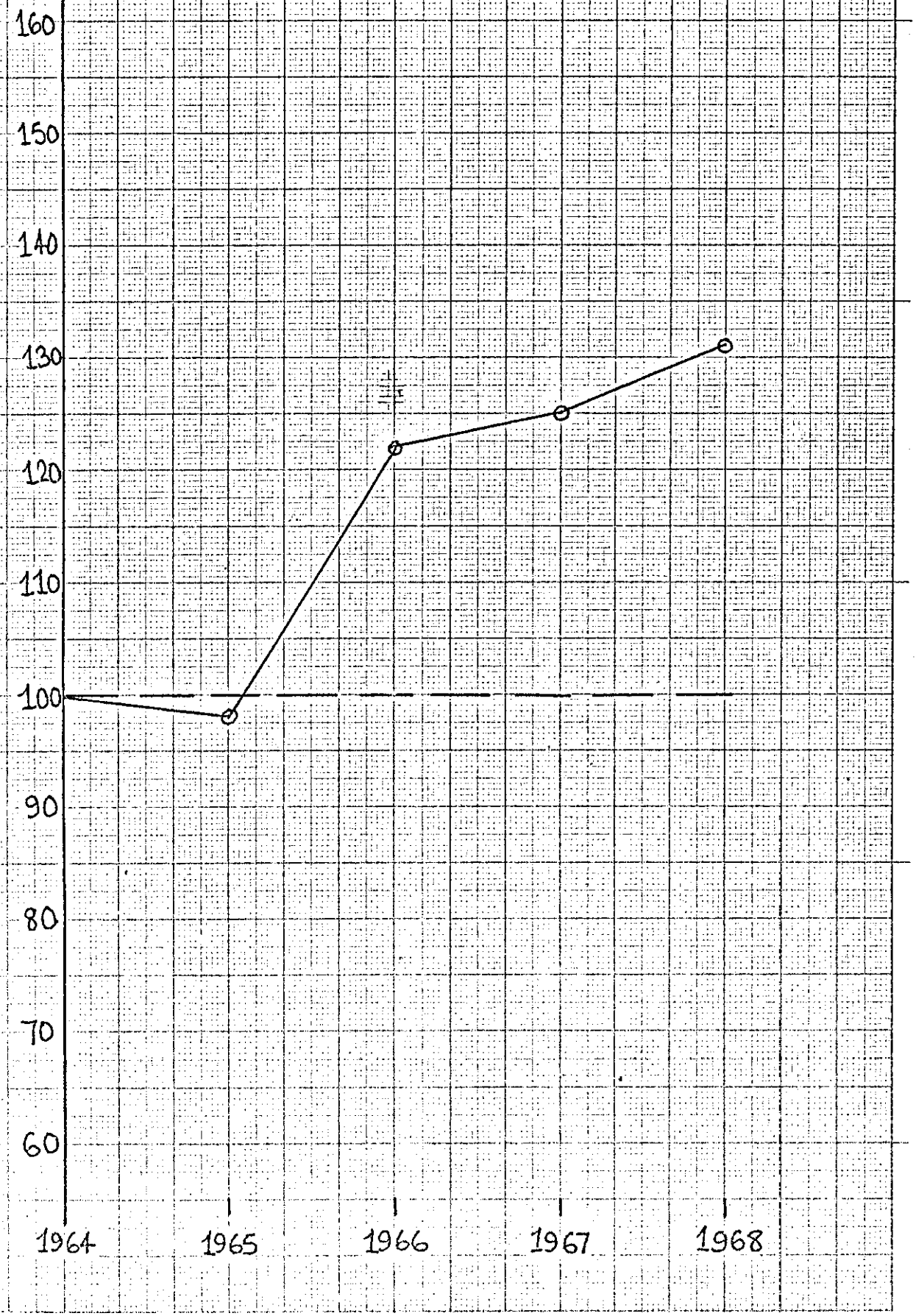
MATERIAL SERVICES PRODUCTIVITY

During the initial stages of the study the productivity index increased rapidly by the high activity levels of 1965 and 1966, the sudden drop in 1967 can be largely explained by the organisational changed in this area which involved large expansions of some of the activities within this group, the introductions of new activities and the transfer of some responsibilities from the shop floor to the Material Services departments. These changes resulted in the total cost of this overhead group nearly doubling in one year and thus the curve cannot be taken as indicative or productivity as the year to year figures are not compatable. A new base year needs to be taken (possibly 1968), in order to establish an index of any value, but this is not possible without applying this new base to all productivity measurements within this study.

Under these circumstances it is perhaps best to acknowledge the structural changes and then consider future movements with this in mind.

ENGINEERING SERVICES PRODUCTIVITY TREND.

[INDEX: 1964 = 100]

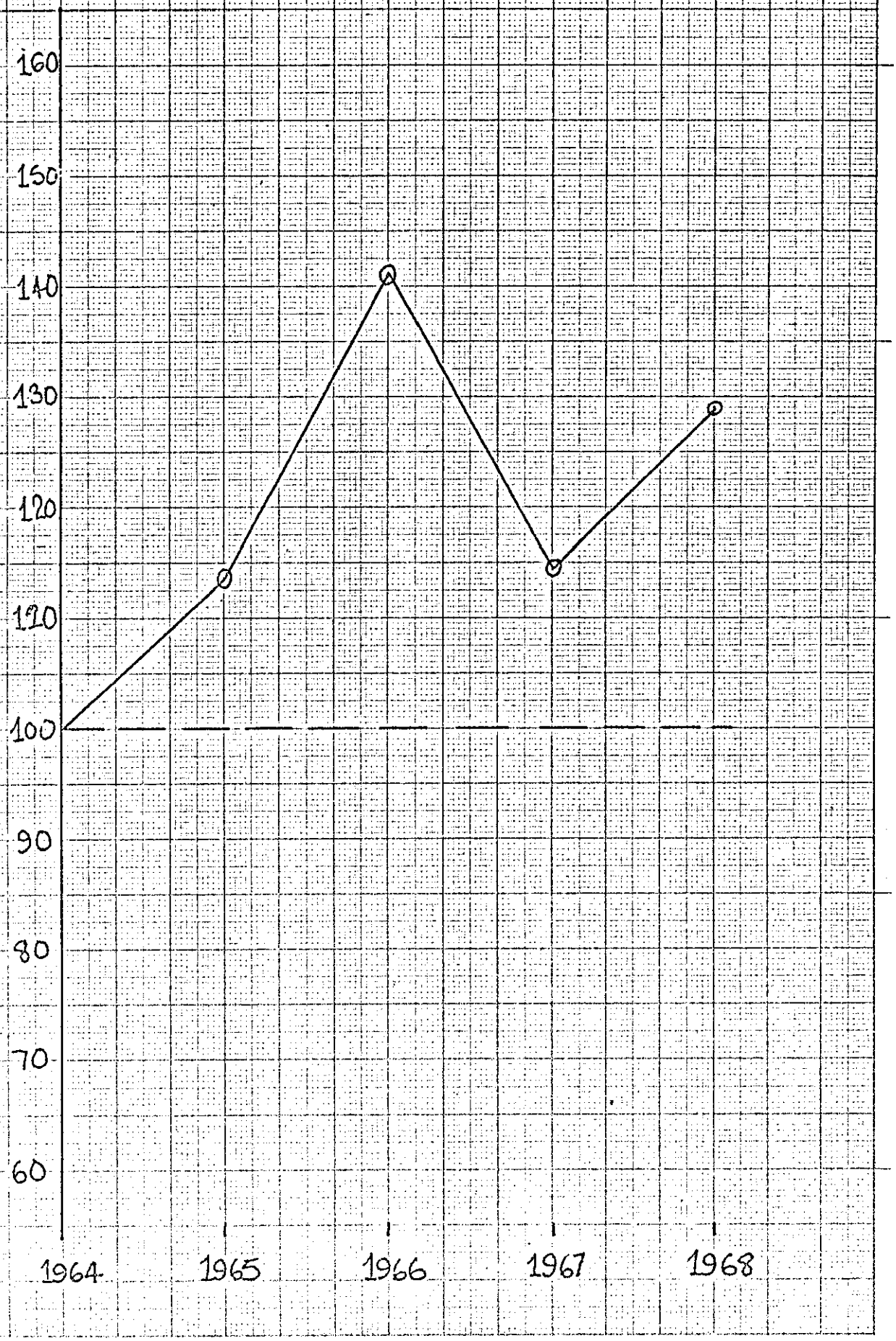


ENGINEERING SERVICES PRODUCTIVITY

Here the trend is again significantly influenced by the 1966 figures showing a rapid rise in the index for 1966, which follows a slight drop in 1965 which appears to be due to an increase in employment level in this category. The sustained high index figures for 1967 and 1968 are largely attributable to the decrease labour within this category in relation to the output (W.P.C) level.

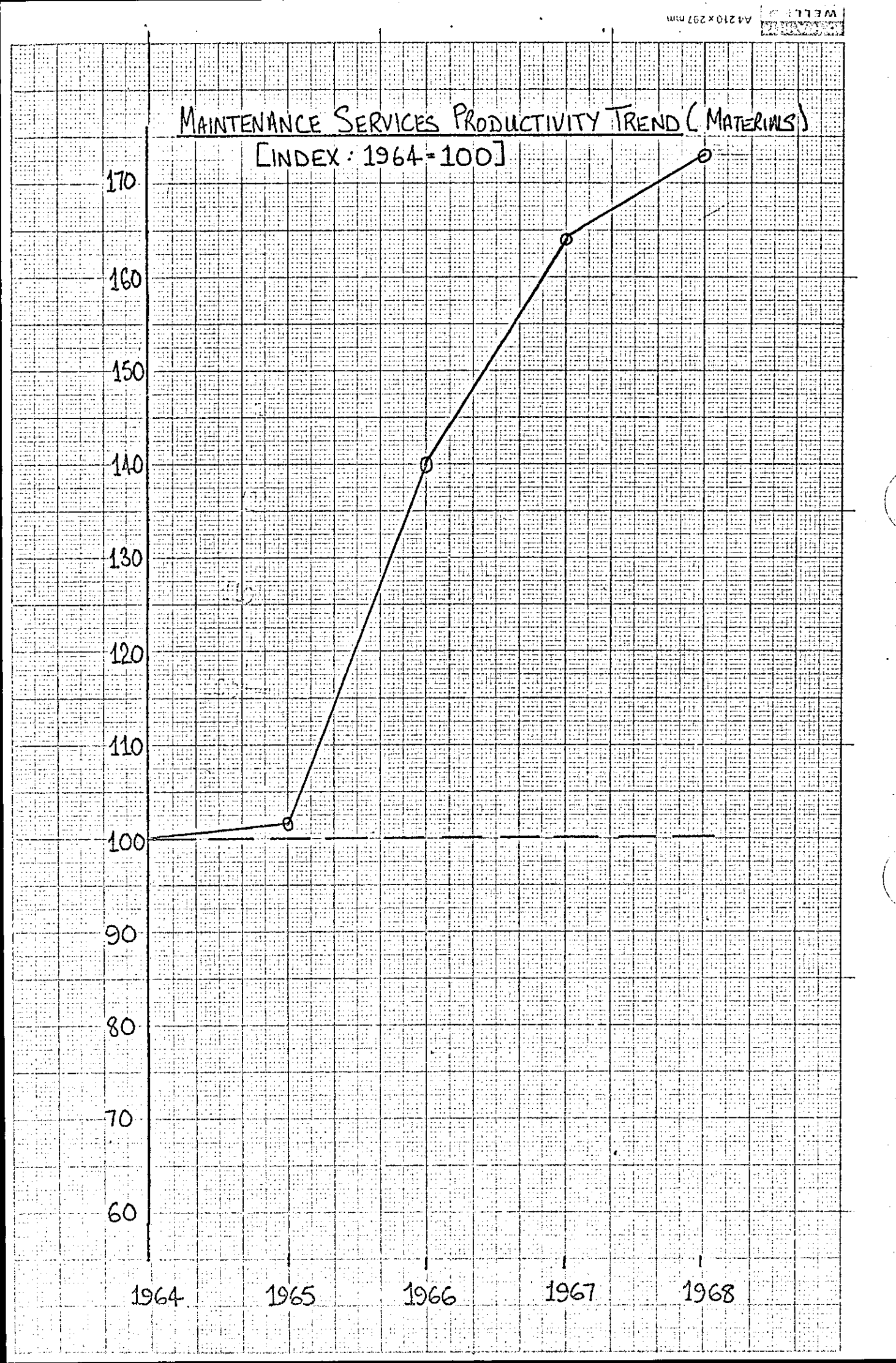
MAINTENANCE SERVICES PRODUCTIVITY TREND. (LABOUR)

[INDEX : 1964 = 100]



MAINTENANCE SERVICES PRODUCTIVITY TREND (MATERIALS)

[INDEX : 1964 = 100]



MAINTENANCE SERVICES PRODUCTIVITY

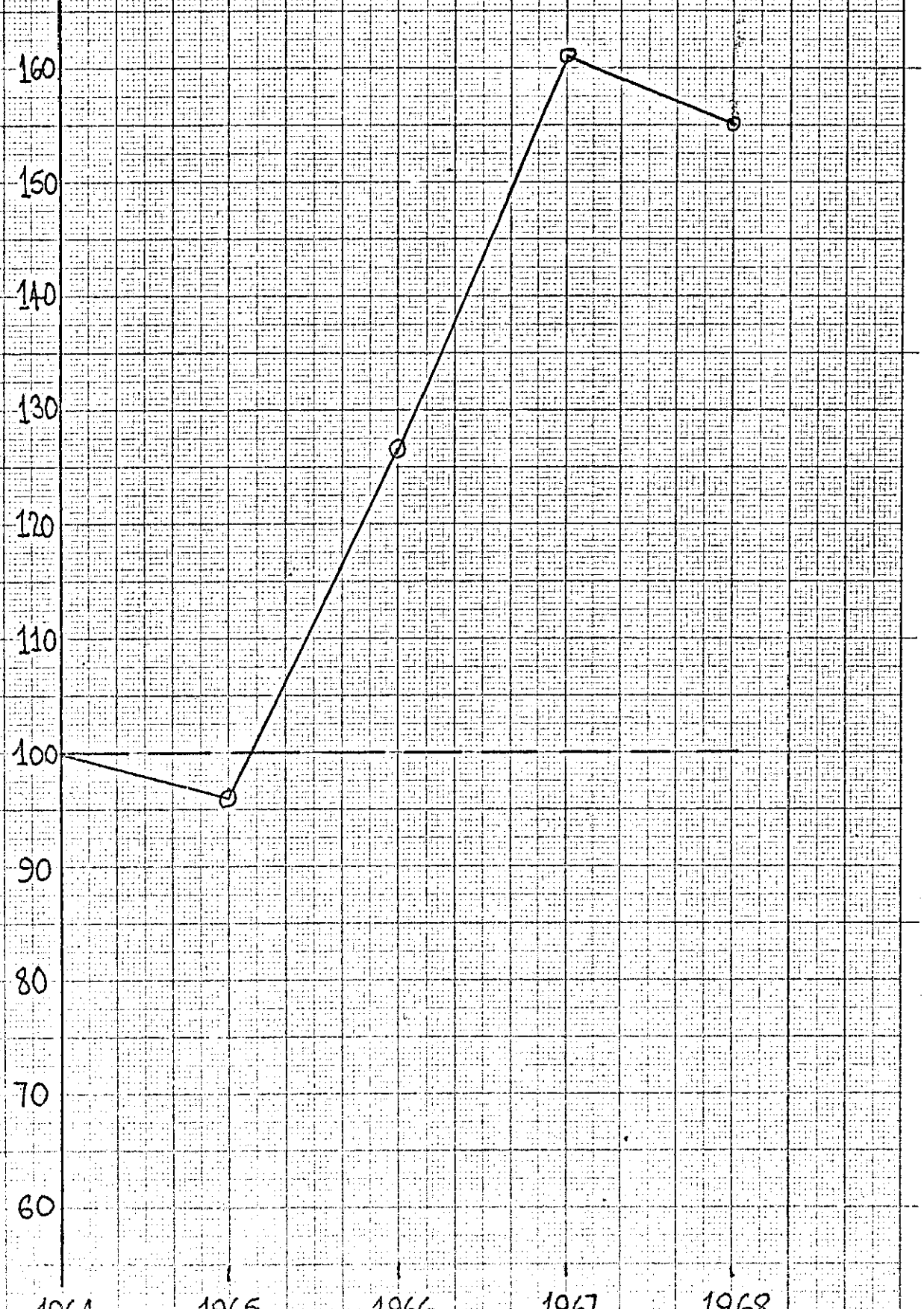
The productivity index for these services follows very closely to the output (W.P.C.) for the years, indicating a relatively stable labour situation. In fact in terms of real values based on 1964 prices, the cost of labour dropped, accounting for the slight upward trend over and above that attributable to output (W.P.C) changes.

This situation exists when measuring over a short period of years because maintenance is only very indirectly linked to output but more directly to the amount of plant and machinery which tend to fluctuate over a much onger period of time.

In the case of Chelmsford works, it was also possible to plot the cost, on output, of material which reveals a rapid upward trend in the index. This may be linked to the high rate of new capital investment in 1964 and 1965 which would require less replacement parts or material than would older plant.

LABOUR SERVICES PRODUCTIVITY TREND.

[INDEX : 1964 = 100]



LABOUR SERVICES PRODUCTIVITY

In the case of this input factor, the index drops in 1965 probably due to the higher overall labour situation which would require greater costs in this area as well. The rapid rise in 1966 may again be attributed to the high level of activity in this year, with little change in indirect labour. The continuing rise in 1967 to a new peak and maintenance of a high level in 1968 may be largely due to a change in policy affecting contract labour.

Contract labour employed within the Chelmsford works are charged as follows, they are charged to the section in which they are are employed at the average rate for that section, the balance of the cost is charged against overheads and is included within this category.

Thus it may be seen that a reduction in contract labour would reduce the labour charge against labour services overhead, this reduction being approximately £175,000 in 1967.

SUMMARY

The above analysis of productivity within the Chelmsford work shows a steady upward trend, although the graphs are somewhat dominated by the 1966 figures which show an exceptional standard of performance.

The relative movements of the labour and capatal indexes seem to suggest that some of the increase in labour productivity is due to the substitution of capital for labour.

The transfer of costs from the shop floor expense codes to material services has been largely responsible, along with the expansion of the material services, for the rapid drop in the productivity index for this input factor.

The elimination of contract labour from the Chelmsford works has resulted in a continued climb in the labour services productivity index.

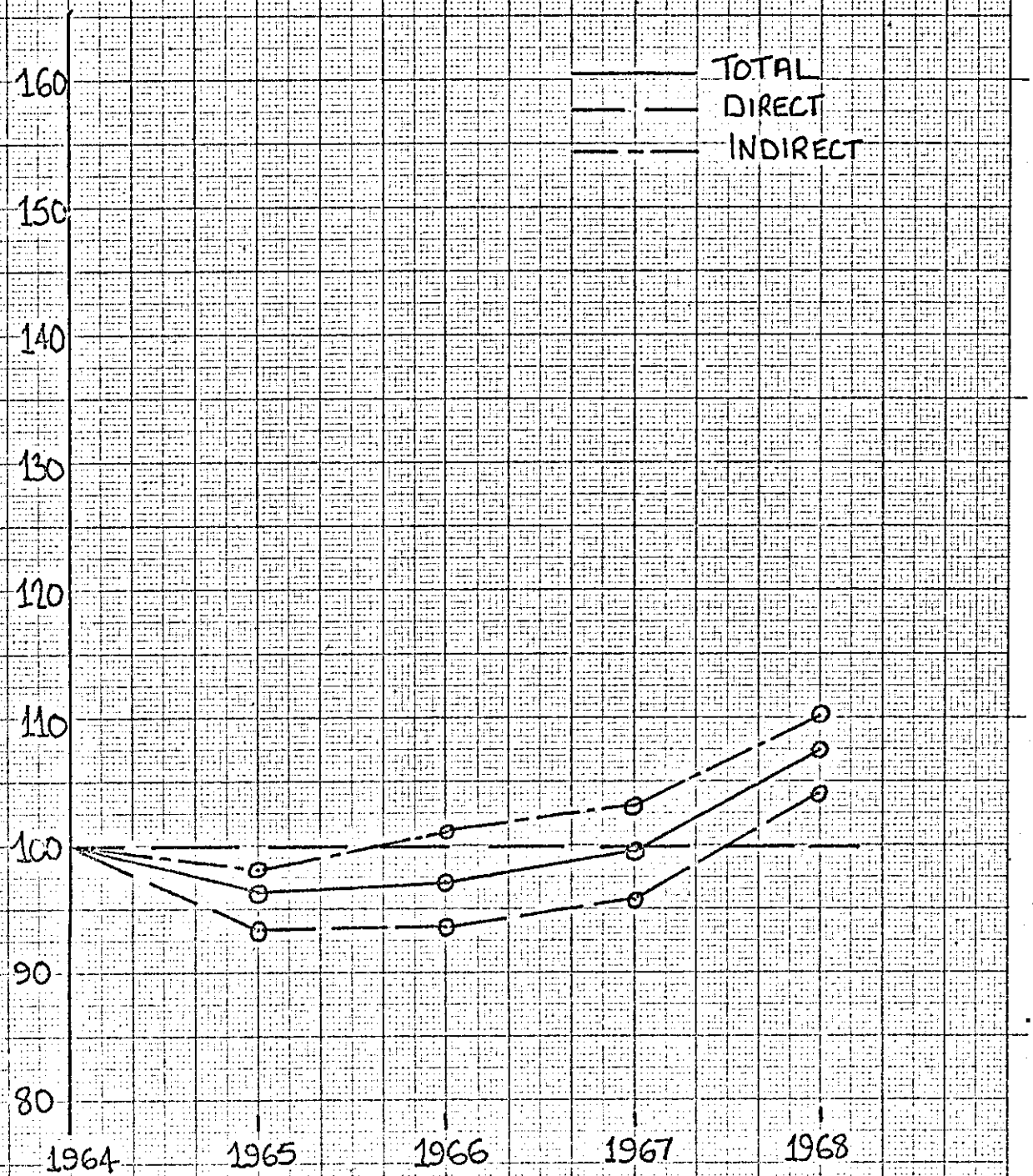
The steady upward climb in activity level has supported this trend along with a positive management policy to reduce indirect costs.

SECTION I

WEMBLEY WORKS

LABOUR PRODUCTIVITY TRENDS.

[INDEX: 1964 = 100]



LABOUR PRODUCTIVITY

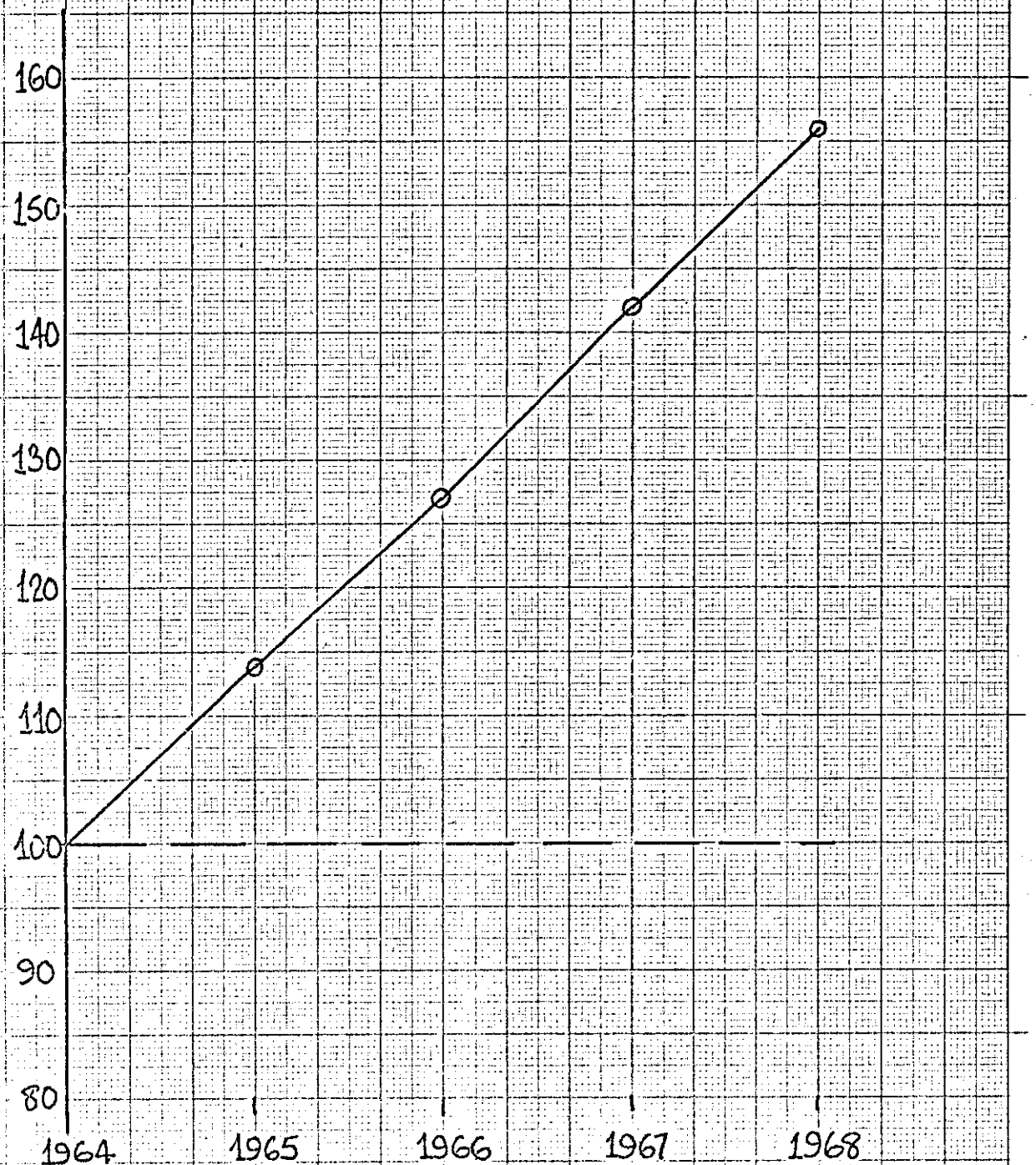
The Wembley Works are relatively new, having commenced operation in 1963, the increase in activity level has been fairly slow until a sharp rise occurred in 1968. In contrast to this there has been a considerable and steady effort to increase labour resourcesof both direct and indirect categories. This may be due to the location of the factory in North West London and the labour situation there.

The combined effect of these two factors has resulted in a drop in the labour productivity index in 1965 which is followed by a slow but steady recovery in the following years, resulting in an increased productivity index in both categories by 1968. Had 1965 been chosen as the base year a continuous improvement would be shown

The poorer performance shown by direct labour would appear to be partially due to the lower flexibility of this category of labour in this area. It is less easy to dismiss and recruit many of the direct grades of labour. There was however, a cut back in employment level in 1967 which assisted the increase in the productivity index.

CAPITAL PRODUCTIVITY TREND

[INDEX : 1964 = 100]



CAPITAL PRODUCTIVITY

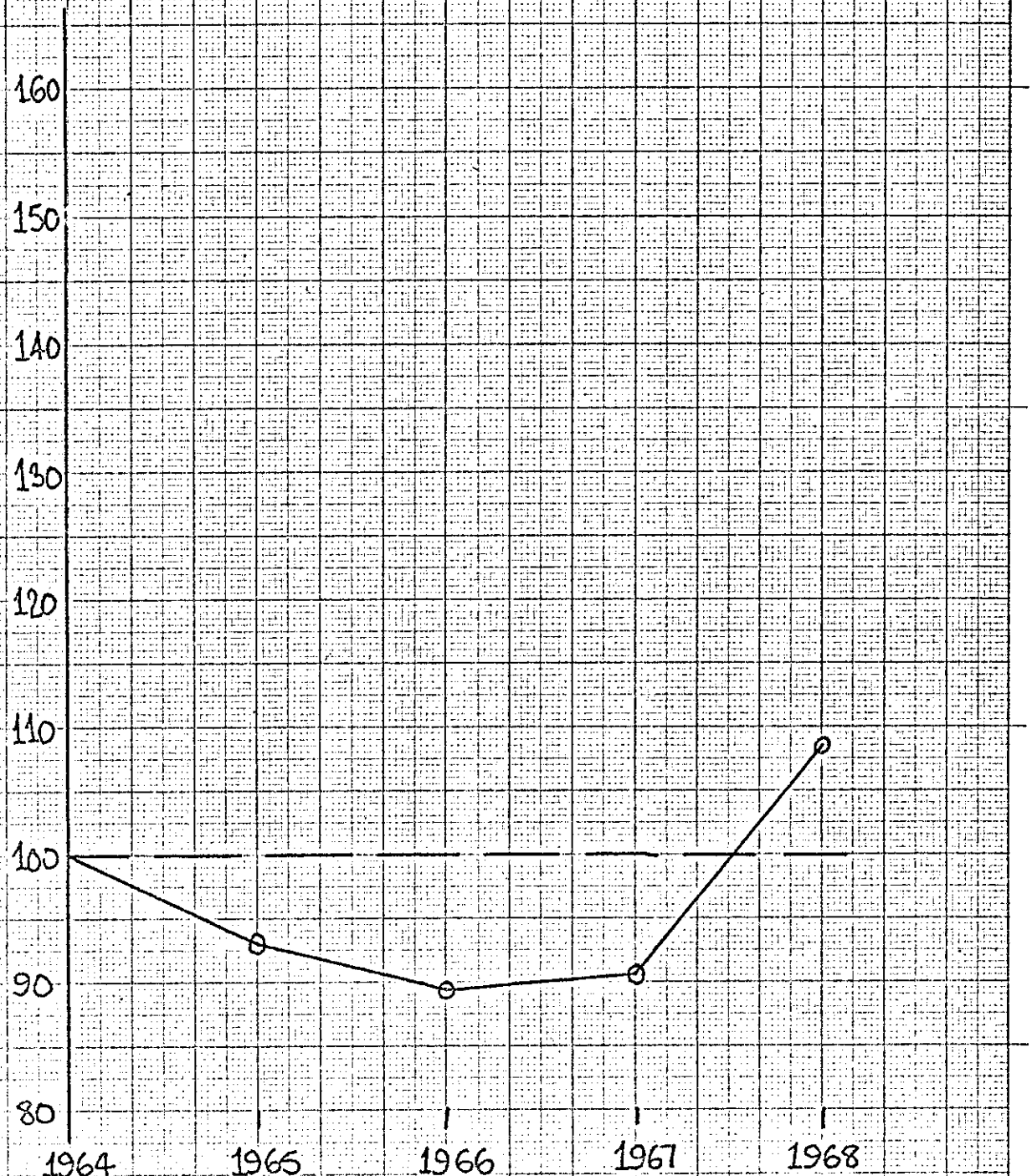
The capital productivity trend has shown a remarkable and continuous upward movement.

This is probably due to the factory being relatively new and requiring little new capital investment over and above that existing at the base date of 1964. In fact the value of fixed assets depreciation has exceeded the rate of new investment showing a net increase in fixed assets in 1964, 1965 1966 and 1967 with a small increase in 1968, which is in line with the increased activity

In the light of these figures for capital productivity the steady climb in labour productivity since 1965 appears to be wholly due to increased labour efficiency at a high activity level.

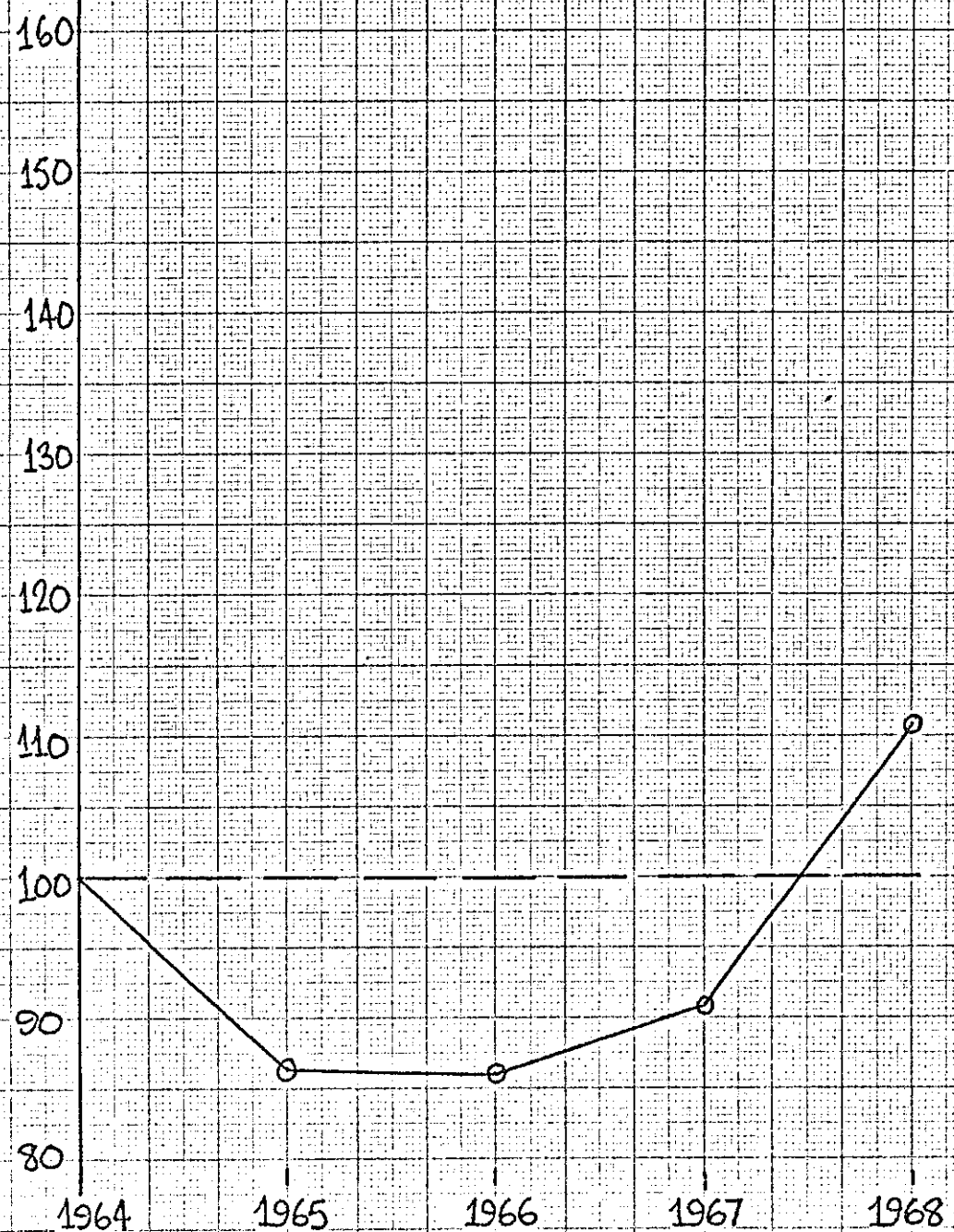
PRODUCTION SUPERVISION PRODUCTIVITY TREND.

[INDEX: 1964 = 100]



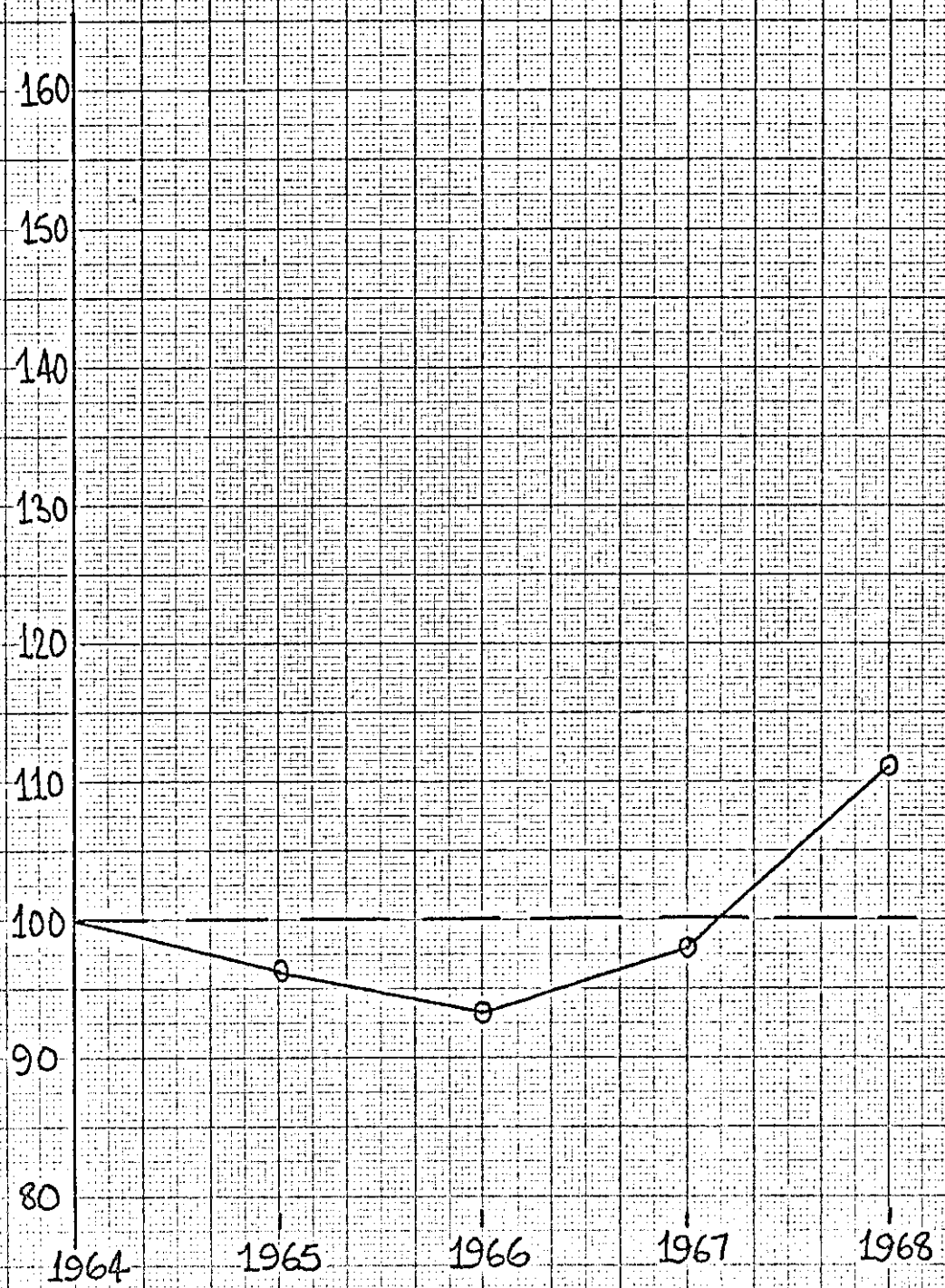
MATERIAL SERVICES PRODUCTIVITY TREND.

[INDEX : 1964 = 100]



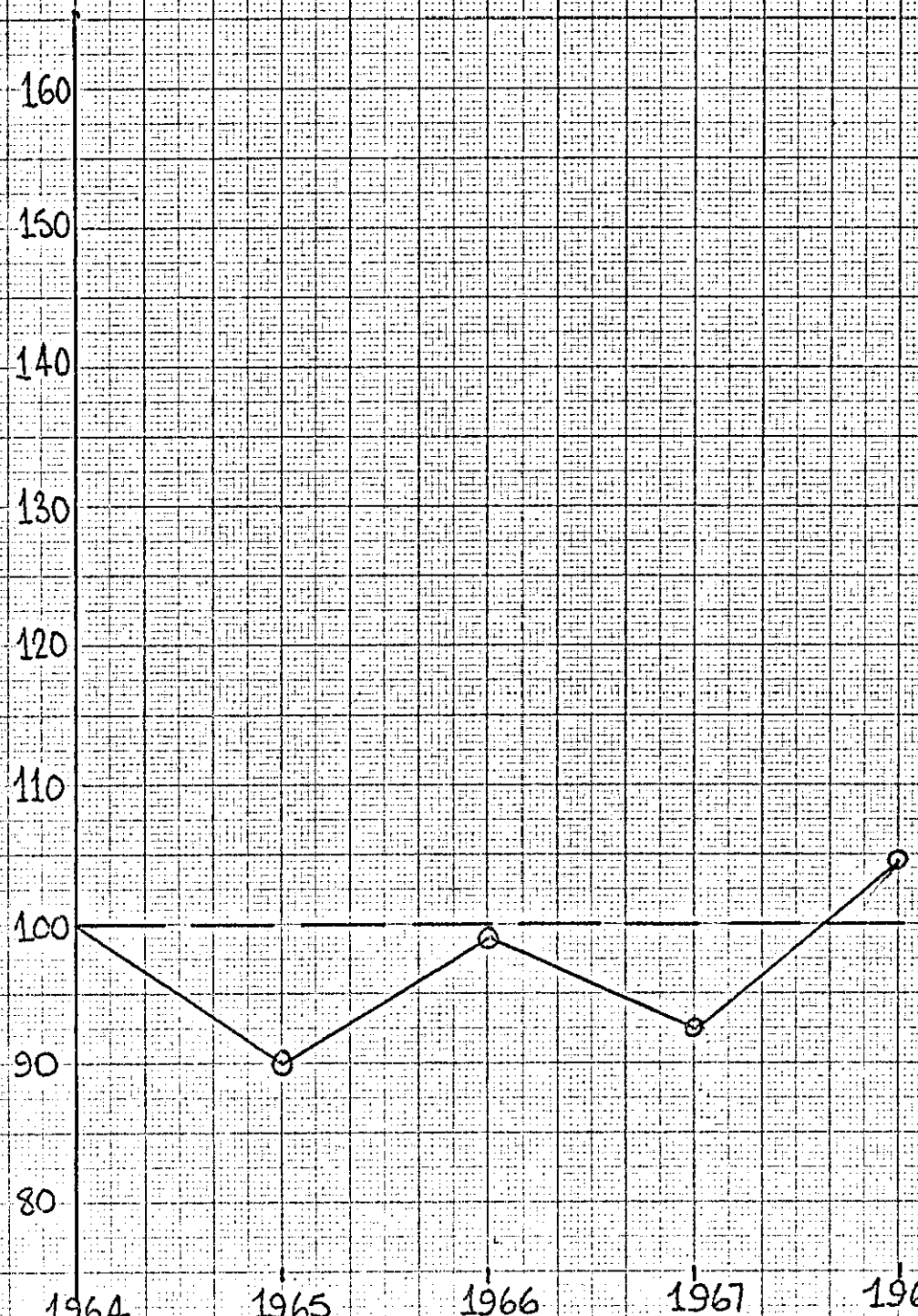
ENGINEERING SERVICES PRODUCTIVITY TREND.

[INDEX : 1964 = 100]



MAINTENANCE SERVICES PRODUCTIVIT TREND.

[INDEX : 1964 = 100]



PRODUCTIVITY OF:-

PRODUCTION SUPERVISION

MATERIAL SERVICES

ENGINEERING SERVICES

MAINTENANCE SERVICES

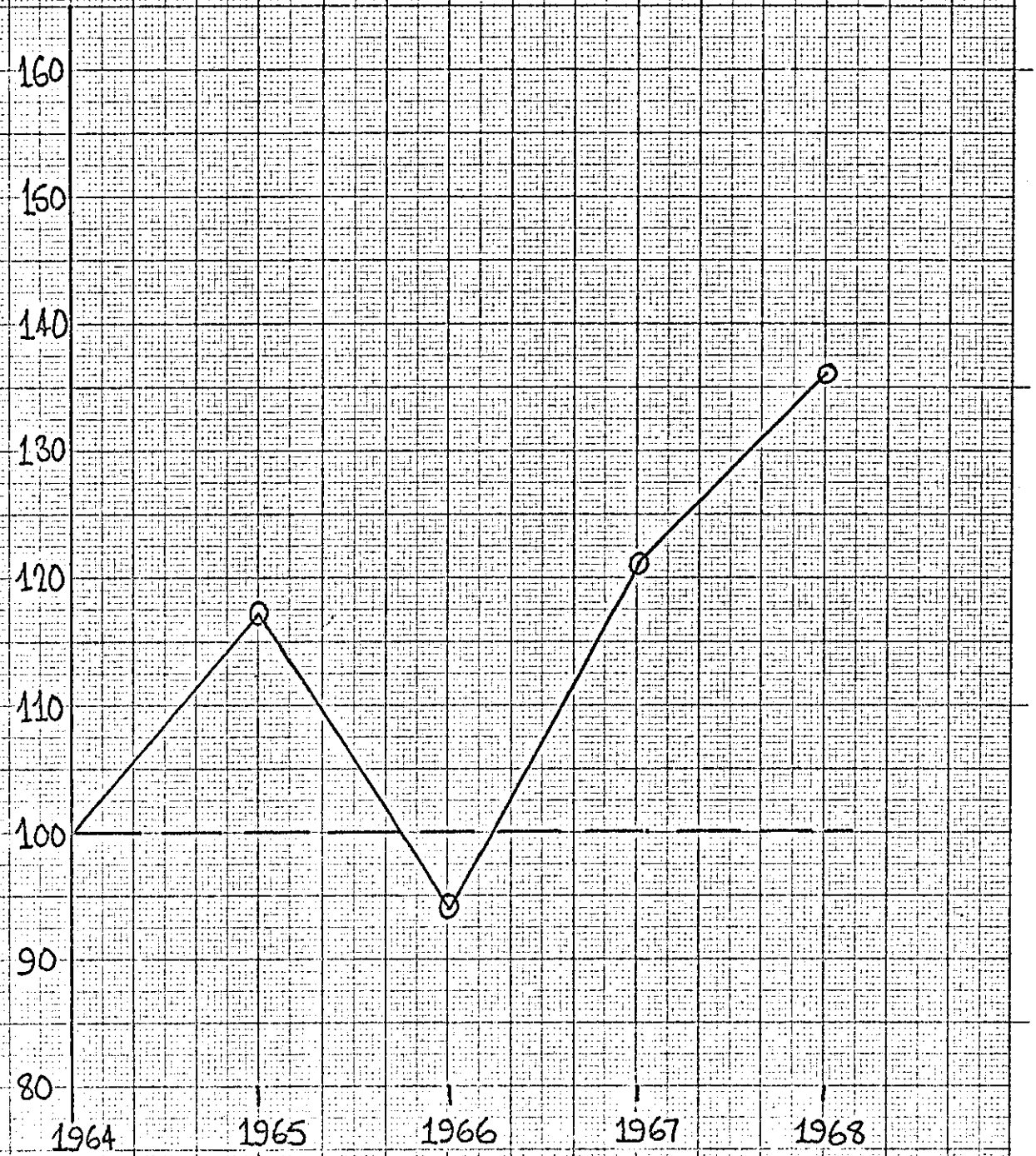
The trend of all these services follow the same pattern a pattern which is similar to that of labour in general. The main difference between these services and the total indirect labour being the slight continuation of the decline of the index in 1966 and the more rapid escalation in 1968. This only serves to emphasise the relative inflexibility of indirect labour in terms of numbers employed.

The improvement of the index for maintenance services in 1966 is due to an apparent decrease in numbers in that year, which appears to have been a temporary situation.

The reasons for the general trend has already been discussed under labour productivity and these also apply to these services.

LABOUR SERVICES PRODUCTIVITY TREND.

[INDEX : 1964 = 100]



LABOUR SERVICES PRODUCTIVITY

Here the productivity trend differs from the others in 1965 this being largely due to a fall in costs of this overhead Holiday pay rose in 1965 so the decrease must have occurred in training or welfare payment.

The trend returns to a similar pattern in 1966 and may be explained as previously in the analysis of labour productivity

SUMMARY

Wembley Works being of recent origin shows an initial drop in labour productivity but starts to recover in a steady manner so that in 1968 a total recovery has been made with some advancement on the base year (1964). Most of this recovery appears to be due to increased efficiency and not to capital investment.

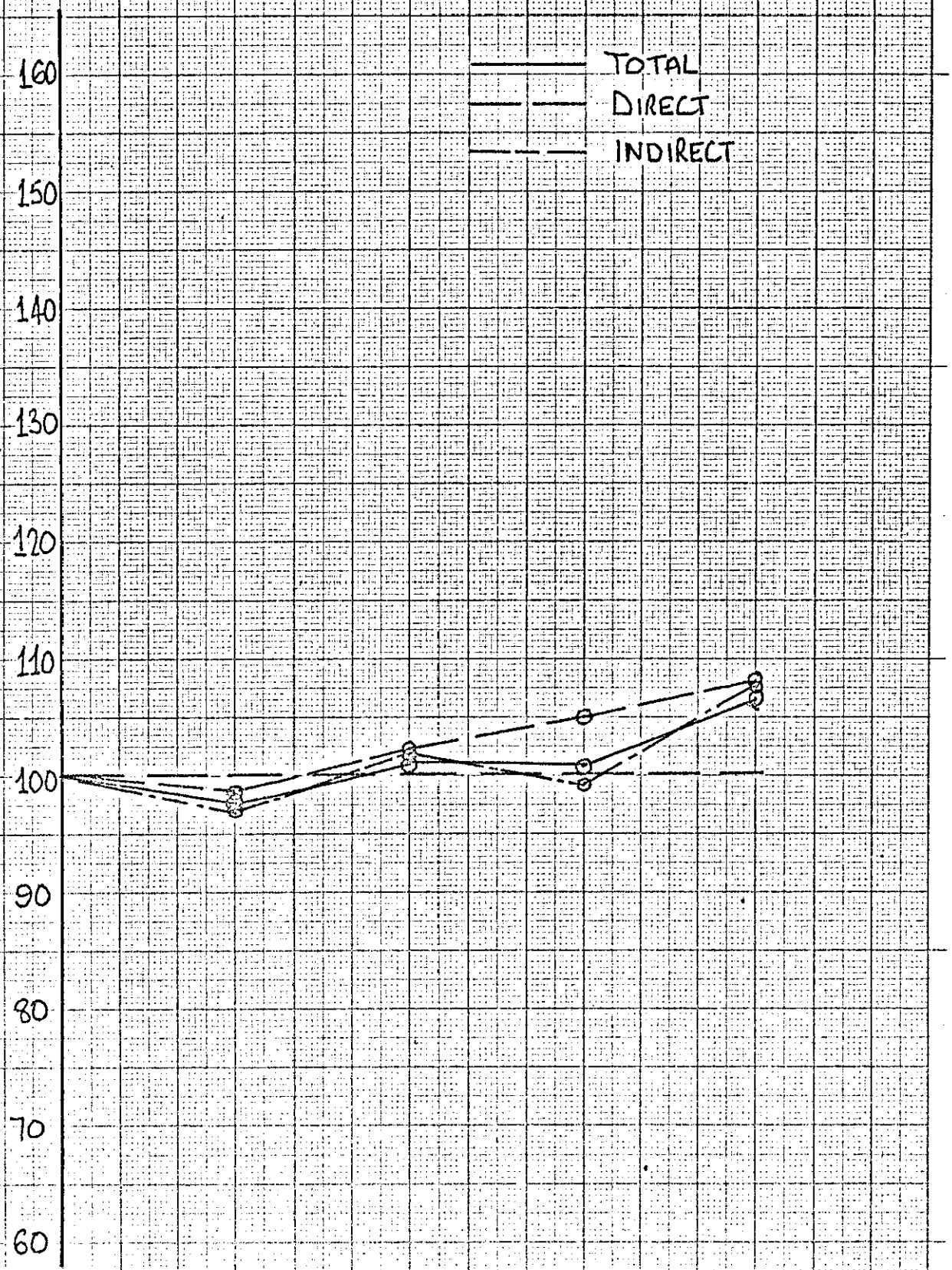
The activities level of Wembley Wprks has increased steadily over the years of the study, and the final increase in 1968 has resulted in more efficient use of resources. A good control appears to have been exercised over the labour costs and much of the improved productivity is due to this.

SECTION I

B A S I L D O N W O R K S (No.1)

LABOUR PRODUCTIVITY TREND.

[INDEX : 1964 = 100]



LABOUR PRODUCTIVITY

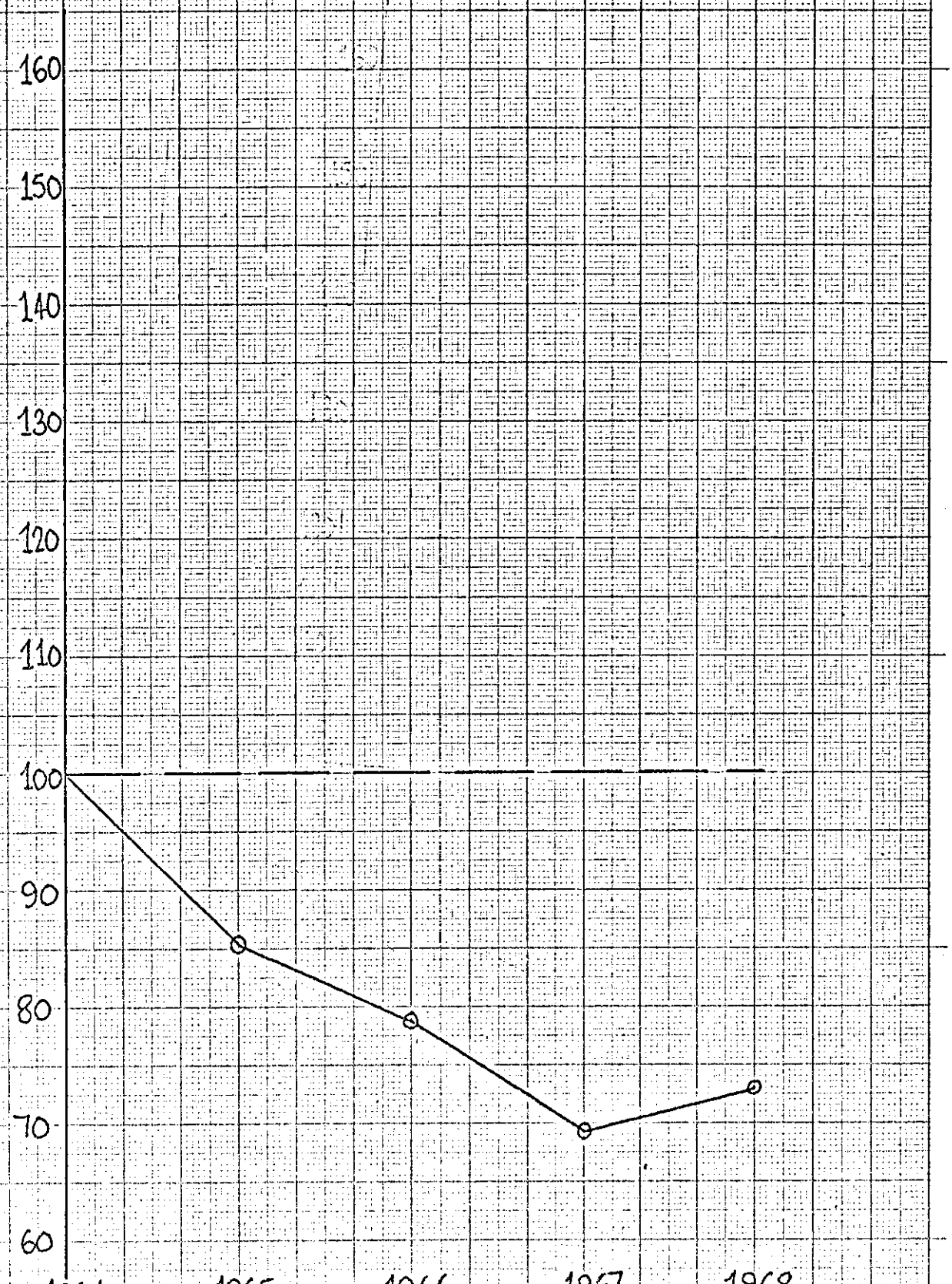
There appears to have been little real change in productivity of either total labour or indirect labour until 1968, when a high level of activity and W.P.C. spend occurred creating a rise of about 7% over the base year performance. Direct labour however, has moved ahead after a slight drop in 1965. Much of this movement may be due to the continuous injection of new capital in the terms of fixed assets.

Real labour costs have risen steadily indicating increase in numbers employed, especially within the indirect categories this may also be responsible for the low increase in productivity particularly in the years 1965 and 1966 when labour costs rose at a faster rate than the value of output (W.P.C.).

The cut back in labour cost during 1967 was sufficient in the case of direct labour to maintain the rise in productivity but insufficient to hold indirect labour productivity at its 1966 levels.

CAPITAL PRODUCTIVITY TREND.

[INDEX : 1964 = 100]



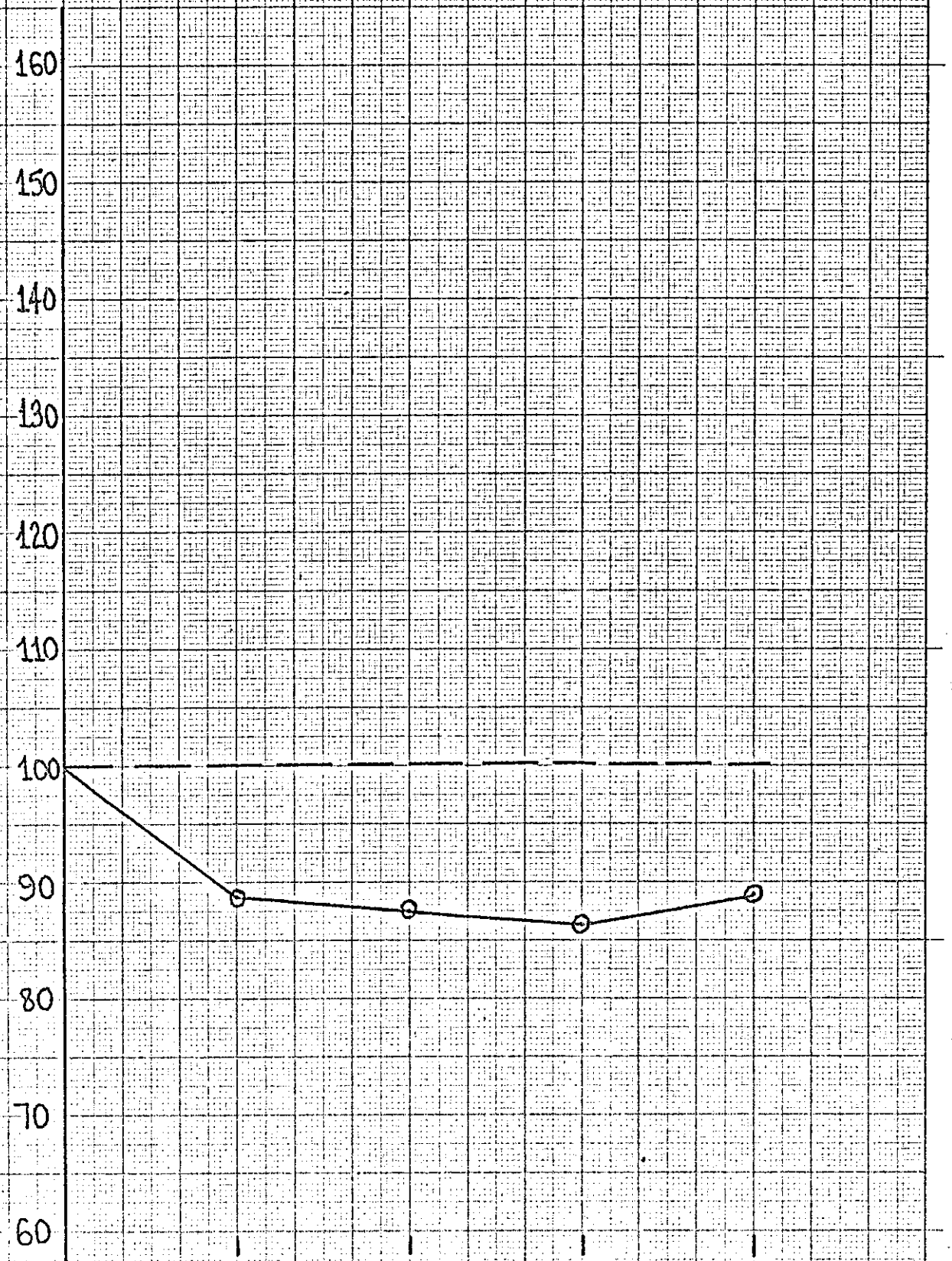
CAPITAL PRODUCTIVITY

The capital productivity trend is rapidly downwards reflecting the high rate of capital expenditure, without the supporting levels of output (W.P.C.) the slight recovery in 1968 being due to the increased output (W.P.C) in that year.

Unfortunately, the drop in productivity of capital is not balanced by the expected increased in labour productivity and it is hoped that the investments show improved labour productivity before long combined with an improvement in capital productivity.

PRODUCTION SUPERVISION PRODUCTIVITY TREND.

[INDEX: 1964 = 100]



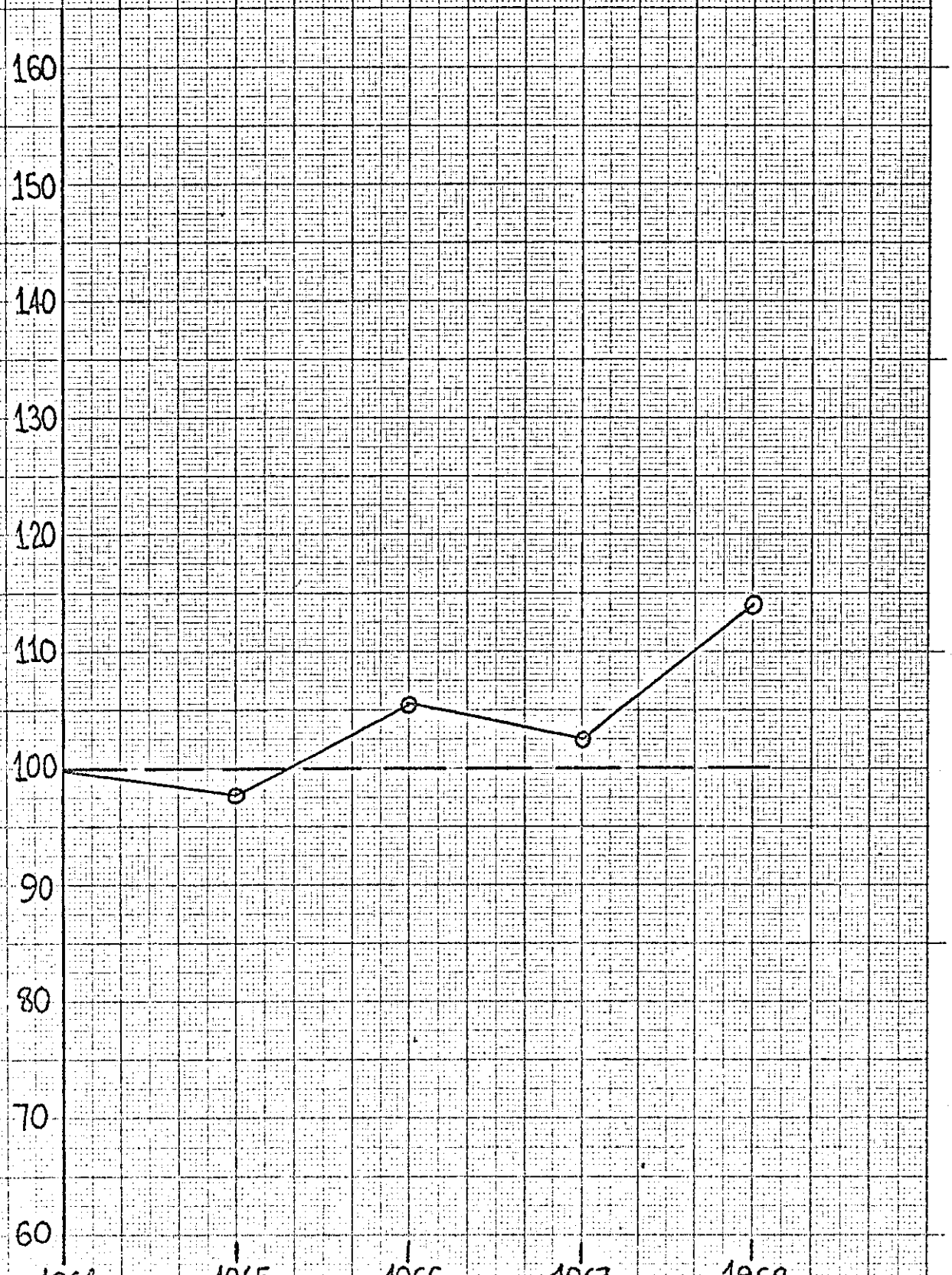
PRODUCTIVITY OF PRODUCTIONS SUPERVISION

The trend of this input factor has been steadily downwards with a slight recovery in 1968. This movement reflects the high rate of increase in the cost of production supervision which has exceeded the rise in Works processing.

The ratio of Supervisory costs to works processing seems high in comparison with other works and this may be the reason for the poor results. On the other hand it may be that the type of labour now employed, or the nature of the work, requires higher levels of supervision than was the case in 1964.

MATERIAL SERVICES PRODUCTIVITY TREND.

[INDEX: 1964 = 100]



MATERIAL SERVICES PRODUCTIVITY

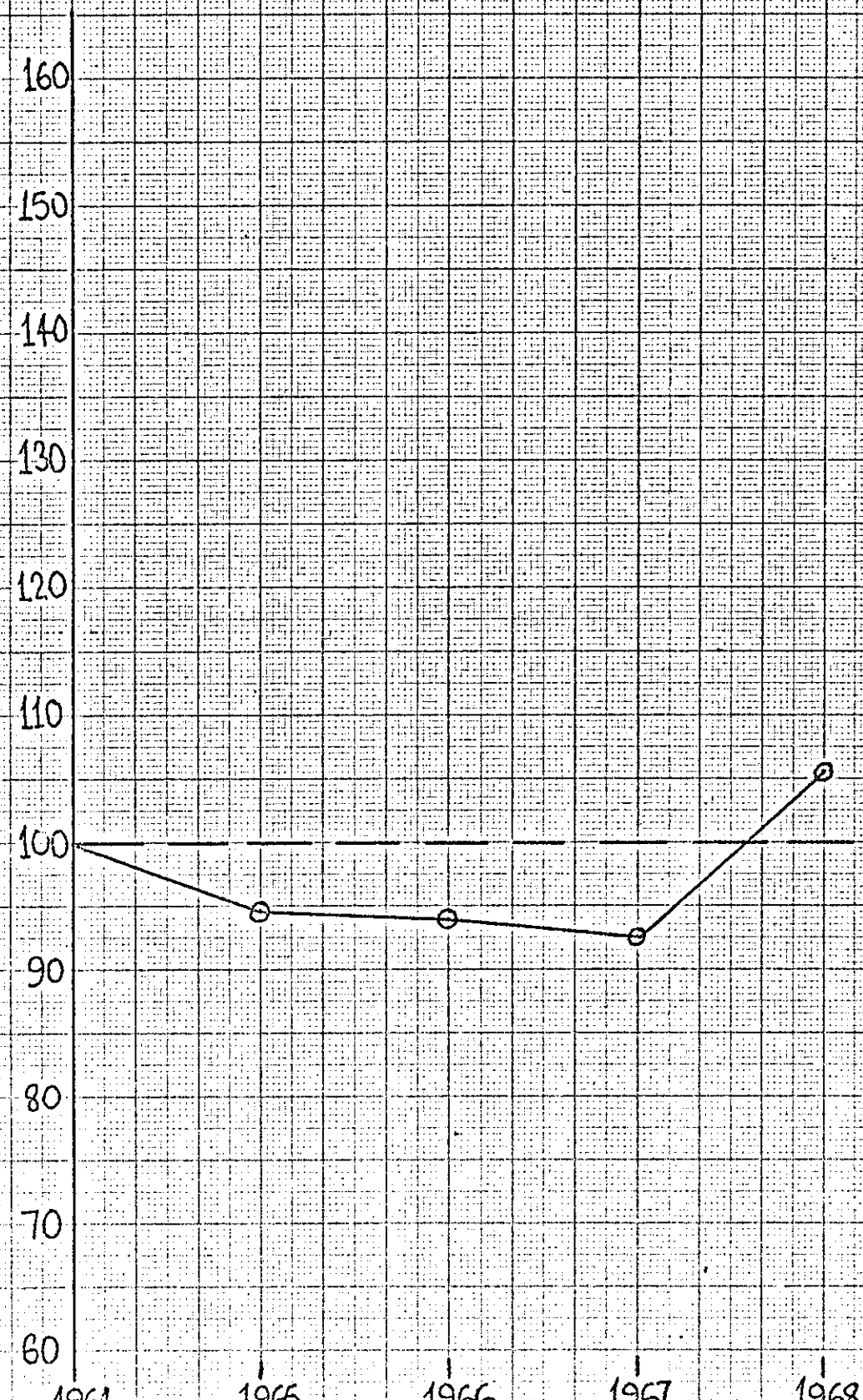
The movement of the index in this case, although flutuating from year to year, has been steadily upwards, resulting in a 14% improvement by 1968.

The peak in the graph for 1966 being due to the higher level of activity in that year, and the fall in 1965 being due apparently to a sharp increase in the labour costs which appear to be general across all the service inputs.

The relatively good performance here, has assisted in holding the overall performance of indirect labour fairly steady.

ENGINEERING SERVICES PRODUCTIVITY TREND.

[INDEX : 1964 = 100]



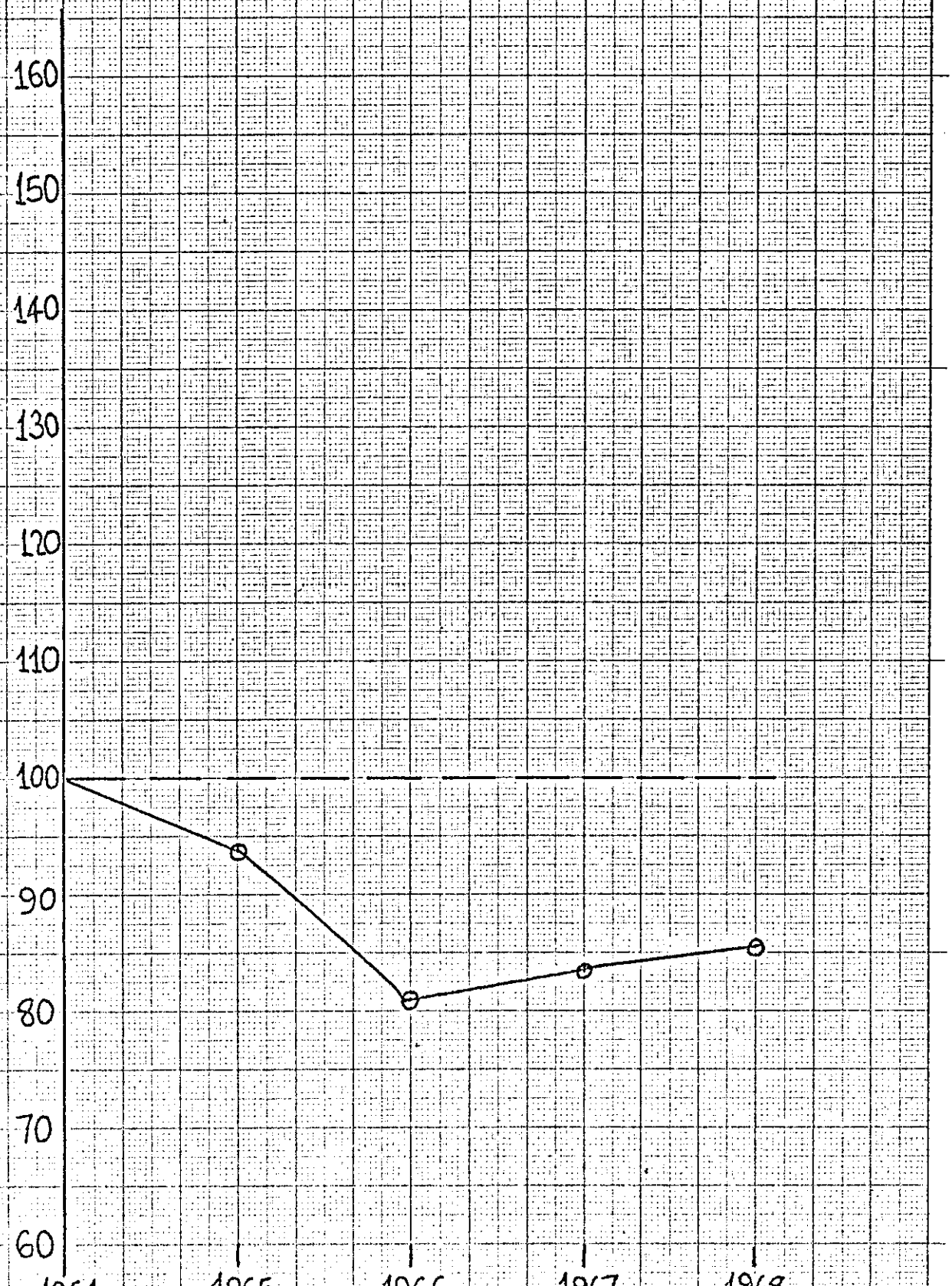
ENGINEERING SERVICES PRODUCTIVITY

Here again we have a similar pattern of productivity to that which we have seen for production supervision.

A steady increase in output (W.P.C.) has not been sufficient to support the more rapidly expanding labour costs which represents additional labour, over the period 1964-1966. The continued drop in 1967 occurred because although labour costs were cut, they were not reduced in line with output (W.P.C.) The recovery in 1968 came about because not only did output (W.P.C.) expand but, labour costs were considerably further reduced.

MAINTENANCE SERVICES PRODUCTIVITY TREND.

[INDEX: 1964 = 100]



MAINTENANCE SERVICES PRODUCTIVITY

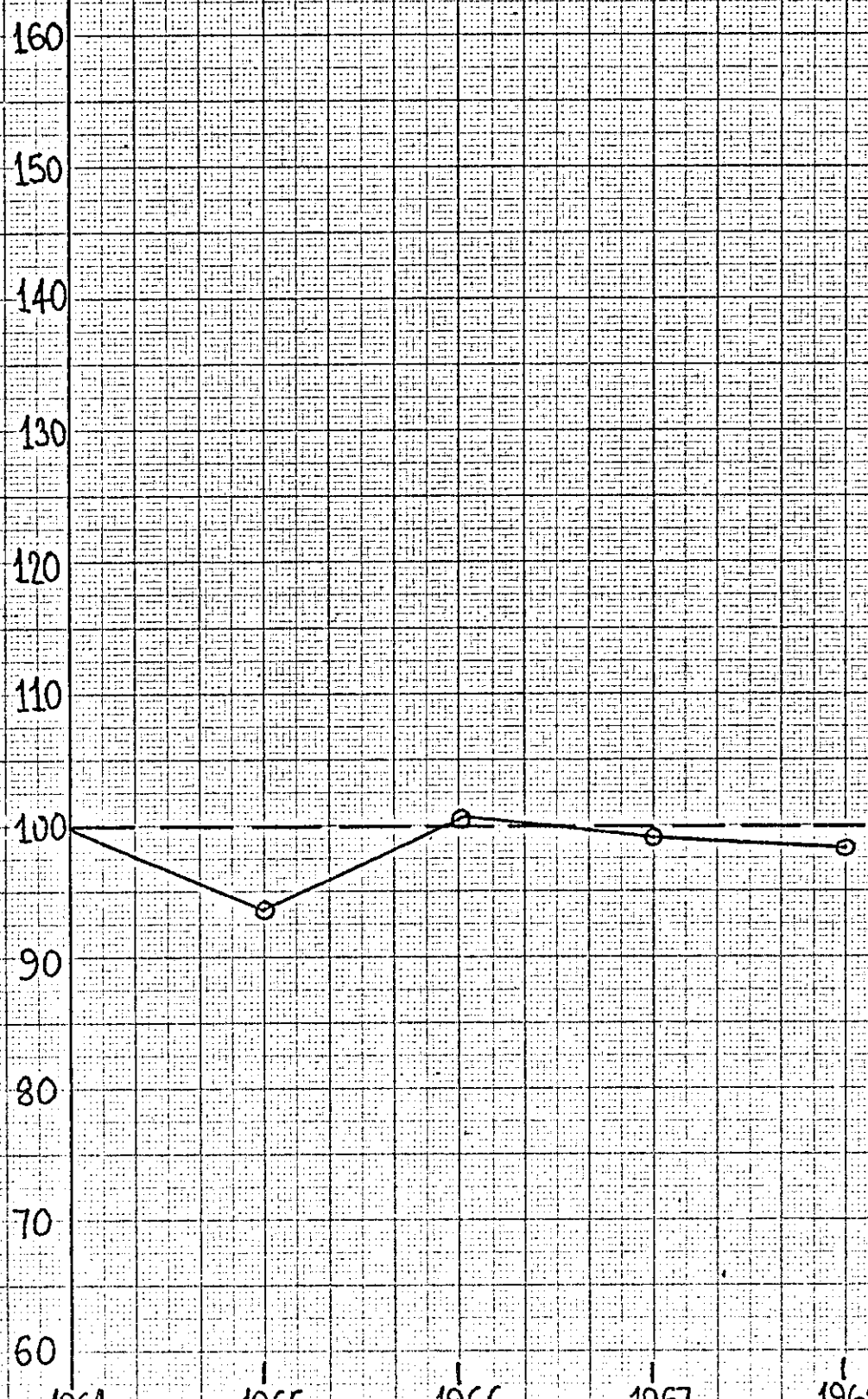
The trend here is again the fall in the early years of the study followed by a slight recovery.

However, the sharp decline in 1966 appears to be due to a rapid expansion of maintenance services and not just average movement. It is therefore, doubtful if the period prior to 1966 is compatable with the years 1966 onwards in real terms, but when viewed from the viewpoint of the management, the future trends will still be of considerable interest.

The original level of maintenance may have been inadequate and with increasing fixed assets, in the form of plant and machinery additional expenditure would be required.

LABOUR SERVICES PRODUCTIVITY TRENDS.

[INDEX: 1964 = 100]



LABOUR SERVICES PRODUCTIVITY

Here the effect of rapidly increasing labour force shows itself in the 1965 figures the additional holiday pay, welfare payments and training or the additional labour force in total, all being reflected in this input factor.

The large increase in labour in 1966 in conjunction with a smaller increase in output (W.P.C.) resulted in the drop in productivity and the recovery in 1966 was due to a high level of Works processing. This recovery was maintained to some extent but a slight fall resulted from the continuing high level of costs.

SUMMARY

The general picture illustrated by these graphs is one of a decline in production in the arly years of the study but a recovery occurred toward the end.

The impression received from these graphs was that the manufacturing unit was increasing labour and capital resources in anticipation of further orders, these did not materialise until toward the end of the study period and hence the plant was working under capacity and should be able to show further improvement given an adequate work load.

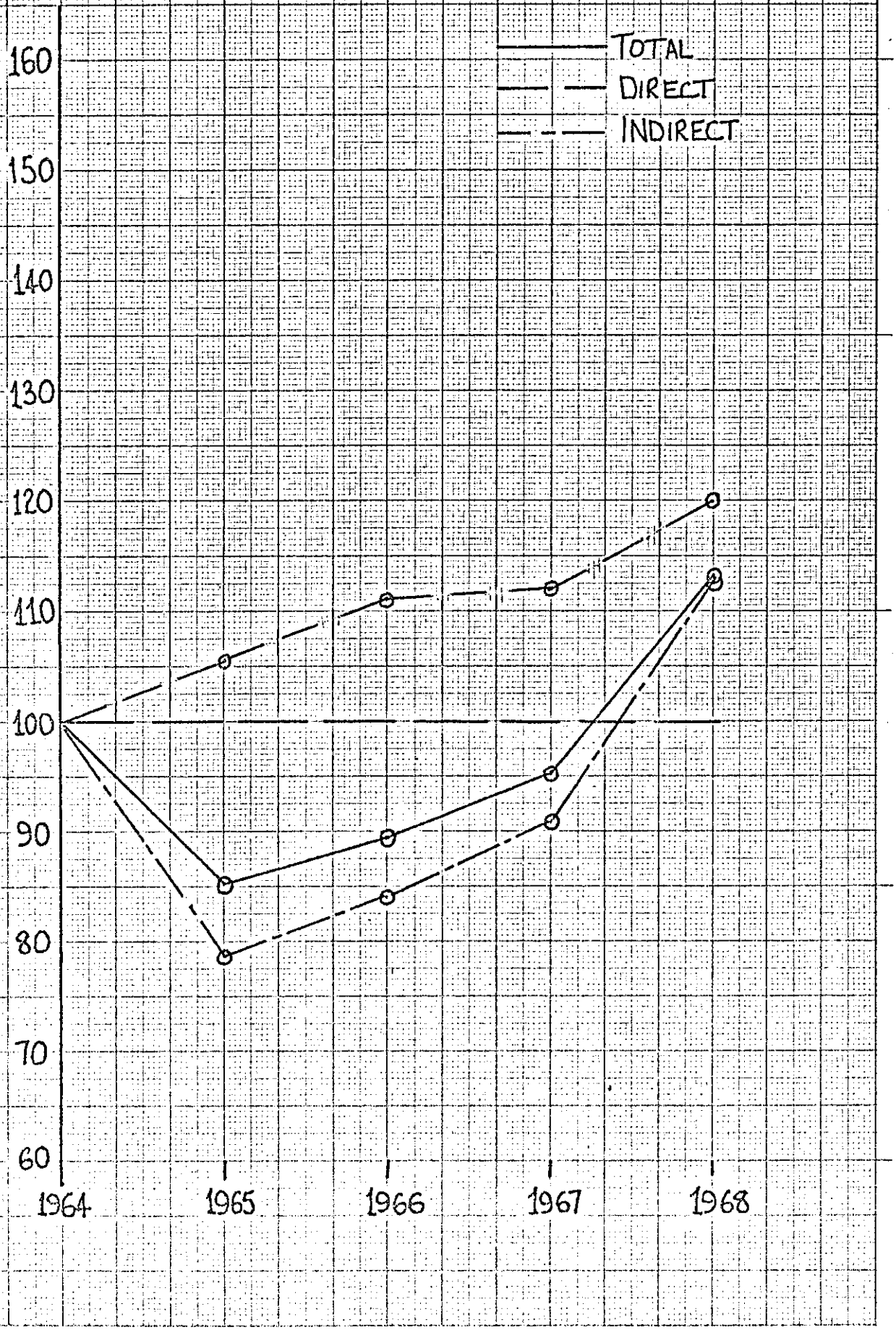
N.B. For the purpose of company interest the data given is for Basildon 1 and excludes the "MARTEL" Project.

SECTION I

GATESHEAD WORKS

LABOUR PRODUCTIVITY TREND.

[INDEX : 1964 = 100]



LABOUR PRODUCTIVITY

The trend of direct and indirect labour present two slightly different pictures, but with the exception of the 1965 results, the stories are the same.

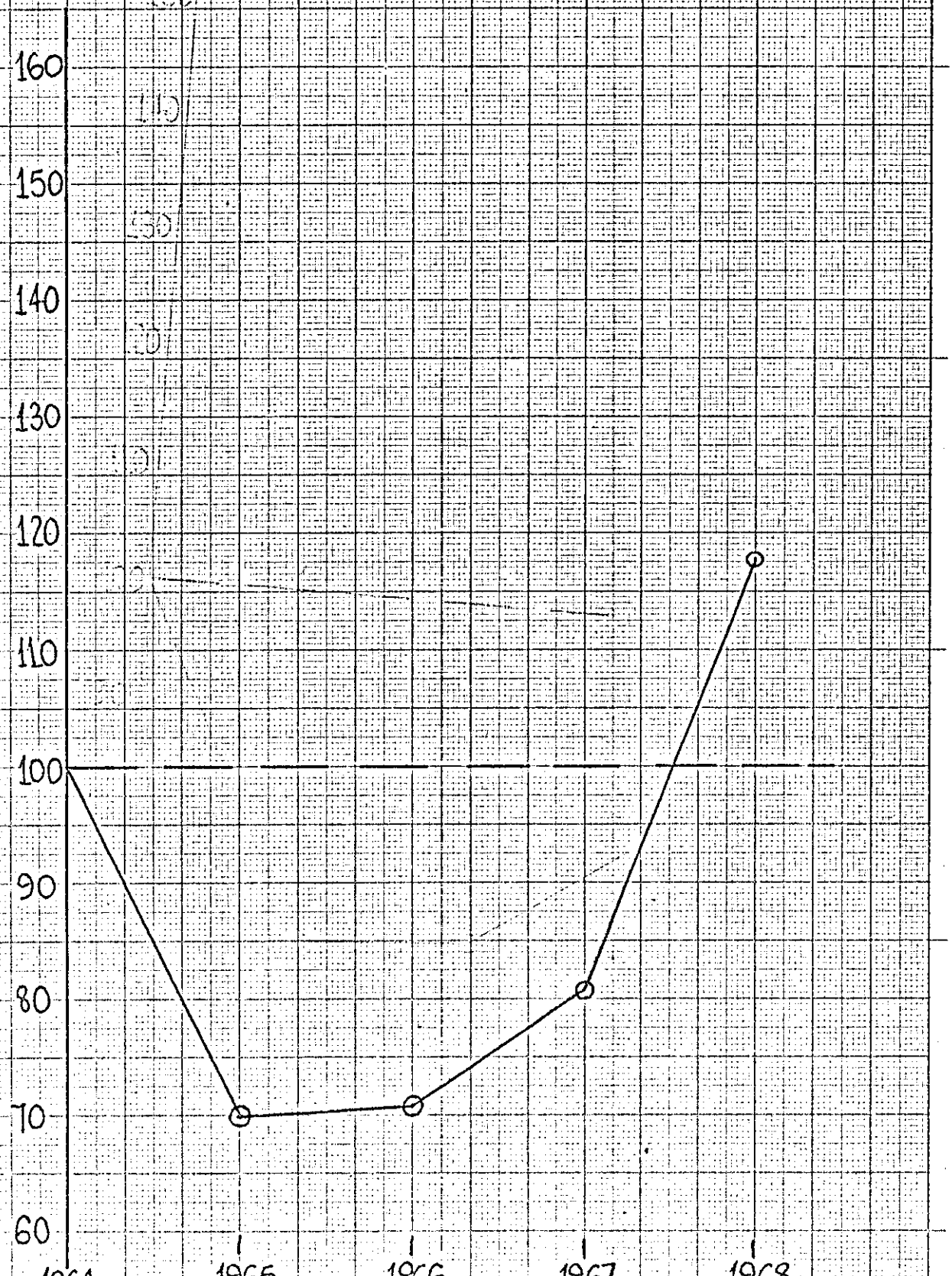
The Direct Labour index has shown continuous progress throughout the period of the study and achieved a 20% improvement over the five year period. This was achieved in spite of a falling output (W.P.C.) initially by a sharp decrease in labour levels. The sudden increase in activity levels in 1968 was met by a very rapid recruitment of labour and once more. This state of affairs being largely due to the considerable greater availability of labour in this area in comparison with the other works located in close proximity to London.

The Indirect Labour productivity index clumped in 1965, thus,was because of the sudden drop in output(W.P.C.) and beeause of the additional problems associated with discharging indirect categories of labour. The recovery after this point however, whows as the result of a steady reduction in indirect labour. The final stage of recovery being again due to the expansion in activity and the availability of labour to support it.

The overall picture is a good one providing the new level of activity is maintained or increased without increasing the labour force at too greater a rate,

CAPITAL PRODUCTIVITY TREND.

[INDEX: 1964 = 100]



CAPITAL PRODUCTIVITY

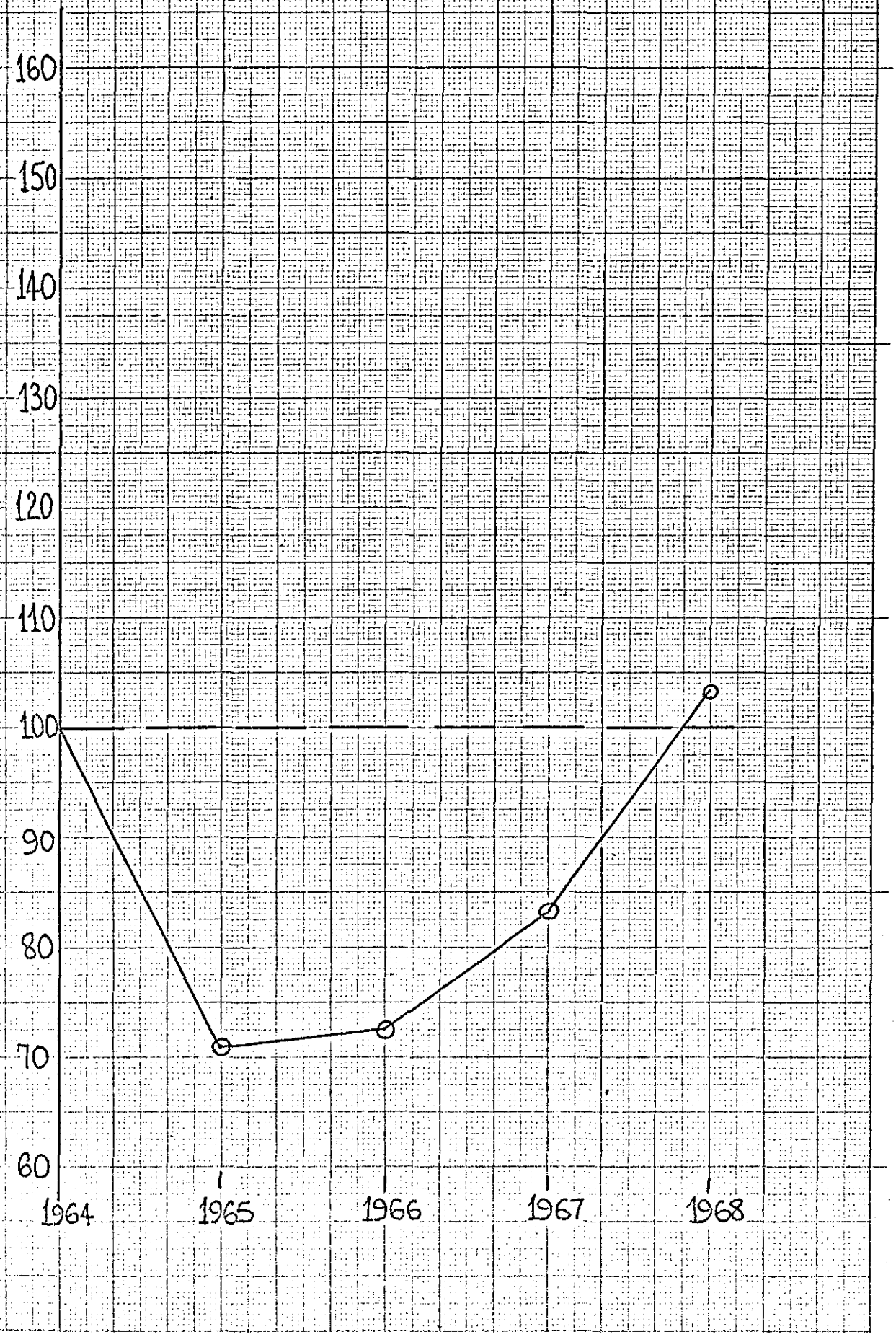
The capital productivity index shows a pattern similar to that of indirect labour, but for different reasons.

Capital investment was rather high in 1965 resulting in the sudden drop in the index to which, output (W.P.C.) had falled. The subsequent recovery being achieved by the transfer of large amounts of fixed assets to other works and finally by the sudden increase in activity level during 1968.

It is difficult under these circumstances to see any interaction between labour productivity and capital investment the picture being so blurred by the rapid changes in labour levels and in the amount of capital investment.

PRODUCTION SUPERVISION PRODUCTIVITY TREND.

[INDEX : 1964=100]

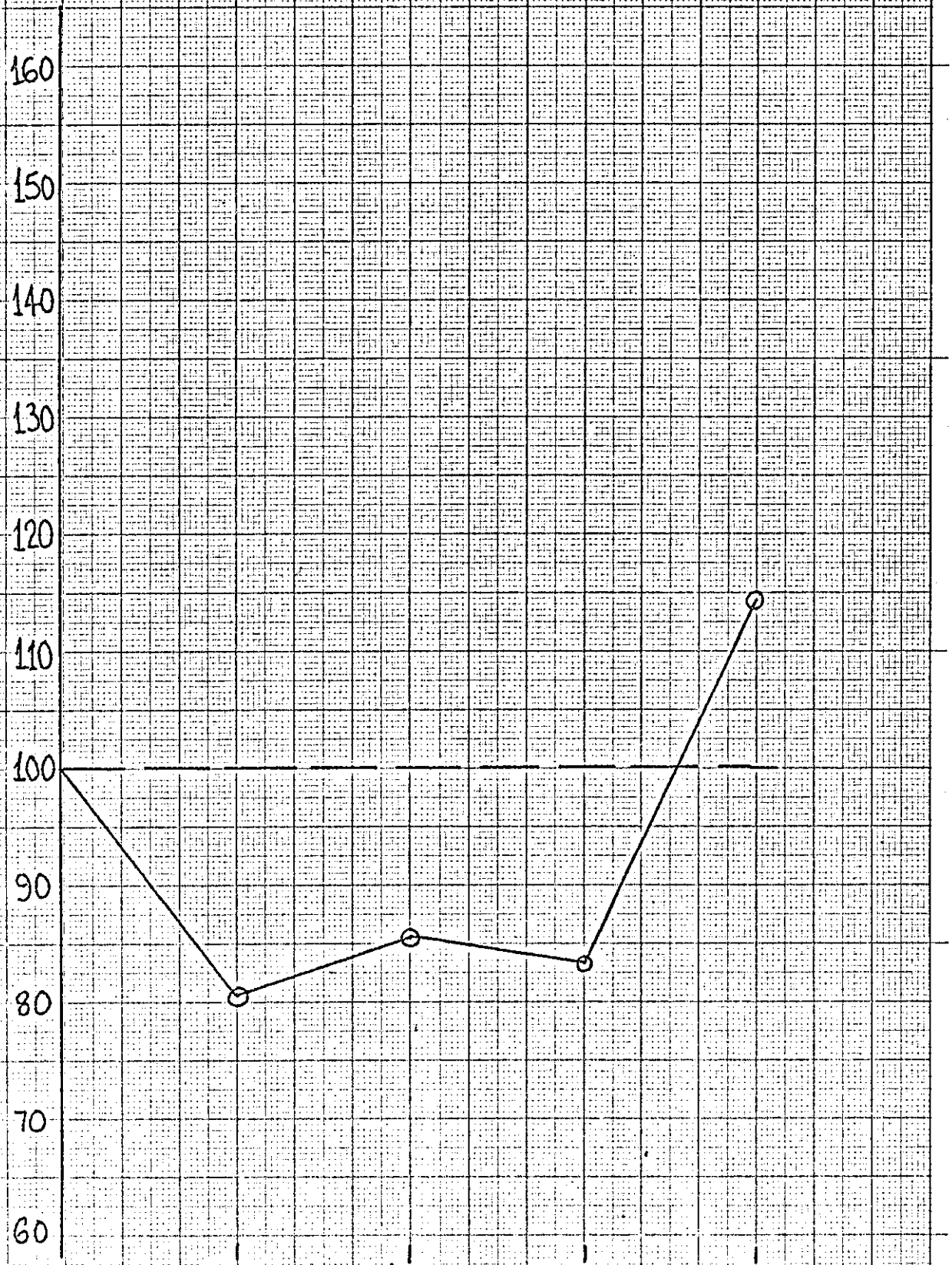


PRODUCTION SUPERVISION PRODUCTIVITY

The increase of the cost of production supervision in 1965 at a time when the activity level had been drastically reduced resulted in the sharp drop in the index for this input factor. The decrease in costs in the two subsequent years provided the base for a steady recovery and as production activity increased in 1968 the recovery was complete although the increase in costs that year seems rather high.

MATERIAL SERVICES PRODUCTIVITY TREND.

[INDEX : 1964 = 100]



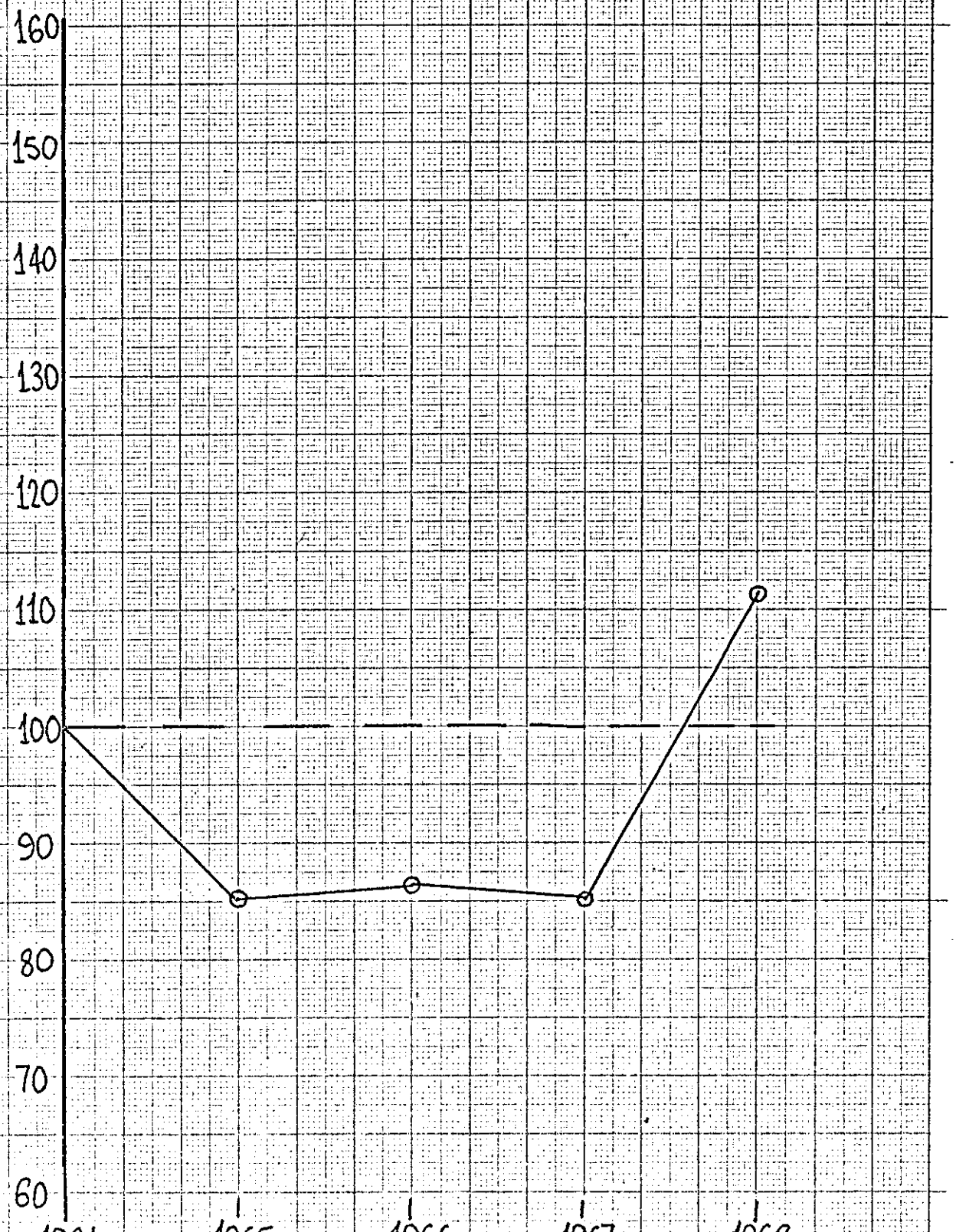
MATERIAL SERVICES PRODUCTIVITY

The trend here is similar to that discussed under production supervision, but the drop in 1965 was less because a cut back in expenditure was achieved and although it was insufficient to hold the index steady, it did reduce the fall. A slight recovery was made in 1966 partly due to further cuts in cost and partly due to a slight increase in output (W.P.C.) The small drop in 1967 was almost totally due because of a further decline in activity level but there was also a very small increase in the cost of this input factor.

A good recovery was made in 1968 by the rapid increase in activity and the availability again of the necessary labour.

ENGINEERING SERVICES PRODUCTIVITY TREND.

[INDEX: 1964=100]

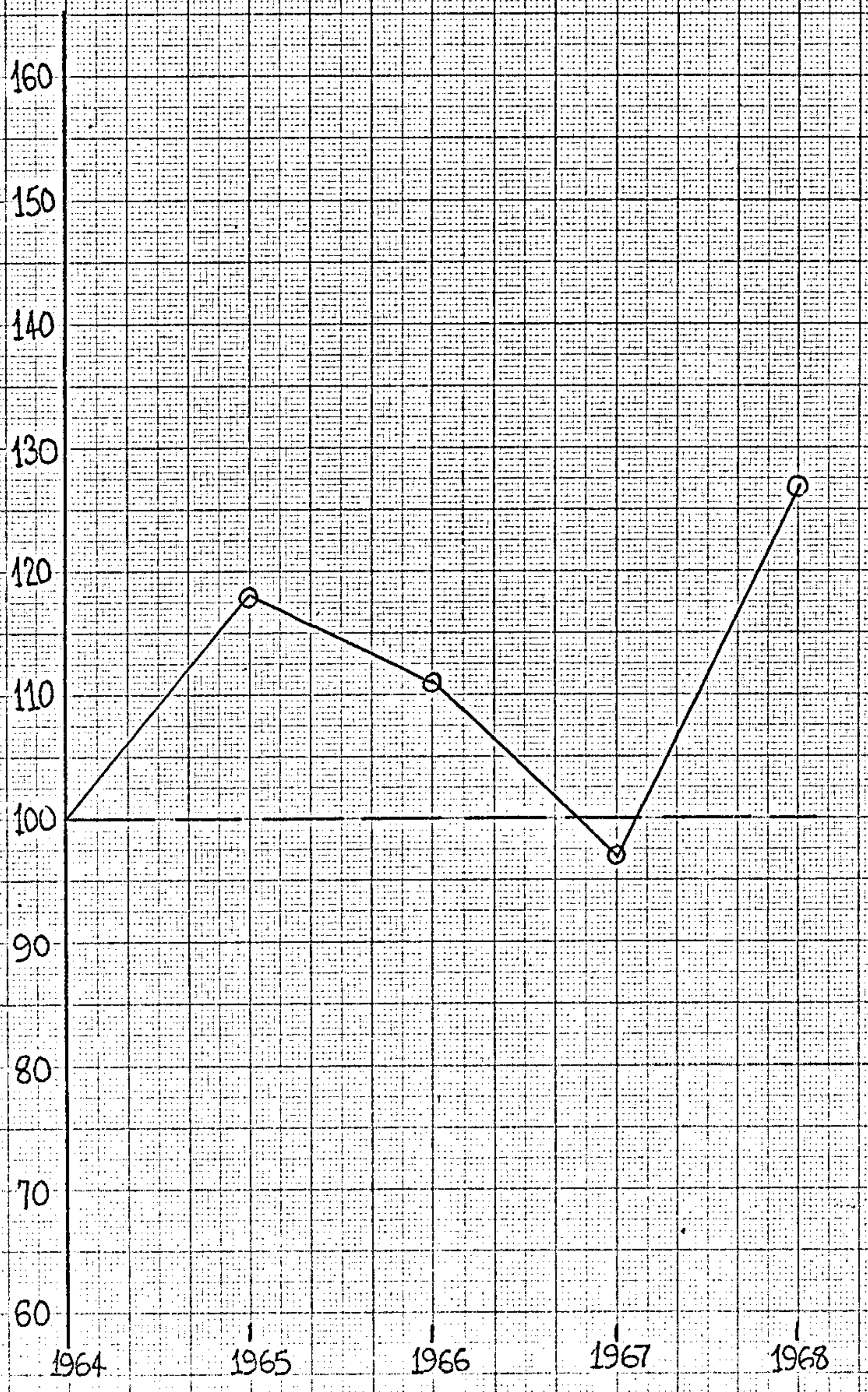


ENGINEERING SERVICES PRODUCTIVITY

The trend of the index of engineering services is the same as for material services. The magnitude of the changes are however, slightly different, the costs are reduced rapidly in 1965, resulting in only a 15% drop the level after this is nearly constant and the graph largely reflects changes in output (W.P.C.) The recovery occurs in the now characteristic manner with the rapid increase in activity accompanied by the increase in labour to support it, whilst achieving substantial increase in productivity.

MAINTENANCE SERVICES PRODUCTIVITY TREND.

[INDEX: 1964=100]



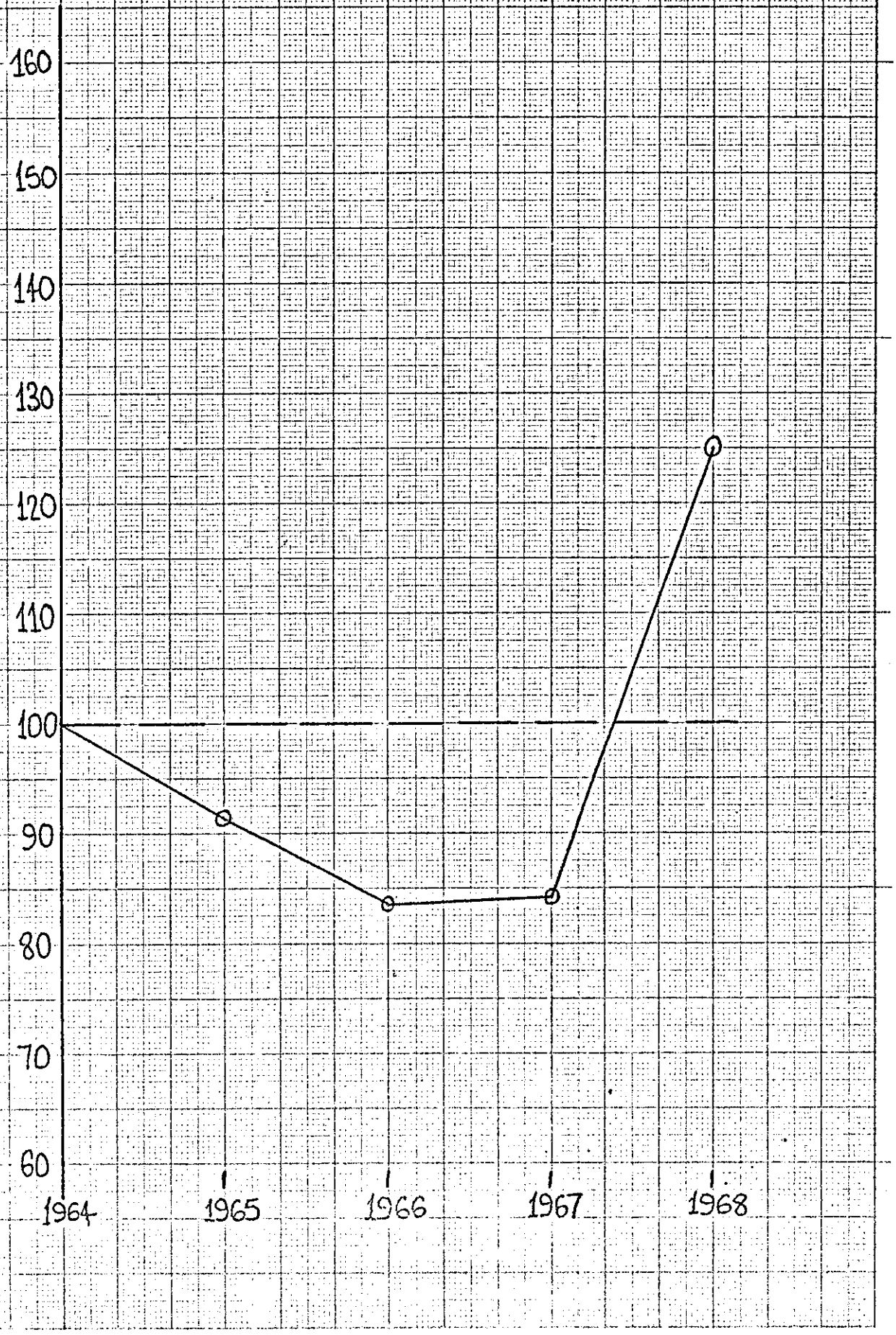
MAINTENANCE SERVICES PRODUCTIVITY

The movements of the maintenance services index is unlike that for any of the other input factors for this manufacturing unit, with the exception of the recovery in 1968.

The sharp rise in productivity in 1965 is due to a severe cut-in labour cost in this category, the slower decline in the index. in 1966 and 1967 being the result of a slow build up of labour cost in this category once more. The final recovery resulting from the high activity level in 1968 which was accompanied by only a small increase in labour costs.

LABOUR SERVICES PRODUCTIVITY TREND.

[INDEX : 1964 = 100]



LABOUR SERVICES PRODUCTIVITY

This graph reflects the general movement of labour indicated by the previous factors. The small labour force requiring lower payments from this overhead category. The total labour situation did not change as rapidly as the output resulting in the lower index value in 1965 and 1966 figure also being affected by the fact that though it was down in 1964 it was up in 1965. The further drop in costs in 1967 resulted in a small improvement and the rapid change in output (W.P.C) in 1968 with little or no change in the cost of this input factor resulting in the considerable improvement in that year.

SUMMARY

The index movements shown by these graphs illustrate the change in fortunes of this manufacturing unit.

The decrease in activity resulting in the necessity to lower the labour force and hence costs. The graphs show the high degree of success in reducing the direct labour force rapidly and thus improving the productivity of this section of labour. The graphs also show the somewhat slower reaction in the indirect section and thus again illustrate the lower flexibility of indirect labour.

The capital graph shows the normal lag that occurs when dealing with capital, this also taking a year or so to reduce.

The overall recovery shown in all the graphs by the return to a high activity level with little or no "real" increase in the total labour costso over the 1964 figures reflects hope for future improvements.

PART III

SECTION I

INTER-MANUFACTURING UNIT COMPARISONS

The comparison of the manufacturing units with each other presents a number of problems. The difference in age of the establishments, the age of the plant, the skills required, the type of product, the cost of labour and the availability of labour, all create a changing and dynamic situation.

Each of the manufacturing units contained in this study display different needs and facilities in respect to the factors mentioned above, Wembley having been in operation only since 1963 in comparison with Chelmsford which dated back to 1897, the manufacture of mechanical components at Gateshead in comparison with the wide variety of sophisticated electronic equipment at Chelmsford. The different wage rates at Wembley (Landon rates) in comparison with Gateshead.

The variations between the units inhibit detailed comparison of productivity and it is only in the terms of overall trends that comparisons may be drawn.

The comparisons of movements in labour productivity and capital productivity seem to present the best basis for comparison.

N.B. To some extent changes in wages rates are cancelled by the selection of "Works processing cost" as the output measurement, any increase in labour rates being reflected in Works processing cost.

Chelmsford Works has a situation where the index of labour productivity is steadily improving over the period of the study but appears to be doing so as the result of considerable capital expenditure, the index of capital productivity moving slowly downwards in general. This suggests that although some of the increase in labour productivity may be due to increased efficiency of labour, much of it is probably as the result of capital substitution for labour.

Wembley works in comparison has shown with the exception of a general drop in 1965, a steady improvement of labour productivity, whilst at the same time creating little or no increase in fixed assets, which has resulted in a very rapid rise in capital productivity. It appears therefore, that Wembley has not only improved it labour efficiency, but done so with reduced assets. This however, may not be the true picture, remembering that Wembley a relatively new unit and hence most of its plant is new and its operators new. This could mean that much of the improvement is due to not just increased in labour, efficiency but to additional training and increased experience.

Basildon works has been involved in heavy capital expenditure which has resulted in a massive drop in the capital index. The labour index of productivity has been rather erratic but, shows a slight upward trend. This small upward trend of the labour index is not however, in keeping with the somewhat larger movement of the capital index, which could be greater

potential for future production (there normally being a lag between investment and resultant production).

Gateshead works have had a very lean period and have responded well in maintaining their direct labour index in a steady climb and also well in containing their indirect index in the manner shown, The recent climb in the capital index in parallel with the climb in the labour index indicates considerable improvement in labour efficiency, and although some of the improvement in the capital index was due to the transfer and sale of fixed assets, the continuous investment in new fixed assets through out the period of the study would appear to place Gateshead works in a very strong position. Labour availability has a very great importance in the result of these works.

As may be seen from the above the comparison of actual results is almost impossible because of the variation in the environmental factors affecting each individual manufacturing unit. However, it may be seen that all works have, over the five year period made some advance in labour productivity, the greatest advance being obtained by Chelmsford Works. It may also be seen that only two units have succeeded in improving both capital and labour indexes, Gateshead and Wembley works, but the reasons for this have already been discussed and only future years will show how permanent these improvements may be

Other factors that can have a major influence on the performance are the main company order book and the proportion of work which can be handled by any one of the manufacturing units by virtue of the type of product.

PART IV

DATA SHEETS

(i) CHELMSFORD WORKS

(ii) WEMBLEY WORKS

(iii) BASILDON WORKS

iV GATESHEAD WORKS

(i) CHELMSFORD WORKS

CHELMSFORD WORKS.

£(000)s.

		1964	1965	1966	1967	1968
1	"OUTPUT" WORKS PROCESSING COST	3115	3606	4526	3659	4055
2	PRICE INDEX 1958 BASE	111·5	116·7	119·9	121·4	126·8
3	PRICE INDEX ADJUSTED TO 1964 BASE	100	105	107·5	109	114
4	WORKS PROCESSING COST ADJUSTED TO 1964 BASE.	3115	3440	4200	3360	3560

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"ECONOMIC REVIEW"

$$(3) = \frac{\text{INDEX FOR CURRENT YEAR.}}{\text{INDEX FOR BASE YEAR.}} \times 100$$

$$(4) = \frac{\text{"OUTPUT"}}{\text{ADJUSTED INDEX}} \times 100$$

CHELMSFORD WORKS.

£(000)s.

	1964	1965	1966	1967	1968
OPENING CAPITAL FOR PERIOD	933,357	1,080,849	1,251,349	1,256,549	1,270,799
ADDITIONS	219,704	235,741	269,926	192,036	162,712
SALES	(4,170)	(3,826)	(9,806)	(7,532)	(918)
TRANSFERS	26,232	40,395	(135,534)	1,500	(6,286)
DEPRECIATION	(94,265)	(95,433)	(118,796)	(170,424)	(175,524)
NET ADDITIONS TO CAPITAL	147,492	176,877	5,627	15,580	(20,016)
CAPITAL INDEX 1958 BASE	109	113	118	119	123
CAPITAL INDEX 1964 BASE	100	103·7	108·1	109·2	112·8
ADDITIONS TO CAPITAL ADJUSTED	147,492	170,500	5,200	14,250	(17,750)
CLOSING BALANCE FOR PERIOD	1,080,849	1,251,349	1,256,549	1,270,799	1,253,049
AVERAGE INVESTMENT FOR PERIOD	1,007,103	1,166,099	1,253,949	1,263,674	1,261,924

CHELMSFORD WORKS.

£s.

		1964	1965	1966	1967	1968
1	DIRECT LABOUR COST	850	908	1,110	925	1,036
2	WAGE INDEX (HOURLY RATE) 1958 BASE	129·9	138	147·3	153·1	163·5
3	WAGE INDEX ADJUSTED TO 1964 BASE	100	104	109	115	120
4	DIRECT LABOUR COST ADJUSTED	850	875	1,020	820	864
5	INDIRECT LABOUR COST	2,098	2,103	2,268	2,235	2,416
6	WAGE INDEX (WEEKLY RATE) 1958 BASE	123·4	128·7	134·7	139·6	148·8
7	WAGE INDEX ADJUSTED TO 1964 BASE	100	106·1	113·5	118	126
8	INDIRECT LABOUR COST ADJUSTED	2,098	1,985	2,000	1,890	1,915
9	TOTAL LABOUR COST	2,948	3,011	3,378	3,160	3,453
10	WAGE INDEX (WIEGHTED) 1964 BASE [2x7) +(3) /3]	100	105	110	115	122
11	TOTAL LABOUR COST ADJUSTED	2,948	2,860	3,070	2,750	2,830

CHELMSFORD WORKS.

£s.

	1964	1965	1966	1967	1968
COST OF PRODUCTION SUPERVISION	193	240	280	224	235
COST OF MATERIAL SERVICES	202	213	215	375	411
COST OF ENGINEERING SERVICES	735	867	889	727	806
COST OF MAINTENANCE SERVICES	137	140	144	148	153
COST OF LABOUR SERVICES	189	228	221	145	174
WAGE INDEX 1958 BASE	125·6	131·8	138·9	144·1	153·7
WAGE INDEX ADJUSTED TO 1964 BASE	100	105	110	115	122
ADJUSTED COSTS 1964 BASE					
PRODUCTION SUPERVISION	193	228·5	254·5	195	193
MATERIAL SERVICES	202	203	195·5	326	362
ENGINEERING SERVICES	735	826	810	632	660
MAINTENANCE SERVICES	137	133	131	129	125
LABOUR SERVICES	189	217	201	126	142·5

CHELMSFORD WORKS.

£(000)s.

	1964	1965	1966	1967	1968
MAINTENANCE MATERIAL COSTS	163	186	169	117	122
PRICE INDEX 1958 BASE	111·5	116·7	119·9	121·4	126·8
PRICE INDEX ADJUSTED TO 1964 BASE	100	104·5	107·5	109	113·5
ADJUSTED MAINTENANCE MATERIALS COSTS	163	177	157	107	107·5

ii. WEMBLEY WORKS

WEMBLEY WORKS.

£(000)s.

		1964	1965	1966	1967	1968
1	"OUTPUT" WORKS PROCESSING COST	552·7	589·2	641·1	660·7	772
2	PRICE INDEX 1958 BASE	111·5	116·7	119·9	121·4	126·8
3	PRICE INDEX ADJUSTED TO 1964 BASE	100	105	107·5	109	114
4	WORKS PROCESSING COST ADJUSTED TO 1964 BASE.	552·7	561	596	606	677

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WEMBLEY WORKS.

£(000)s.

	1964	1965	1966	1967	1968
OPENING CAPITAL FOR PERIOD	174,547	159,263	157,703	144,003	129,653
ADDITIONS	7,230	19,371	28,712	10,373	51,182
SALES	(745)	(1,065)	(534)	(217)	(2,647)
TRANSFERS	2,762	1,211	(25,534)	(53)	(3,443)
DEPRECIATION	(24,531)	(21,136)	(17,435)	(25,798)	(23,873)
NET ADDITIONS TO CAPITAL	(15,284)	(1,619)	(14,791)	(15,695)	21,219
CAPITAL INDEX 1958 BASE	109	113	118	119	123
CAPITAL INDEX 1964 BASE	100	103·7	108·1	109·2	112·8
ADDITIONS TO CAPITAL ADJUSTED	(15,284)	(1,560)	(13,700)	(14,350)	18,820
CLOSING BALANCE FOR PERIOD	159,263	157,703	144,003	129,653	148,473
AVERAGE INVESTMENT FOR PERIOD	166,905	158,483	150,853	136,828	139,063

WEMBLEY WORKS.

£s.

		1964	1965	1966	1967	1968
1	DIRECT LABOUR COST	150	170	189	195	210
2	WAGE INDEX (HOURLY RATE) 1958 BASE	129·9	138	147·3	153·1	163·5
3	WAGE INDEX ADJUSTED TO 1964 BASE	100	104	109	113	120
4	DIRECT LABOUR COST ADJUSTED	150	163·5	173·5	172·5	175
5	INDIRECT LABOUR COST	267	293	323	335	374
6	WAGE INDEX (WEEKLY RATE) 1958 BASE	123·4	128·7	134·7	139·6	148·8
7	WAGE INDEX ADJUSTED TO 1964 BASE	100	106·1	113·5	118	126
8	INDIRECT LABOUR COST ADJUSTED	267	276	285	284	297
9	TOTAL LABOUR COST	417	463	512	530	584
10	WAGE INDEX (WIEGHTED) 1964 BASE [2×(7)+(3)/3]	100	105	110	115	122
11	TOTAL LABOUR COST ADJUSTED	417	441	466	461	478

WEMBLEY WORKS.

£s.

	1964	1965	1966	1967	1968
COST OF PRODUCTION SUPERVISION	23,797	28,450	32,982	34,413	34,208
COST OF MATERIAL SERVICES	31,009	38,383	42,912	43,176	41,870
COST OF ENGINEERING SERVICES	101,370	112,187	129,248	130,497	136,202
COST OF MAINTENANCE SERVICES	18,818	22,212	22,492	25,631	27,025
COST OF LABOUR SERVICES	27,823	25,280	35,160	28,861	29,392
WAGE INDEX 1958 BASE	125·6	131·8	138·9	144·1	153·7
WAGE INDEX ADJUSTED TO 1964 BASE	100	105	110	115	122
ADJUSTED COSTS 1964 BASE					
PRODUCTION SUPERVISION	23,797	27,100	30,000	30,000	28,000
MATERIAL SERVICES	31,009	36,500	39,000	37,500	34,350
ENGINEERING SERVICES	101,370	107,000	117,500	113,500	111,800
MAINTENANCE SERVICES	18,818	21,200	20,450	22,300	22,150
LABOUR SERVICES	27,823	24,100	31,900	25,100	24,100

iii BASILDON WORKS

BASILDON WORKS.

£(000)s.

		1964	1965	1966	1967	1968
1	"OUTPUT" WORKS PROCESSING COST	1,458	1,620	1,845	1,774	2,069
2	PRICE INDEX 1958 BASE	111·5	116·7	119·9	121·4	126·8
3	PRICE INDEX ADJUSTED TO 1964 BASE	100	105	107·5	109	114
4	WORKS PROCESSING COST ADJUSTED TO 1964 BASE.	1,458	1,540	1,715	1,630	1,815

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$$(3) = \frac{\text{INDEX FOR CURRENT YEAR.}}{\text{INDEX FOR BASE YEAR.}} \times 100 \qquad (4) = \frac{\text{"OUTPUT"}}{\text{ADJUSTED INDEX}} \times 100$$

BASILDON WORKS.

£(000)s.

	1964	1965	1966	1967	1968
OPENING CAPITAL FOR PERIOD	470,204	527,851	716,351	774,551	840,551
ADDITIONS	104,302	256,359	216,826	152,469	128,660
SALES	(7,478)	(1,988)	(5,696)	(2,488)	(236)
TRANSFERS	(2,653)	(3,432)	(67,388)	—	(415)
DEPRECIATION	(36,524)	(55,249)	(80,800)	(77,864)	(102,167)
NET ADDITIONS TO CAPITAL	57,647	195,690	62,942	72,117	25,842
CAPITAL INDEX 1958 BASE	109	113	118	119	123
CAPITAL INDEX 1964 BASE	100	103·7	108·1	109·2	112·8
ADDITIONS TO CAPITAL ADJUSTED	57,647	188,500	58,200	66,000	23,000
CLOSING BALANCE FOR PERIOD	527,851	716,351	774,551	840,551	863,551
AVERAGE INVESTMENT FOR PERIOD	499,028	622,101	745,451	807,551	852,051

BASILDON WORKS.

£s.

		1964	1965	1966	1967	1968
1	DIRECT LABOUR COST	423	470	529	510	584
2	WAGE INDEX (HOURLY RATE) 1958 BASE	129·9	138	147·3	153·1	163·5
3	WAGE INDEX ADJUSTED TO 1964 BASE	100	104	109	113	120
4	DIRECT LABOUR COST ADJUSTED	423	452	486	451	487
5	INDIRECT LABOUR COST	649	747	846	861	945
6	WAGE INDEX (WEEKLY RATE) 1958 BASE	123·4	128·7	134·7	139·6	148·8
7	WAGE INDEX ADJUSTED TO 1964 BASE	100	106·1	113·5	118	126
8	INDIRECT LABOUR COST ADJUSTED	649	705	745	730	750
9	TOTAL LABOUR COST	1,072	1,217	1,375	1,371	1,529
10	WAGE INDEX (WIEGHTED) 1964 BASE [2x(7)+(3)/3]	100	105	110	115	122
11	TOTAL LABOUR COST ADJUSTED	1,072	1,160	1,250	1,190	1,255

BASILDON WORKS.

£s.

	1964	1965	1966	1967	1968
COST OF PRODUCTION SUPERVISION	76,417	94,890	112,990	113,457	130,218
COST OF MATERIAL SERVICES	78,858	89,242	96,668	98,838	104,885
COST OF ENGINEERING SERVICES	254,463	298,886	351,044	354,184	366,048
COST OF MAINTENANCE SERVICES	31,340	37,031	49,920	48,331	56,219
COST OF LABOUR SERVICES	80,442	95,204	103,284	104,332	124,079
WAGE INDEX 1958 BASE	125·6	131·8	138·9	144·1	153·7
WAGE INDEX ADJUSTED TO 1964 BASE	100	105	110	115	122
ADJUSTED COSTS 1964 BASE					
PRODUCTION SUPERVISION	76,417	90,400	102,700	98,800	107,000
MATERIAL SERVICES	78,858	85,000	87,900	86,000	86,000
ENGINEERING SERVICES	254,463	284,500	319,000	308,000	300,000
MAINTENANCE SERVICES	31,340	35,300	45,400	42,000	46,100
LABOUR SERVICES	80,442	90,700	94,000	90,900	101,800

IV GATESHEAD WORKS

GATESHEAD WORKS.

£(000)s.

		1964	1965	1966	1967	1968
1	"OUTPUT" WORKS PROCESSING COST	584	479	491	486	757
2	PRICE INDEX 1958 BASE	111·5	116·7	119·9	121·4	126·8
3	PRICE INDEX ADJUSTED TO 1964 BASE	100	105	107·5	109	114
4	WORKS PROCESSING COST ADJUSTED TO 1964 BASE.	584	456	457	446	665

ALL INDEX NUMBERS USED ARE OBTAINED FROM :-

THE NATIONAL INSTITUTE OF ECONOMIC AND SOCIAL RESEARCH
"ECONOMIC REVIEW"

(3) = $\frac{\text{INDEX FOR CURRENT YEAR.}}{\text{INDEX FOR BASE YEAR.}} \times 100$

(4) = $\frac{\text{"OUTPUT"}}{\text{ADJUSTED INDEX}} \times 100$

GATESHEAD WORKS.

£(000)s.

	1964	1965	1966	1967	1968
OPENING CAPITAL FOR PERIOD	243,252	250,710	301,310	247,310	234,010
ADDITIONS	29,832	79,463	47,155	15,923	36,466
SALES	(2,357)	(6,934)	(2,578)	(1,810)	(4,299)
TRANSFERS	1,471	—	(76,756)	(14,048)	(2,545)
DEPRECIATION	(21,478)	(20,074)	(26,267)	(29,142)	(24,879)
NET ADDITIONS TO CAPITAL	7,458	52,455	(58,446)	(29,077)	9,833
CAPITAL INDEX 1958 BASE	109	113	118	119	123
CAPITAL INDEX 1964 BASE	100	103·7	108·1	109·2	112·8
ADDITIONS TO CAPITAL ADJUSTED	7,458	50,600	(54,000)	(26,600)	8,700
CLOSING BALANCE FOR PERIOD	250,710	301,310	247,310	220,710	243,843
AVERAGE INVESTMENT FOR PERIOD	246,981	276,010	274,310	234,010	238,927

GATESHEAD WORKS.

£s.

		1964	1965	1966	1967	1968
1	DIRECT LABOUR COST	172	132	132	132	196
2	WAGE INDEX (HOURLY RATE) 1958 BASE	129·9	138	147·3	153·1	163·5
3	WAGE INDEX ADJUSTED TO 1964 BASE	100	104	109	115	120
4	DIRECT LABOUR COST ADJUSTED	172	127	121	117	163·2
5	INDIRECT LABOUR COST	337	356	358	335	427
6	WAGE INDEX (WEEKLY RATE) 1958 BASE	123·4	128·7	134·7	139·6	148·8
7	WAGE INDEX ADJUSTED TO 1964 BASE	100	106·1	113·5	118	126
8	INDIRECT LABOUR COST ADJUSTED	337	335	315	284	339
9	TOTAL LABOUR COST	509	488	490	467	623
10	WAGE INDEX (WIEGHTED) 1964 BASE [2x(7)+(3)/3.]	100	105	110	115	122
11	TOTAL LABOUR COST ADJUSTED	509	465	445	407	510

GATESHEAD WORKS.

£s.

	1964	1965	1966	1967	1968
COST OF PRODUCTION SUPERVISION	31,089	35,782	36,683	32,800	41,886
COST OF MATERIAL SERVICES	28,401	28,931	28,537	29,872	34,341
COST OF ENGINEERING SERVICES	135,777	130,612	136,754	140,194	169,615
COST OF MAINTENANCE SERVICES	22,649	16,106	17,933	20,490	25,162
COST OF LABOUR SERVICES	37,020	33,105	38,176	38,343	40,941
WAGE INDEX 1958 BASE	125·6	131·8	138·9	144·1	153·7
WAGE INDEX ADJUSTED TO 1964 BASE	100	105	110	115	122
ADJUSTED COSTS 1964 BASE					
PRODUCTION SUPERVISION	31,089	34,050	33,500	28,500	34,300
MATERIAL SERVICES	28,401	27,500	25,950	26,000	28,150
ENGINEERING SERVICES	135,777	124,300	123,300	122,000	139,000
MAINTENANCE SERVICES	22,649	15,330	16,300	17,800	20,300
LABOUR SERVICES	37,020	31,500	34,700	33,450	33,600

PART V

PRODUCTIVITY CALCULATIONS

(i) CHELMSFORD WORKS

(ii) WEMBLEY WORKS

(iii) BASILDON WORKS

(IV) GATESHEAD WORKS.

(i) CHELMSFORD WORKS

PRODUCTIVITY INDICIES.

CHELMSFORD WORKS.

LABOUR.

i). TOTAL LABOUR PRODUCTIVITY.

$$\text{INDEX} = \left[\frac{\text{W.P.C. (C.P.)}}{\text{LABOUR COST (C.P.)}} \Big/ \frac{\text{W.P.C. (B.P.)}}{\text{LABOUR COST (B.P.)}} \right]$$

WHERE CP : CURRENT PERIOD.
& BP : BASE PERIOD.

	1964	1965	1966	1967	1968
WPC / LABOUR COST =	3115 / 2948 = 1·06	3440 / 2860 = 1·20	4200 / 3070 = 1·37	3360 / 2750 = 1·22	3560 / 2830 = 1·26
PRODUCTIVITY INDEX	100	113	130	115	120

SAMPLE CALCULATION.

$$\text{INDEX (1965)} = \frac{1{\cdot}20}{1{\cdot}06} \times 100 = 113$$

ii) DIRECT LABOUR PRODUCTIVITY.

$$\text{INDEX} = \left[\frac{\text{W.P.C (CP)}}{\text{DIRECT LABOUR COST (CP)}} \Big| \frac{\text{W.P.C (BP)}}{\text{DIRECT LABOUR COST (BP)}} \right]$$

	1964	1965	1966	1967	1968
WPC / DIRECT LABOUR COST =	3115/850	3440/875	4200/1020	3360/820	3560/864
	3·66	3·93	4·12	4·1	4·12
PRODUCTIVITY INDEX	100	107·5	112·5	112	112·5

SAMPLE CALCULATION.

$$\text{INDEX (1965)} = \frac{3.93}{3.66} \times 100 = 107.5$$

iii) INDIRECT LABOUR PRODUCTIVITY

$$\text{INDEX} = \left[\frac{\text{WPC (CP)}}{\text{INDIRECT LABOUR COST (CP)}} \Big/ \frac{\text{WPC (BP)}}{\text{INDIRECT LABOUR COST (BP)}} \right]$$

	1964	1965	1966	1967	1968
WPC / INDIRECT LABOUR COST =	3115/2098	3440/1985	4200/2000	3360/1890	3560/1915
	1·48	1·73	2·10	1·78	1·86
PRODUCTIVITY INDEX.	100	117	142	120	125·7

SAMPLE CALCULATION.

$$\text{INDEX (1965)} = \frac{1.73}{1.48} \times 100 = 117$$

CAPITAL PRODUCTIVITY.

$$\text{INDEX} = \left[\frac{\text{WPC (CP)}}{\text{CAPITAL (CP)}} \Big/ \frac{\text{WPC (BP)}}{\text{CAPITAL (BP)}} \right]$$

	1964	1965	1966	1967	1968
WPC / CAPITAL =	3115 / 1007 = 3·1	3440 / 1166 = 2·95	4200 / 1254 = 3·35	3360 / 1264 = 2·66	3560 / 1262 = 2·82
PRODUCTIVITY INDEX	100	95·2	108	86	91

SAMPLE CALCULATION

$$\text{INDEX (1965)} = \frac{2.95}{3.1} \times 100 = 95.2$$

PRODUCTIVITY OF PRODUCTION SUPERVISION.

$$\text{INDEX} = \left[\frac{\text{WPC (CP)}}{\text{COST (CP)}} \Big/ \frac{\text{WPC (BP)}}{\text{COST (BP)}} \right]$$

	1964	1965	1966	1967	1968
WPC / COST =	3115 / 193 = 16·1	3440 / 228·5 = 15·1	4200 / 254·5 = 16·5	3360 / 195 = 17·2	3560 / 193 = 19
PRODUCTIVITY INDEX.	100	94	102·5	107	118

SAMPLE CALCULATION

$$\text{INDEX (1965)} = \frac{15.1}{16.1} \times 100 = 94$$

PRODUCTIVITY OF MATERIAL SERVICES.

$$\text{INDEX} = \left[\frac{\text{WPC (CP)}}{\text{COST (CP)}} \Big/ \frac{\text{WPC (BP)}}{\text{COST (BP)}} \right]$$

	1964	1965	1966	1967	1968
WPC / COST =	3115 / 202 = 15·4	3440 / 203 = 19·6	4200 / 195·5 = 21·5	3360 / 326 = 10·3	3560 / 362 = 10·1
PRODUCTIVITY INDEX	100	127	137	67	65·6

SAMPLE CALCULATION

$$\text{INDEX (1965)} = \frac{19{\cdot}6}{15{\cdot}4} \times 100 = 127$$

PRODUCTIVITY OF ENGINEERING SERVICES.

$$\text{INDEX} = \left[\frac{\text{WPC (CP)}}{\text{COST (CP)}} \Big/ \frac{\text{WPC (BP)}}{\text{COST (BP)}} \right]$$

	1964	1965	1966	1967	1968
WPC / COST =	3115 / 735 = 4·24	3440 / 826 = 4·16	4200 / 810 = 5·18	3360 / 632 = 5·31	3560 / 660 = 5·55
PRODUCTIVITY INDEX	100	98	122	125	131

SAMPLE CALCULATION

$$\text{INDEX (1965)} = \frac{4{\cdot}16}{4{\cdot}24} \times 100 = 98$$

PRODUCTIVITY OF MAINTENANCE SERVICES.

$$\text{INDEX} = \left[\frac{\text{WPC (CP)}}{\text{COST (CP)}} \Big/ \frac{\text{WPC (BP)}}{\text{COST (BP)}} \right]$$

	1964	1965	1966	1967	1968
WPC / COST =	3115 / 137 = 22·7	3440 / 133 = 25·8	4200 / 131 = 32	3360 / 129 = 26	3560 / 125 = 29·3
PRODUCTIVITY INDEX	100	113·5	141	114·5	129

SAMPLE CALCULATION

$$\text{INDEX}(1965) = \frac{25{\cdot}8}{22{\cdot}7} \times 100 = 113{\cdot}5$$

PRODUCTIVITY OF LABOUR SERVICES.

$$\text{INDEX} = \left[\frac{\text{WPC (CP)}}{\text{COST (CP)}} \Big/ \frac{\text{WPC (BP)}}{\text{COST (BP)}} \right]$$

	1964	1965	1966	1967	1968
WPC / COST =	3115 / 189 = 16·5	3440 / 217 = 15·8	4200 / 201 = 20·9	3360 / 126 = 26·6	3560 / 142·5 = 25·6
PRODUCTIVITY INDEX	100	96	126·5	161	155

SAMPLE CALCULATION

$$\text{INDEX}(1965) = \frac{15{\cdot}8}{16{\cdot}5} \times 100 = 96$$

PRODUCTIVITY OF MAINTENANCE SERVICES. (MATERIAL COSTS)

$$\text{INDEX} = \left[\frac{\text{WPC (CP)}}{\text{MATERIAL COST (CP)}} \Big/ \frac{\text{WPC (BP)}}{\text{MATERIAL COST (BP)}} \right]$$

	1964	1965	1966	1967	1968
WPC / MATERIAL COST =	3115 / 163 = 19·1	3440 / 177 = 19·4	4200 / 157 = 26·8	3360 / 107 = 31·4	3560 / 107·5 = 33·1
PRODUCTIVITY INDEX	100	101·5	140	164	173·3

SAMPLE CALCULATION

$$\text{INDEX (1965)} = \frac{19{\cdot}4}{19{\cdot}1} \times 100 = 101{\cdot}5$$

ii WEMBLEY WORKS

PRODUCTIVITY INDICIES.

WEMBLEY WORKS.

LABOUR.

i). TOTAL LABOUR PRODUCTIVITY.

$$\text{INDEX} = \left[\frac{\text{W.P.C. (C.P.)}}{\text{LABOUR COST (C.P.)}} \Big/ \frac{\text{W.P.C. (B.P.)}}{\text{LABOUR COST (B.P.)}} \right]$$

WHERE CP : CURRENT PERIOD.
& BP : BASE PERIOD.

	1964	1965	1966	1967	1968
WPC / LABOUR COST =	552·7 / 417	561 / 441	596 / 466	606 / 461	677 / 478
	1·32	1·27	1·28	1·315	1·42
PRODUCTIVITY INDEX	100	96·2	97	99·5	107·5

SAMPLE CALCULATION.

$$\text{INDEX (1965)} = \frac{1{\cdot}27}{1{\cdot}32} \times 100 = 96{\cdot}2$$

ii) DIRECT LABOUR PRODUCTIVITY.

$$\text{INDEX} = \left[\frac{\text{W.P.C (CP)}}{\text{DIRECT LABOUR COST (CP)}} \Big| \frac{\text{W.P.C (BP)}}{\text{DIRECT LABOUR COST (BP)}} \right]$$

	1964	1965	1966	1967	1968
WPC / DIRECT LABOUR COST =	552·7 / 150	561 / 163·5	596 / 173·5	606 / 172·5	677 / 175
	3·68	3·43	3·44	3·52	3·82
PRODUCTIVITY INDEX	100	93·2	93·5	95·6	104

SAMPLE CALCULATION.

$$\text{INDEX (1965)} = \frac{3{\cdot}43}{3{\cdot}68} \times 100 = 93{\cdot}2$$

iii) INDIRECT LABOUR PRODUCTIVITY

$$\text{INDEX} = \left[\frac{\text{WPC (CP)}}{\text{INDIRECT LABOUR COST (CP)}} \Big/ \frac{\text{WPC (BP)}}{\text{INDIRECT LABOUR COST (BP)}} \right]$$

	1964	1965	1966	1967	1968
WPC / INDIRECT LABOUR COST =	552·7 / 267	561 / 276	596 / 285	606 / 284	677 / 297
	2·07	2·03	2·09	2·13	2·28
PRODUCTIVITY INDEX.	100	98	101	103	110

SAMPLE CALCULATION.

$$\text{INDEX (1965)} = \frac{2{\cdot}03}{2{\cdot}07} \times 100 = 98$$

CAPITAL PRODUCTIVITY.

$$\text{INDEX} = \left[\frac{\text{WPC (CP)}}{\text{CAPITAL (CP)}} \Big/ \frac{\text{WPC (BP)}}{\text{CAPITAL (BP)}} \right]$$

	1964	1965	1966	1967	1968
WPC / CAPITAL =	552·7 / 166·9 = 3·315	561 / 158·5 = 3·54	596 / 150·9 = 3·95	606 / 136·8 = 4·43	677 / 139·1 = 4·86
PRODUCTIVITY INDEX	100	113·8	127	142	156

SAMPLE CALCULATION

$$\text{INDEX (1965)} = \frac{3{\cdot}54}{3{\cdot}315} \times 100 = 113{\cdot}8$$

PRODUCTIVITY OF PRODUCTION SUPERVISION.

$$\text{INDEX} = \left[\frac{\text{WPC (CP)}}{\text{COST (CP)}} \Big/ \frac{\text{WPC. (BP)}}{\text{COST (BP)}} \right]$$

	1964	1965	1966	1967	1968
WPC / COST =	552·7 / 24·8 = 22·3	561 / 27·1 = 20·7	596 / 30 = 19·9	606 / 30 = 20·2	677 / 28 = 24·2
PRODUCTIVITY INDEX.	100	93	89·4	90·6	108·5

SAMPLE CALCULATION

$$\text{INDEX (1965)} = \frac{20{\cdot}7}{22{\cdot}3} \times 100 = 93$$

PRODUCTIVITY OF MATERIAL SERVICES.

$$\text{INDEX} = \left[\frac{\text{WPC (CP)}}{\text{COST (CP)}} \Big/ \frac{\text{WPC (BP)}}{\text{COST (BP)}} \right]$$

	1964	1965	1966	1967	1968
WPC / COST =	552·7 / 31 = 17·8	561 / 36·5 = 15·4	596 / 39 = 15·3	606 / 37·5 = 16·15	677 / 34·35 = 19·7
PRODUCTIVITY INDEX	100	86·5	86	90·8	110·8

SAMPLE CALCULATION

$$\text{INDEX (1965)} = \frac{15.4}{17.8} \times 100 = 86.5$$

PRODUCTIVITY OF ENGINEERING SERVICES.

$$\text{INDEX} = \left[\frac{\text{WPC (CP)}}{\text{COST (CP)}} \Big/ \frac{\text{WPC (BP)}}{\text{COST (BP)}} \right]$$

	1964	1965	1966	1967	1968
WPC / COST =	552·7 / 101·4 = 5·45	561 / 107 = 5·24	596 / 117·5 = 5·07	606 / 113·5 = 5·34	677 / 111·8 = 6·06
PRODUCTIVITY INDEX	100	96·2	93·2	98	111

SAMPLE CALCULATION

$$\text{INDEX (1965)} = \frac{5.24}{5.45} \times 100 = 96.2$$

PRODUCTIVITY OF MAINTENANCE SERVICES.

$$\text{INDEX} = \left[\frac{\text{WPC (CP)}}{\text{COST (CP)}} \Big/ \frac{\text{WPC (BP)}}{\text{COST (BP)}} \right]$$

	1964	1965	1966	1967	1968
WPC / COST =	552·7 / 18·8 = 29·4	561 / 21·2 = 26·5	596 / 20·5 = 29·1	606 / 22·3 = 27·2	677 / 22·15 = 30·6
PRODUCTIVITY INDEX	100	90	99	92·5	104

SAMPLE CALCULATION

$$\text{INDEX}(1965) = \frac{26.5}{29.4} \times 100 = 90$$

PRODUCTIVITY OF LABOUR SERVICES.

$$\text{INDEX} = \left[\frac{\text{WPC (CP)}}{\text{COST (CP)}} \Big/ \frac{\text{WPC (BP)}}{\text{COST (BP)}} \right]$$

	1964	1965	1966	1967	1968
WPC / COST =	552·7 / 27·8 = 19·9	561 / 24·1 = 23·3	596 / 31·9 = 18·7	606 / 25·1 = 24·15	677 / 24·1 = 28·1
PRODUCTIVITY INDEX	100	117	94	121	141

SAMPLE CALCULATION

$$\text{INDEX}(1965) = \frac{23.3}{19.9} \times 100 = 117$$

III BASILDON WORKS

PRODUCTIVITY INDICIES.

BASILDON WORKS.

LABOUR.

i). TOTAL LABOUR PRODUCTIVITY.

$$\text{INDEX} = \left[\frac{\text{W.P.C. (C.P.)}}{\text{LABOUR COST (C.P.)}} \Big/ \frac{\text{W.P.C. (B.P.)}}{\text{LABOUR COST (B.P.)}} \right]$$

WHERE CP : CURRENT PERIOD.
& BP : BASE PERIOD.

	1964	1965	1966	1967	1968
$\frac{\text{WPC}}{\text{LABOUR COST}}$ =	$\frac{1458}{1072}$ = 1·36	$\frac{1540}{1160}$ = 1·328	$\frac{1715}{1250}$ = 1·372	$\frac{1630}{1190}$ = 1·37	$\frac{1815}{1255}$ = 1·45
PRODUCTIVITY INDEX	100	97·7	101	100·8	106·5

SAMPLE CALCULATION.

$$\text{INDEX (1965)} = \frac{1{\cdot}328}{1{\cdot}36} \times 100 = 97{\cdot}7$$

ii) DIRECT LABOUR PRODUCTIVITY.

$$\text{INDEX} = \left[\frac{\text{W.P.C (C.P)}}{\text{DIRECT LABOUR COST (C.P)}} \Big| \frac{\text{W.P.C (B.P)}}{\text{DIRECT LABOUR COST (B.P)}} \right]$$

	1964	1965	1966	1967	1968
WPC / DIRECT LABOUR COST =	1458 / 423	1540 / 452	1715 / 486	1630 / 451	1815 / 487
	3·45	3·41	3·53	3·62	3·73
PRODUCTIVITY INDEX	100	98·6	102·2	105	108

SAMPLE CALCULATION.

$$\text{INDEX (1965)} = \frac{3{\cdot}41}{3{\cdot}45} \times 100 = 98{\cdot}6$$

iii) INDIRECT LABOUR PRODUCTIVITY

$$\text{INDEX} = \left[\frac{\text{WPC (CP)}}{\text{INDIRECT LABOUR COST (CP)}} \Big/ \frac{\text{WPC (BP)}}{\text{INDIRECT LABOUR COST (BP)}} \right]$$

	1964	1965	1966	1967	1968
WPC / INDIRECT LABOUR COST =	1458 / 649	1540 / 705	1715 / 745	1630 / 730	1815 / 750
	2·25	2·185	2·3	2·235	2·42
PRODUCTIVITY INDEX.	100	97	102	99·3	107·5

SAMPLE CALCULATION.

$$\text{INDEX (1965)} = \frac{2{\cdot}185}{2{\cdot}25} \times 100 = 97$$

CAPITAL PRODUCTIVITY.

$$\text{INDEX} = \left[\frac{\text{WPC (CP)}}{\text{CAPITAL (CP)}} \Big/ \frac{\text{WPC (BP)}}{\text{CAPITAL (BP)}} \right]$$

	1964	1965	1966	1967	1968
WPC / CAPITAL =	1458 / 499. = 2·92	1540 / 622 = 2·485	1715 / 745 = 2·3	1630 / 808 = 2·02	1815 / 852 = 2·13
PRODUCTIVITY INDEX	100	85·2	78·8	69·2	73

SAMPLE CALCULATION

$$\text{INDEX (1965)} = \frac{2{\cdot}485}{2{\cdot}92} \times 100 = 85{\cdot}2$$

PRODUCTIVITY OF PRODUCTION SUPERVISION.

$$\text{INDEX} = \left[\frac{\text{WPC (CP)}}{\text{COST (CP)}} \Big/ \frac{\text{WPC. (BP.)}}{\text{COST (BP)}} \right]$$

	1964	1965	1966	1967	1968
WPC / COST =	1458 / 76·4 = 19·2	1540 / 90·4 = 17·05	1715 / 102·7 = 16·7	1630 / 98·8 = 16·5	1815 / 107 = 16·95
PRODUCTIVITY INDEX.	100	88·8	87·5	86·4	89

SAMPLE CALCULATION

$$\text{INDEX (1965)} = \frac{17{\cdot}05}{19{\cdot}2} \times 100 = 88{\cdot}8$$

PRODUCTIVITY OF MATERIAL SERVICES.

$$\text{INDEX} = \left[\frac{\text{WPC (CP)}}{\text{COST (CP)}} \Big/ \frac{\text{WPC (BP)}}{\text{COST (BP)}} \right]$$

	1964	1965	1966	1967	1968
WPC / COST =	1458 / 78·9 = 18·5	1540 / 85 = 18·2	1715 / 87·9 = 19·5	1630 / 86 = 18·95	1815 / 86 = 21·1
PRODUCTIVITY INDEX	100	97·8	105·5	102·7	114

SAMPLE CALCULATION

$$\text{INDEX (1965)} = \frac{18.2}{18.5} \times 100 = 97.8$$

PRODUCTIVITY OF ENGINEERING SERVICES.

$$\text{INDEX} = \left[\frac{\text{WPC (CP)}}{\text{COST (CP)}} \Big/ \frac{\text{WPC (BP)}}{\text{COST (BP)}} \right]$$

	1964	1965	1966	1967	1968
WPC / COST =	1458 / 254·5 = 5·72	1540 / 284·5 = 5·42	1715 / 319 = 5·38	1630 / 308 = 5·3	1815 / 300 = 6·05
PRODUCTIVITY INDEX	100	94·8	94	92·6	105·5

SAMPLE CALCULATION

$$\text{INDEX (1965)} = \frac{5.42}{5.72} \times 100 = 94.8$$

PRODUCTIVITY OF MAINTENANCE SERVICES.

$$\text{INDEX} = \left[\frac{\text{WPC (CP)}}{\text{COST (CP)}} \Big/ \frac{\text{WPC (BP)}}{\text{COST (BP)}} \right]$$

	1964	1965	1966	1967	1968
WPC / COST =	1458 / 31·3 = 46·6	1540 / 35·3 = 43·7	1715 / 45·4 = 37·8	1630 / 42 = 39·8	1815 / 46·1 = 39
PRODUCTIVITY INDEX	100	93·8	81	83·4	85·5

SAMPLE CALCULATION

$$\text{INDEX (1965)} = \frac{43.7}{46.6} \times 100 = 93.8$$

PRODUCTIVITY OF LABOUR SERVICES.

$$\text{INDEX} = \left[\frac{\text{WPL (CP)}}{\text{COST (CP)}} \Big/ \frac{\text{WPC (BP)}}{\text{COST (BP)}} \right]$$

	1964	1965	1966	1967	1968
WPC / COST =	1458 / 80·4 = 18·15	1540 / 90·7 = 17	1715 / 94 = 18·25	1630 / 90·9 = 17·95	1815 / 101·8 = 17·8
PRODUCTIVITY INDEX	100	93·7	100·5	99	98·2

SAMPLE CALCULATION

$$\text{INDEX (1965)} = \frac{17}{18.15} \times 100 = 93.7$$

IV GATESHEAD WORKS

PRODUCTIVITY INDICIES.

GATESHEAD WORKS.

LABOUR.

i). TOTAL LABOUR PRODUCTIVITY.

$$\text{INDEX} = \left[\frac{\text{W.P.C. (C.P.)}}{\text{LABOUR COST (C.P.)}} \Big/ \frac{\text{W.P.C. (B.P.)}}{\text{LABOUR COST (B.P.)}} \right]$$

WHERE CP : CURRENT PERIOD.
& BP : BASE PERIOD.

	1964	1965	1966	1967	1968
WPC / LABOUR COST =	584 / 509 = 1·15	456 / 465 = 0·98	457 / 445 = 1·028	446 / 407 = 1·094	665 / 510 = 1·3
PRODUCTIVITY INDEX	100	85·2	89·5	95·3	113·3

SAMPLE CALCULATION.

$$\text{INDEX (1965)} = \frac{0.98}{1.15} \times 100 = 85.2$$

ii) DIRECT LABOUR PRODUCTIVITY.

$$\text{INDEX} = \left[\frac{\text{W.P.C (C.P.)}}{\text{DIRECT LABOUR COST (C.P.)}} \Big| \frac{\text{W.P.C (B.P.)}}{\text{DIRECT LABOUR COST (B.P.)}} \right]$$

	1964	1965	1966	1967	1968
WPC / DIRECT LABOUR COST =	584 / 172 = 3·4	456 / 127 = 3·59	457 / 121 = 3·78	446 / 117 = 3·81	665 / 163·2 = 4·07
PRODUCTIVITY INDEX	100	105·5	111	112	120

SAMPLE CALCULATION.

$$\text{INDEX (1965)} = \frac{3.59}{3.4} \times 100 = 105.5$$

iii) INDIRECT LABOUR PRODUCTIVITY

$$\text{INDEX} = \left[\frac{\text{WPC (CP)}}{\text{INDIRECT LABOUR COST (CP)}} \Big/ \frac{\text{WPC (BP)}}{\text{INDIRECT LABOUR COST (BP)}} \right]$$

	1964	1965	1966	1967	1968
WPC / INDIRECT LABOUR COST =	584 / 337 = 1·73	456 / 335 = 1·36	457 / 315 = 1·45	446 / 284 = 1·57	665 / 339 = 1·96
PRODUCTIVITY INDEX.	100	78·7	84	90·8	113·2

SAMPLE CALCULATION.

$$\text{INDEX (1965)} = \frac{1.36}{1.73} \times 100 = 78.7$$

CAPITAL PRODUCTIVITY.

$$\text{INDEX} = \left[\frac{\text{WPC (CP)}}{\text{CAPITAL (CP)}} \Big/ \frac{\text{WPC (BP)}}{\text{CAPITAL (BP)}} \right]$$

	1964	1965	1966	1967	1968
WPC / CAPITAL =	584 / 247	456 / 276	457 / 274·3	446 / 234	665 / 238·9
	2·36	1·65	1·68	1·9	2·78
PRODUCTIVITY INDEX	100	70	70·8	80·7	117·8

SAMPLE CALCULATION

$$\text{INDEX (1965)} = \frac{1.65}{2.36} \times 100 = 70$$

PRODUCTIVITY OF PRODUCTION SUPERVISION.

$$\text{INDEX} = \left[\frac{\text{WPC (CP)}}{\text{COST (CP)}} \Big/ \frac{\text{WPC. (BP)}}{\text{COST (BP)}} \right]$$

	1964	1965	1966	1967	1968
WPC / COST =	584 / 31·1	456 / 34·1	457 / 33·5	446 / 28·5	665 / 34·3
	18·8	13·36	13·65	15·62	19·4
PRODUCTIVITY INDEX.	100	71	72·6	83·2	103·2

SAMPLE CALCULATION

$$\text{INDEX (1965)} = \frac{13.36}{18.8} \times 100 = 71$$

PRODUCTIVITY OF MATERIAL SERVICES.

$$\text{INDEX} = \left[\frac{\text{WPC (CP)}}{\text{COST (CP)}} \Big/ \frac{\text{WPC (BP)}}{\text{COST (BP)}} \right]$$

	1964	1965	1966	1967	1968
WPC / COST =	584 / 28·4 = 20·6	456 / 27·5 = 16·6	457 / 26 = 17·6	446 / 26 = 17·15	665 / 28·2 = 23·6
PRODUCTIVITY INDEX	100	80·6	85·5	83·3	114·4

SAMPLE CALCULATION

$$\text{INDEX (1965)} = \frac{16.6}{20.6} \times 100 = 80.6$$

PRODUCTIVITY OF ENGINEERING SERVICES.

$$\text{INDEX} = \left[\frac{\text{WPC (CP)}}{\text{COST (CP)}} \Big/ \frac{\text{WPC (BP)}}{\text{COST (BP)}} \right]$$

	1964	1965	1966	1967	1968
WPC / COST =	584 / 135·8 = 4·3	456 / 124·3 = 3·66	457 / 123·3 = 3·71	446 / 122 = 3·66	665 / 139 = 4·78
PRODUCTIVITY INDEX	100	85·2	86·4	85·2	111·2

SAMPLE CALCULATION

$$\text{INDEX (1965)} = \frac{3.66}{4.3} \times 100 = 85.2$$

PRODUCTIVITY OF MAINTENANCE SERVICES.

$$\text{INDEX} = \left[\frac{\text{WPC (CP)}}{\text{COST (CP)}} \Big/ \frac{\text{WPC (BP)}}{\text{COST (BP)}} \right]$$

	1964	1965	1966	1967	1968
WPC / COST =	584 / 22·6 = 25·8	456 / 15·3 = 30·45	457 / 16·3 = 28·7	446 / 17·8 = 2·5	665 / 20·3 = 3·27
PRODUCTIVITY INDEX	100	118	111	97	126·8

SAMPLE CALCULATION

$$\text{INDEX}(1965) = \frac{30.45}{25.8} \times 100 = 118$$

PRODUCTIVITY OF LABOUR SERVICES.

$$\text{INDEX} = \left[\frac{\text{WPC (CP)}}{\text{COST (CP)}} \Big/ \frac{\text{WPC (BP)}}{\text{COST (BP)}} \right]$$

	1964	1965	1966	1967	1968
WPC / COST =	584 / 37 = 15·8	456 / 31·5 = 14·46	457 / 34·7 = 13·2	446 / 33·5 = 13·3	665 / 33·6 = 19·8
PRODUCTIVITY INDEX	100	91·5	83·5	84·2	125

SAMPLE CALCULATION

$$\text{INDEX}(1965) = \frac{14.46}{15.8} \times 100 = 91.5$$

PART VI

CONCLUSIONS

The use of financial units of measurement was found, for the purposes of this study, to be the most appropriate unit of measurement for both input and output facotrs, these are measured in pounds sterling. The source of output data found most appropriate was that of Works processing cost, as this represents the true value of the product added by the manufacturing unit.

Adjustments of values and prices to a base year equivalent value was found necessary in order to obtain data which was comparable in real terms.

The input factors of Labour and Capital were found to be the most meaningful, although the other input factors are considered to be useful in determining the underlying reasons for for changes in indirect labour productivity in addition to capital

The formations of data on direct labour similar to that constructed for the constituent parts of indirect could be useful in further determining reasons for movements in direct labour productivity, and this could possible be an area of further interest and worthy of investigation.

Capital plays a significant role in the productivity of labour, as is shown by the graphs and analysis of part III of this study, and though the actual magnitude is not explicitly determined the overall effect is demonstratable.

The productivity indicies constructed in this study appear to be adequate to determine yearly movements for the manufacturing units, and although further improvements could be made in the light of the experience gained by the author, they would seem to have little effect of the trends, but perhaps some effect on the magnitude of the flutuations.

However, it does not appear to be possible to conduct any real or meaningful comparison of the performance of one manufacturing unit with the performance of another, using the data compiled for this study. It would appear though that some information of value can be obtained by comparing trends in the light of known policy and environmental differences and evaluating the relative performance of the labour and capital input factors. The main reasons for the failure to establish a valid base of comparison is the hetrogeneous nature of the products, the location of the manufacturing units, and the problem of time. It is felt however, that some more investigation in this area would be justified but using a different basis of measurement. It appears unlikely that one method can serve to solve both problems that of year to year movements within manufacturing units, and that of inter-manufacturing unit comparison.

The method of calculating capital investment in fixed assets would appear to be open to some criticism and some modification could serve to improve the accuracy of this index.

The main source of criticism is the selection of gross book values and the adjusting of depreciation charged to a 1964 base The view of some accountants is that the selection of gross book values tends to over state the value of sales and transfers, but as additions are gross values and depreciation is at a fixed rate on the gross value the author has retained his original method of evaluating capital. This could however, bear further investigation in its own right but in view of time limitations and the fact that the primary effect will be on magnitude of flutuation rather than overall trends the matter has not been dealt with in this study.

The value of "output", works processing cost, could also be subject to serve minor errors, in the order of 2% owing to a late realisation of the effect of changes in overhead recovery rates and the possible surplus or deficet on overhead recovery. This factor was identified on prior to writing these conclusions and although it has been possible to describe its effect in the analysis of Chelmsford Works labour productivity graph (it is probably more pronounced here than elsewhere) it does not seem possible to consider the matter in greater detail.

The fact that the denomiter and numnrator of the productivity indecies are composed of similar data and that the denominator is always a proportion of the numerator may effect the ratio values, but it does not appear to adversely affect the percentage movements of the various indecios and thus the author considers the basis of calculating the indicies to be

valid and accurate. (an illustration of this point is that the cost of Direct Labour is included in the output (WPC) value and therefore any movement in Direct Labour cost will affect the works processing cost).

The use of the above data is strictly limited to management information and is not suitable for application as a management or labour numeration systems. Should the company wish to apply productivity measurements to some mere specific role, then a further and more detailed study would be required into the establishment of that application.

It has become quite apparent in the course of this study that the measurement of productivity within a company requires the clear definitions of the following:-

(i) The purpose to which it is to be put.

(ii) Whose productivity is to be measured.

(iii) It is to be user-orientated or resource-orientated

The use of productivity measures as a basis for inventive schemes would appear, as a result of this study, to be a long way off in a complex company of this nature and in view of the difficulty of determining the true effect of capital on productivity

APPENDIX

REFERENCES

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ii National Conference Board - Measuring Company Productivity.

iii Bela Gold - Foundations of Productivity Analysis

iv T.E. Easterfield - Productivity Measurement In Great Britain.

(2) Bela Gold - See (1) (iii)

(3) O.E.C.D. - See (1) (i)

(4) O.E.C.D. - See (1) (i)

(5) Bela Gold - See (1) (iii)

(6) National Conf. Board - See (1) (ii)
(ii) Dr. Laszlo Rosta - See O.E.C.D. (1) (i)
(iii) Bela Gold See 1 (iii)

(7) Bela Gold - See (1) (iii) P.

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