

Productivity
(1956 folder)

Productivity Measurement

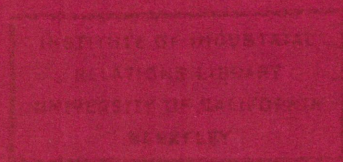
PLANT LEVEL
MEASUREMENTS
METHODS AND RESULTS

Volume II



EUROPEAN PRODUCTIVITY AGENCY

PUBLISHED BY THE ORGANISATION FOR
EUROPEAN ECONOMIC CO-OPERATION PARIS



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(1956 folder)

Productivity Measurement

II, ✓ PLANT LEVEL MEASUREMENTS, METHODS AND RESULTS .../



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EUROPEAN PRODUCTIVITY AGENCY

ORGANISATION FOR EUROPEAN ECONOMIC CO-OPERATION

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The Organisation for European Economic Co-operation comprises the following Member countries : Austria, Belgium, Denmark, France, Germany, Greece, Iceland, Ireland, Italy, Luxemburg, the Netherlands, Norway, Portugal, Sweden, Switzerland, Turkey and the United Kingdom. The Organisation came into being with the signing of the Convention for European Economic Co-operation on 16th April 1948, when Member Governments pledged themselves " to combine their economic strength, to join together to make the fullest collective use of their individual capacities and potentialities, to increase their production, develop and modernise their industrial and agricultural equipment, expand their commerce, reduce progressively barriers to trade among themselves, promote full employment and restore or maintain the stability of their economies and general confidence in their national currencies ". Representatives of each of the Member countries meet daily at OEEC's headquarters, the Château de la Muette, Paris, to discuss their economic problems and work out common solutions. The United States and Canada, although not members of the Organisation, participate in its work.

The European Productivity Agency, which is responsible for the publication of the present report, was set up as a new branch of the OEEC in May, 1953. Its task is to stimulate productivity, and thereby raise European standards of living, by influencing not only Governments but also industrial, agricultural and research organisations, private and collective enterprises and public services. One of its primary aims is to convince management and workers alike of the benefits of productivity and to enlist their co-operation.

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INTRODUCTION

As opposed to Volume I which explains the principles on which productivity measurement is based, Volumes II and III give a brief account of what has been done in this field in the various European countries.

Volume II deals with productivity measurement based on data collected directly in the firm, i. e. "direct measurement".

Volume III deals with productivity measurement based on official existing statistics, i. e. "indirect measurement".

Both Volume II and Volume III are in two parts:

The first part is concerned with methodology, while in the second an attempt is made to compare results obtained.

Productivity measurement has many aspects and is in fact concerned with numerous problems all centred round the desire to know and evaluate the extent to which the fullest use is made of the means of production in the enterprise, in trade and in the nation as a whole.

Diversity of aims gives rise to a certain diversity in methods. However, practical needs have often led to the finding of comparable solutions and to the beginning of a common doctrine.

Nevertheless, experience acquired in this field is still only recent. Productivity measurement, like all methods of forecasting and checking in matters of business administration, can only develop along with the general organisation of enterprises.

Most of the examples examined here only deal, therefore, with a small number of sectors and often with those in which a particular effort in organisation has been made, more especially within the framework of programmes for increasing productivity, assisted or encouraged by the State, or as the result of United States Missions. Whole sectors, such as distribution and agriculture, have been but slightly touched upon or not dealt with at all, for lack of experience over a sufficiently long period.

However, the methods which it is intended to examine, are still valid in these various other sectors. They can equally well be applied to an individual concern, although this report lays particular stress on the aspect of comparison between enterprises.

Although the general characteristics of "direct productivity measurement" are dealt with in Chapter I, some preliminary information might be of use.

As everyone knows, overall productivity is arrived at by the relationship:

Production measurement
Measurement of the sum of factors used

To calculate this it must be assumed that a system of measurement has been devised, applicable not only to different products but also to differing factors.

We shall deliberately refrain from examining this last problem here. It is one, in fact, that at present falls within the scope of studies dealing with the individual enterprise and, on its own merits, deserves very considerable development.

Industrial studies are generally restricted to a comparison of less synthesised data or ratios which are both easier and more rewarding to interpret as they can be acted upon immediately.

From this point of view, comparative data which can be estimated in this way can in fact be classified in order of increasing importance as follows:

- general statistical data on production, consumption...
- comparative working ratios, comparisons of costs,
- comparison of overall productivity...
- comparison of productivity of one factor with another at different stages.

These studies have given rise to many enquiries recently and are the subject of the present Report.

More often than not, therefore, productivity can be expressed by the relationship:

Production measurement
Measurement of the factor used

The factor most often taken into consideration is the labour factor for which it is easy to find a unit of measurement (usually man-hours or minutes). There remains the measurement of production which, in the case of factories turning out different kinds of goods, often poses thorny problems. Solutions have, however, almost always been found, and Chapter IV gives information about methods used to achieve this.

Furthermore, the term "production" as used here has a very wide sense since it can be applied just as much to the result of a single operation transforming a product as to the whole cycle of production.

Productivity measurement has not been the sole subject dealt with in the studies to be examined in the pages that follow, although the general aim has been to measure the degree of efficiency attained in the utilisation of one or other of the fac-

tors of production, either by compiling data for the whole manufacturing process or by analysing individual operations.

They may be divided into two groups:

1. Measurements of an economic nature to determine the productivity of an industrial sector and review its development or establish international comparisons.

2. Measurements of a technical nature to bring out differences in productivity between firms and so discover the reasons for those differences and if possible ways of improving working methods.

Research of this kind is a very valuable tool of management. The individual manufacturer has no means of knowing whether he is using his plant or labour to the best advantage and is reluctant to change his old-established methods without knowing how much profit he is likely to make.

A comparison between his own results and those of other firms for the same operations may reveal the defects in his organisation and, if the data obtained are sufficiently detailed, enable him to put them right.

Even a mere comparison between the overall figures can lead to healthy competition by showing each manufacturer how he stands compared with his fellow industrialists. It is no wonder that research of this kind has increased considerably in almost all European countries in the last few years.

The first achievements in this field go back quite a long way. As early as the nineties the U. S. Bureau of Labor Statistics made direct estimates of labour times in a limited number of works in certain industries and circulated the results.*

In Germany, a different kind of research was undertaken in 1952 by the Statistisches Reichsamt and a large number of publications were issued.** Surveys were carried out at regular intervals on cost structure in commerce and the handicrafts industry and these were continued up to 1939.

The data were supplied by:

- 12,500 handicrafts workers,
- 12,000 retailers,
- 1,700 wholesalers,
- 1,200 hotel managers.

Similar surveys were carried out in 1935 in certain commercial sectors in the Netherlands.

* E.g. "Hand and Machine Labor", 13th Report by the Commissioner of Labor, Volumes I and II, Washington, D.C. 1898.

** Erste Berichte d.g.f. Reichsgesetze. Statistisches Reichsamt 15/4 1/1926.

Vierteljahrshefte zur Statistik des deutschen Reich-Stat., Reichsamt 1935-1936
Die Statistik in Deutschland nach ihrem heutigen Stand. Friedrich Burghofer-Statistisches Reichsamt 1940.

About the same period the launching of the National Research Project in the United States gave a new stimulus to research in that country. Indices were compiled for about 60 industrial sectors showing trends in labour productivity over a long period.

Some years later Congress allocated extra funds to the Bureau of Labor Statistics for permanent research on productivity.

After the war, additional research efforts were based on the utilisation of physical data drawn from the internal statistics of firms. This research consisted in analysing the data collected so as to establish a more accurate comparison between the volume of production and the corresponding labour times.

This research may be divided into two types.

1. Research which is designed to show trends in a particular branch of industry and differs from previous research in that its results are independent of fluctuations in productivity attributable to changes in the structure of the industry.* The resulting publications appeared under the title "Productivity Direct Reports".

2. Technical research which is mainly designed to bring out the reasons for differences in productivity between firms in the same branch by the detailed analysis of complete manufacturing processes. This research is dealt with in publications issued under the title "Case Study data on productivity and factory performance". These reports have had considerable influence in both the United States and Europe.

It was the study of the reports published by the Bureau of Labor Statistics which led a large number of countries to initiate similar research.

The work was first taken up in Great Britain where the British Cotton Research Association began measuring productivity in cotton mills in 1946, almost simultaneously with the Bureau of Labor Statistics. The example was soon followed by the Shoe and Allied Trade Research Association.

From 1950 onwards a great many surveys were carried out on the Continent. The chronological list of the main projects speaks for itself.

1950: Austria: Survey on cotton mills by the Oesterreichisches Produktivitäts Zentrum.

France: Survey on cotton mills by the Fédération des Industries cotonnières.

France: Survey on production of boot and shoe industry by the Secrétariat du Comité National de la Productivité.

* The level of productivity in a particular branch may, of course, fluctuate (other things being equal) if a firm whose productivity is above or below average increases or decreases its production.

- France: Survey on the paper industry by the trade association.
- 1951: Germany: Investigation by the Statistisches Bundesamt into the structure of costs.
- Norway: Survey on the boot and shoe industry by the Committee of Norwegian Leather and Footwear Industries and the Produktion Teknisk forsknings Institutt.
- 1952: Denmark: Surveys on the shirt and footwear industries by the Danish Productivity Centre.
- United Kingdom: Survey on the building industry by the Building Research Station.
- Netherlands: Surveys on the brick, footwear, and shirt industries by the Centraal Bureau voor de Statistiek.
- 1953: Germany: Survey on the boot and shoe, and drop forge industries by the Rationalisierungs Kuratorium der Deutschen Wirtschaft.
- France: Survey on the women's shoe industry, and the production of tinned mushrooms, peas, mackerel and sardines by the Centre d'Etudes et de Mesures de Productivité.
- Netherlands: Surveys on the foundry, bicycle and cigar industries by the Centraal Bureau voor de Statistiek.
- Norway: Survey on the brick industry by the Institutt for Industrial Economics.
- 1954: Germany: Survey on the production of small tools by the Forschungsinstitut für Rationalisierung.
- Belgium: Trade association survey on the boot and shoe industry.
- Survey by the National Association of Sugar Producers into the sugar industry.
- Survey by the Institute of Economic and Social Research of the University of Louvain into the foundry industry.
- France: Survey by the Centre d'Etudes et de Mesures de Productivité into the production of working clothes, sawn softwood, tinned tomatoes and flour.
- United Kingdom: Trade association survey on the rubber and rayon industries.
- Italy: Investigation by the National Productivity Committee into the engineering and footwear industries.
- Norway: Investigations by the Institute of Industrial Economics into the wool-spinning industry.

Netherlands: Survey by the Centraal Bureau voor de Statistiek on the production of working clothes, the tanning industry and the retreading of tyres.

It is easy to imagine from this impressive list how valuable an analytical survey on the methods used can be.

Part I

METHODS USED IN EUROPE

I

GENERAL CHARACTERISTICS OF DIRECT PRODUCTIVITY MEASUREMENT METHODS

The methods of measuring productivity often differ greatly in detail according to the aim in view.

Two main categories have already been considered in the introduction:

1. Measurements of an economic character, of which the principal aim is to assess the productivity level of a single branch of industry or to determine the factors on which a system of national accounts might be based. Such measurements frequently relate to a large number of firms and the data obtained tend to be rather meagre.

2. Measurements of a technical character, of which the principal aim is to bring out differences in productivity as between individual firms. These generally relate to a fairly small number of firms and, in the main, produce sufficiently detailed information to enable the industrialist to set about improving his working methods.

The distinction between the two categories is sometimes indefinite as the criteria adopted are rather subjective: then many studies belong to both types.

From the point of view of method, two further categories might be established:

1. Measurement of physical data;
2. Measurement of costs.

In any case, the methods of measurement actually used seem almost all to fall within a common plan covering four successive stages. It may be appropriate, therefore, to describe these briefly before analysing the ways in which the various problems arising have been solved in practice.

1. Determining the scope of the study;
2. Measuring production and its contributory factors;
3. Collecting basic data;
4. Presenting and interpreting results.

Determining the scope of the study

The first point, of course, is to delimitate the branch of industry to be studied and to set up a pilot study. The time and space limits within which the data is to be collected can then be fixed, the field of activity to be studied at plant level can be determined, and, lastly, the exact nature of the information to be collected can be decided.

- a) In an investigation of the economic type, the study usually relates either to all the undertakings in a given branch or to a smaller number of firms making up a representative sample. In practice, however, it is rarely quite so simple: productivity measurement requires the willing co-operation of the firms concerned and a readiness on their part to keep sufficiently detailed internal records. Generally speaking, therefore, it is impossible either to obtain the facts relating to every firm or to make up a completely representative sample.

In an investigation of the technical type, it is not essential to work on a representative sample because the aim is principally to bring out differences in productivity as between firms. Such studies are mostly limited to fewer than twenty firms.

- b) The period to which production and manpower figures relate must also be fixed.

This, it will be seen, depends on various factors, particularly the length of the production cycle and the degree to which productivity varies in a single firm. It is necessary to choose a period long enough to ensure that the data obtained reflect accurately the average position of the plant.

The period chosen is usually between three months and a year. It is sometimes less and may be as short as two to four weeks if special observations involving too much work have to be made. It is usual to arrange for simultaneous periods of study in the various factories, so as to eliminate any seasonal fluctuations which might make the results less comparable.

- c) The field of study within the production unit itself is next defined. It frequently occurs that even in a single branch of industry the degree of integration varies from firm to firm. Limits of activity are defined for the typical factory which, for example, uses raw materials or components at a given stage of manufacture and neither repairs its own machines nor undertakes delivery: only data relating to the activity defined will be taken into consideration.

If these precautions are not taken, the calculation of averages for the branch as a whole or the comparison

of the uncorrected results of individual firms will have no significance.

- d) Lastly, the nature of the information to be collected must be specified.

With regard to production, it is usually agreed to undertake the most detailed investigation possible of all the types of product manufactured.

With regard to factors of production, most measurements relating to physical data are confined to labour and a few other factors: raw materials, fuel and power, use of machinery, floor space.

A whole series of further miscellaneous elements are collected to facilitate the interpretation of results. In the case of cost studies, these usually cover most of the input factors.

In the special case of the labour factor, it is often agreed to supplement the overall figures by detailed information enabling the investigator:

- i) to omit clerical staff or count them separately;
- ii) to separate direct from indirect labour;
- iii) to break down direct labour by groups of operations or even individual operations.

The study may, in fact, sometimes be limited to individual operations.

In any case it is, of course, always essential for insuring comparability of results, to lay down beforehand very clear definitions of the information to be collected.

Measuring production and its contributory factors

Once the scope of the study is determined, it becomes necessary to select the units in which production and its factors are to be expressed. Cost studies present no difficulty, for they presuppose the adoption of a monetary unit.

It is easy to determine a unit of production for the manufacture of a single definite article. It is not so easy when production is varied, because it then becomes necessary to establish equivalents between the different types manufactured and a standard type chosen as a unit of reference.

As we have just said, most studies of production factors are limited to labour and a few individual and usually homogeneous elements.

The physical labour unit is normally based on time: a year, a day, an hour or one minute, and it is always assumed that the same period of time is equivalent for all classes of wage earners.

Collection of basic data

Basic data is obtained in two ways:

- a) From existing data, by using the internal records normally kept by the firm;
- b) by direct measurement, either from observations made by the investigators themselves or from special accounts kept by the firm during the period of study.

The facts are recorded in a questionnaire compiled during the opening stages of the work. This is sometimes filled in by the firm alone, but more often an investigator is sent to complete the questionnaire himself or to give the management detailed instructions on how to proceed.

Presentation and interpretation of results

The results are generally expressed in the form of a fraction $\frac{\text{factor}}{\text{production}}$ i.e. the inverse of the productivity of that factor.

Labour figures are usually expressed in units of time, which have the advantage of being easily added together. In other words, the unit of time for a complete manufacturing process is the sum of the time taken for each separate operation.

Statistical tables are usually accompanied by comments to enable them to be interpreted easily. Moreover, in technical studies an attempt is often made to explain the reasons for any divergencies revealed. Occasionally, detailed suggestions are made as to how the less successful firms might improve their productivity.

As may well be imagined, the practical application of these methods, the general structure of which is outlined above, raises many problems.

The solutions reached in practice, which differ according to the types of survey, the aims pursued and the means employed, will be described in the following chapters.

II

SELECTION OF PLANTS

Like many other methods used in productivity measurement, those governing the choice of the plants to be studied largely depend on the aims in view.

If the aim is to obtain results which will be valid for a whole branch of industry, in order to follow the trend of that branch or to show heads of firms how they compare with their competitors, it would seem essential to collect information relating either to all the firms in that branch or to a representative sample.

If, on the other hand, the aim is to show the differences in productivity between various firms, so as to bring out the reason for these differences and to suggest how deficiencies might be remedied, it would seem a prime necessity to study comparable plants, and the difficulty of obtaining a representative sample is replaced by the problem of discovering comparable plants.

In point of fact, the studies so far carried out have rarely belonged exclusively to either category but have more frequently tried to attain both aims simultaneously. It is not always possible to tell which of the two aims is the principal one.

Before dealing with the practical solutions adopted, it should be pointed out that the very nature of productivity measurement demands that the plants involved should be willing to co-operate and should already be organised to some extent.

It frequently happens that a comparatively large proportion of the plants in a given branch refuse to co-operate. It may also prove impossible to collect sufficiently exact information, even in a plant whose willingness is beyond doubt. The collection of data is to be studied in detail in Chapter VI, but without going into the matter too deeply it may easily be appreciated that, when various products are manufactured in the same shop by the same workers, it is extremely difficult to determine the number of man-hours expended on each product without an accurate accounting system.

For these two reasons a study can rarely be brought to bear on all the plants in a given branch. Nor can we rely on using a pre-determined sample for it might not be possible to carry out the measurements in all the firms included in it.

In short, we have to face all the difficulties which arise when statistical enquiries are made among the ordinary public, a fairly large proportion of whom we know will be unable or unwilling to reply.

Both the exhaustive study and the strictly random sample are therefore almost impracticable. The only method which can be generally used to obtain results valid for an entire branch of industry is therefore the quota method. This implies the classification of all the firms according to size and type and possibly geographical distribution, and the selection, within each category, of plants which can participate in the study. Everyone knows that such a method carries no guarantee of accuracy and that a sample so obtained may be strongly biased. But it is a lesser evil, for without it the errors in measurement might be far more serious than the sampling errors.

When comparisons are the sole aim in view, the difficulties are not so great, because it is only necessary to find similar plants. However, if all the plants in the branch are not to be studied, one can never be quite certain of applying the measurements to those firms whose production is highest and which therefore furnish the most instructive examples.

Each of these two categories will be studied in turn below.

Section I

MEASURING THE PRODUCTIVITY LEVEL OF A BRANCH OF INDUSTRY

Investigations centred exclusively on an entire industry are not very common. Practically the only examples of this are the Cotton Board's enquiry into British cotton spinning and, in the field of cost analysis, the present enquiries of the Statistisches Bundesamt from which a national balance sheet is to be drawn up.

The Cotton Board's enquiry dealt with all English cotton-spinning mills. The information requested was not very detailed but it related both to the current period (November 1947) and to an earlier period (May 1939). It was thus sometimes difficult to fill in the questionnaires, which had been sent by post to all the firms in the trade.

Two hundred and eighty plants (representing about two-thirds of the workers employed in that sector) replied, but only 114 questionnaires were found to be fully usable.

The German study, which is on a totally different scale since it is to furnish results valid for the entire productive

economy, deals with the principal processing industries, the building industry, transport, handicrafts, wholesale and retail distribution and the hotel industry, as well as the medical and dental professions.

The other sectors, particularly agriculture, were left out. Adequate information was already available for some of these while others were too small to justify special study.

The sectors concerned together comprised 1,600,000 undertakings. It was decided to use the sample survey method and to concentrate the enquiry on 43,000 firms chosen at random. A cross classification by branches and by size of firm was first prepared from information drawn from current statistics and industrial enquiries. Where this information was inadequate an appeal was made to the trade associations.

The number of branches retained was as follows:

Industry*	200
Handicrafts*	44
Building	1
Wholesale distribution	59
Retail distribution	55
Hotel industry	12
Professions	2

Classification according to size of firm varied from branch to branch but never included more than six subdivisions.

A sub-classification has sometimes been made within a branch, according to the nature of the production.

The selection was, of course, made at random whenever possible, but it was sometimes necessary to use the quota system.

In a number of other studies, the essential aim has also been to measure the productivity level of an industrial sector as a whole, while at the same time giving particular attention to discovering the basic reasons for the differences between the various factories.

This group includes the Austrian study on cotton-spinning, the Norwegian study on the footwear industry by the Branch Council for the Shoe and Leather Industry, the current French studies on the canning of sardines and peas, as well as the study on the building industry by the Building Research Station and the R.K.W. (Rationalisierung Kuratorium der deutschen Wirtschaft) study on the footwear industry.

In the first two of these, information was to have been collected from all the factories in the branch.

In fact, only 52 Norwegian footwear factories replied, though 17 Austrian cotton-spinning firms agreed to take part, out of a total of 21. The very satisfactory percentage in the second

* Excluding building.

case was largely due to the fact that the investigators took the trouble to pay a preliminary visit to each factory.

The other four studies were carried out by the sample survey method. The two French studies were a rather special case, for they were an experiment dealing with 10 to 15 per cent of the plants, to be extended later to the entire sector. The principal aim was to show industrialists how useful the results could be and so encourage them to reply to a subsequently more exhaustive enquiry. The Building Research Station enquiry, which, from this point of view, was extremely well planned, dealt with 151 building contracts for houses of the traditional type in England and Wales.

The contracts making up the sample were chosen from lists kept by the Ministry of Housing and Local Government. The contracts were first classified according to geographical position and size and then random samples were drawn in each group.

As some of the contracts chosen could not be included, others had to be found. The final results of the selection were as follows:

Entirely suitable contracts.....	151
Partially suitable contracts.....	26
Rejected contracts.....	144

The reasons for rejecting some of the contracts are shown in the following table:

Table I
CLASSIFICATION OF REJECTED CONTRACTS

REASON FOR REJECTION	NO. OF CONTRACT	REMARKS
Contractor no longer engaged on building	18	Include cases of business failure, death of principal, etc.
Contractor unwilling or unable to participate in survey	28	Contractor unco-operative or unable to provide office space; ill-health of principals
Inadequate or unsuitable records	50	Mainly cases where other work had been confused with record for contract required
Contracts not fulfilling sample specifications or otherwise unsuitable	48	Contracts including detached houses, bungalows, or non-traditional houses

Despite the changes made in the original sample, the following tables do not suggest that any appreciable bias was introduced:

Table II
DISTRIBUTION OF CONTRACTS IN SAMPLE BY REGION

AREA	NUMBER OF CONTRACTS IN SAMPLE	PERCENTAGE OF CONTRACTS IN SAMPLE	PERCENTAGE OF HOUSES COMPLETED
Northern.....	56	37.0	35.5
Midland	38	25.0	25.0
Southern.....	46	30.5	30.5
London area.....	11	7.5	9.5
Total.....	151	100.0	100.0

Table III
DISTRIBUTION OF CONTRACTS IN SAMPLE BY SIZE OF CONTRACT

SIZE OF CONTRACT	NUMBER OF CONTRACTS IN SAMPLE	PERCENTAGE OF CONTRACTS IN SAMPLE	PERCENTAGE DWELLINGS IN APPROVED TENDERS COMPLETED
2 to 10 houses.....	40	26.5	26.5
11 to 25 houses.....	44	29.0	31.0
26 to 50 houses.....	48	32.0	27.0
51 to 80 houses.....	19	12.5	15.0
Total	151	100.0	100.0

Section II

COMPARATIVE STUDIES

Most of the investigations come under this second heading, though almost all were concerned with a sample large enough* to give information on the productivity level of the branch of industry in question.

Apart from the Netherlands study on the brick industry and the British Cotton Industry study on cotton-spinning, which involved 150 and 99 factories respectively, most of the work related to a comparatively small number of firms.

* Almost the only exception is the Norwegian study of the footwear industry by the Produktionsteknisk Forsknings Institutt, which was confined to comparisons between firms.



Fig. 1. Netherlands Brick Industry
Geographical distribution of the works investigated

The purpose of the two studies mentioned was to investigate all cases so as to discover an optimum for each product and for each manufacturing process.

The Netherlands measurements could only be applied to certain firms because only 145 factories out of a total of 235 took part in the study.

The reasons which prevented the other 90 from being included were:

Special circumstances occurring during the study (re-organisation, stoppage of work)	19
Inadequate accounting systems which made it impossible to collect information on labour	19
Refusal to take part in the study (which was limited to volunteers).....	17
Production included other miscellaneous articles besides bricks (drainpipes, hollow bricks, etc.) ..	13
Other reasons (badly-kept accounts, inability to give information on production, inadequate co-operation, etc.)	22

Nevertheless, the remaining factories represented all categories as regards both production features and geographical distribution of the firms, as will be seen from the accompanying map.

Table IV
FIRMS SELECTED FOR PRODUCTIVITY MEASUREMENT

A. Studies for determination of productivity level in an entire sector

COUNTRY AND ORGANISATION UNDERTAKING STUDY	INDUSTRY CONCERNED	NUMBER OF FIRMS	APPROXIMATE PERCENTAGE OF WHOLE	SPECIAL FEATURES
Germany Statistisches Bundesamt	Principal branches of commerce and industry and professions	43,000	2.7%	Random sample Cost analysis
Austria Osterreichisches Produktivitäts Zentrum	Cotton spinning	17	85%	
United Kingdom Cotton Board	Cotton spinning	280	66%	
United Kingdom Building Research Station	Building	177 con- tracts	60%	Random sample
Norway Branch Council of the Shoe and Leather Industry	Footwear	52	*	

* No information available.

**B. Studies for determination of differences in productivity
between factories**

COUNTRY AND ORGANISATION UNDERTAKING STUDY	INDUSTRY CONCERNED	NUMBER OF FIRMS	SPECIAL FEATURES
Germany Rationalisierung Kuratorium der Deutschen Wirtschaft	Footwear	12	Representative sample
	Drop forges	11	Representative sample
Germany Institut für Betriebs- Rationalisierung Aix-la-Chapelle	Hand tools	12	Sample
Belgium Institut de Recherches Economiques de l'Université de Louvain	Foundry	16	Sample covering factories of all sizes
Denmark Handels Ministeriet Produktivitets Udvalg	Goodyear welt Footwear	7	Representative sample
	Shirt-making industry	6	Firms manufactur- ing comparable articles
France Centre d'Etudes et de Mesures de Productivité	Footwear	9 to 12	Representative sample selected by quota system
	Workmen's clothing	13	
	Canned foods (1st series)	4 to 12	
	Canned foods (2nd series)	20 to 25	Random sample
United Kingdom British Cotton Industry Research Association	Cotton spinning	99	Representative of various types of firms in the area
United Kingdom Shoe and Allied Trade Research Association	Footwear	6 to 12	Firms manufactur- ing sufficiently comparable ar- ticles - firms of all sizes repre- sented
Norway Institut for Industrial Oekonomiks	Brick industry	2	Pilot study
Norway Produktjonteknisk forsknings Institutt	Footwear	5	Pilot study

B. Studies for determination of differences in productivity
between factories (Cont'd)

COUNTRY AND ORGANISATION UNDERTAKING STUDY	INDUSTRY CONCERNED	NUMBER OF FIRMS	SPECIAL FEATURES
Netherlands	Brick industry	150	
Centraal Bureau voor de Statistiek	Goodyear welt Footwear	15	
	Foundry	26	
	Shirtmaking industry	15	Representative sample deter- mined by quota method
	Bicycle industry	12	
	Workmen's clothing	20	
	Cigars	18	
	Retreading of tyres	11	

The English measurements, on the other hand, were carried out in practically all the mills in the Manchester area, as only one refused to co-operate.

Two exceptional cases were met with: the Norwegian study on the brick industry and the French study on the mushroom-canning industry, which dealt with only two and four factories respectively; for both were merely experiments intended to provide guidance for future work.

There would be no point in reviewing all the other studies, each of which deals with between five and twenty-five firms, generally chosen to represent the most important types of factories.

III

PERIOD COVERED BY THE STUDY

The problem of the length of the period covered by the study leads to a new distinction between the various measurement operations.

Some studies are limited to the analysis of a definite state at a given date.

Others try to bring out the trend of the productivity level of a branch of industry, group of firms or even a single factory.

In either case it is essential to obtain information relating to a fairly long period embracing the given date. The operation must be repeated at regular intervals if a trend is to be shown.

The length of the period chosen has a considerable effect on the significance of the result. The factors contributing to a given production could scarcely be analysed over a period less than a complete manufacturing cycle, which may be called the unit period.

Experience also shows that in nearly all industries the productivity level varies considerably, often for purely fortuitous reasons. An example of this will be given in the following pages.

It is therefore necessary for the study period to include a number of unit periods sufficiently long to eliminate the influence of chance variations in productivity.

On the other hand, the study period must not be too long as changes in the organisation of the work, the structure of the production programmes and the plant, might make average results of little use.

Other factors which often have considerable influence on the productivity level are seasonal variations. These may be bound up with demand (particularly in the clothing industry), supplies of raw materials (food industries), the weather (building industry, primary timber processing, etc.) or holiday periods.

In all cases, therefore, care has been taken to ensure that the period of study is simultaneous for all the firms in a single branch. For short-term studies, an effort has always been made to choose a period of full activity and normal working,

for the results might be distorted by disturbances in the work of certain firms due to holiday periods, bank holidays, strikes or epidemics.

In practice, the period chosen almost always ranges between two weeks and a year, according to the characteristics of the industry. There are, however, two exceptions: the Cotton Board's study on British cotton spinning, and the studies of the Central Bureau voor de Statistiek on the Netherlands footwear industry.

The studies already carried out may be divided into two main groups.

1. Those covering a period of between three months and one year;
2. Those covering less than three months.

Section I

STUDIES COVERING A LONG PERIOD

In the first category we may include:

The Netherlands and the French studies on the brick industry (covering one year).

The studies of the Statistisches Bundesamt on the principal branches of industry (covering one year).

The Austrian study on cotton spinning (covering six months).

The Netherlands studies on foundry work, the shirt-making industry, the workmen's clothing industry, the manufacture of cigars and the manufacture of bicycles (covering three months).

The experiments in Italy to follow the trend of productivity in firms producing a wide range of articles (one year or a full season).

The brick industry is a rather special case. After moulding, the bricks are left to dry during practically all the summer. It was therefore found necessary to select a period of study covering a calendar year so as to have information on production which could usefully be compared with data on manpower.

The studies by the Statistisches Bundesamt were confined, as we have seen, to an analysis of costs.

The first necessity was, therefore, that the study should take place in a period of monetary stability: the year 1950 was therefore chosen as suitable from that point of view.

Furthermore, as the firms completed the questionnaires themselves, the period of study had to correspond to a financial year, so as to ease their work. The calendar year 1950 was

therefore decided upon in principle or, failing that, the financial year ending in 1950.

The Austrian cotton spinning study is somewhat different, for the measurements are repeated every six months and indicate the trend of productivity. Care was taken to choose a period long enough to eliminate the effects of chance variations yet short enough for the trend of productivity of the firms to be followed at reasonably close intervals. It was the same with the Netherlands studies mentioned, except that the period chosen was three months instead of six.

The United Kingdom study on the building industry by the Building Research station can also be included in this category.

The period chosen was the time taken for the execution of the contract and varied according to the firm. The maximum time was 30 months.

The date of execution of each contract was defined as the mean interval between the conclusion of the contract and the conclusion of the work. To make the periods coincide closely enough, this average date was taken as between October 1948 and December 1949. The period of completion of the contract was, of course, greater, and extended from October 1947 to March 1951.

Section II

STUDIES COVERING A SHORT PERIOD

In this second category, we may include most of the operations which require direct statistical information to be collected by the investigators in the shops themselves.

It includes:

The French studies on the canned food industry, the footwear industry, the workmen's clothing industry and the timber industry (covering a period of one to four weeks).

The British Cotton Industry Research Association study on cotton spinning (covering four weeks).

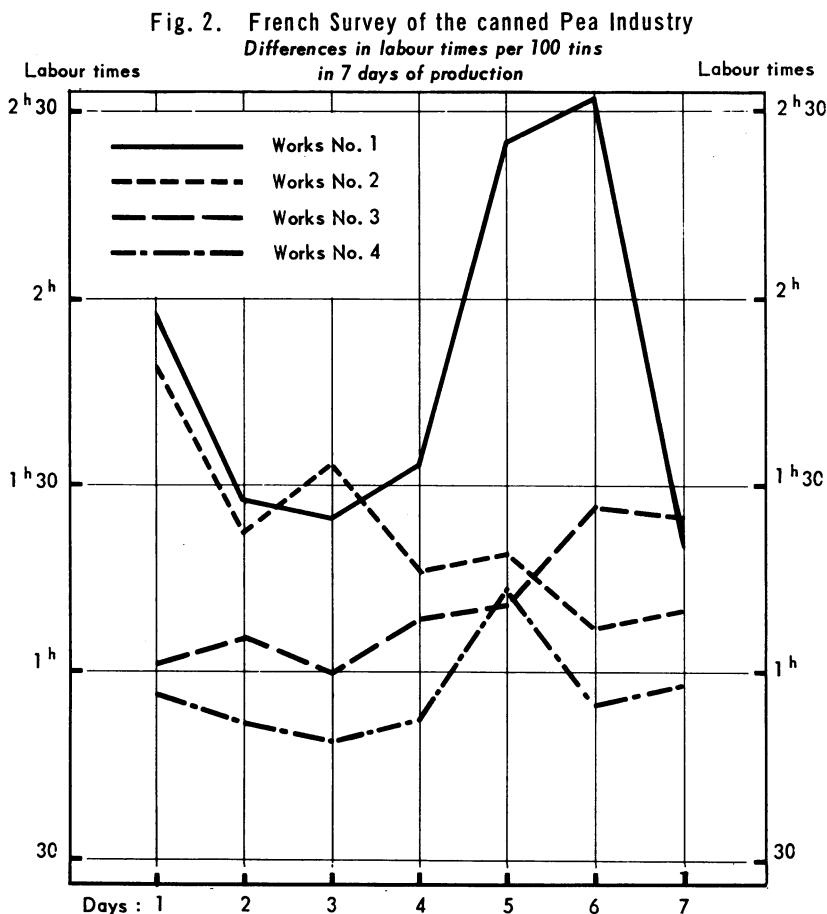
The British Boot, Shoe and Allied Trades Association studies on the footwear industry (covering four weeks).

The Norwegian study on the brick industry (covering eight weeks).

The British Cotton Board study on cotton spinning (covering two periods of one week).

The French studies on the canning industry are a rather special case. They almost always concerned small firms, some with varied activities, which were rarely capable of supplying exact information on labour times.

It was therefore decided to introduce a simplified labour accounting system in these firms but experience showed that it was difficult to get the forms kept up to date for more than three to four weeks at a time.



The information collected in this way was analysed to see whether it gave significant results. The unit of time (corresponding to a production cycle) was one day, and the aim of the study was to discover to what extent the productivity level of the firms varied from day to day.

In the canning of mushrooms, for example, it was discovered that, over a period of three weeks, the time required for treating one kilogramme of material varied, in the same firm, from 15 to 22 minutes according to the day. On the other hand, the weekly average ranged only between 17.1 and 18.7 minutes, so that although the weekly figures were not absolutely accurate, they did provide indisputable evidence of the differences between factories, which were nearly always higher.

The same kind of analysis applied to vegetable canning led to similar conclusions, as shown in Fig. 2.

A second problem was to fix a time for the study period.

The study on pea-canning is quite characteristic in this respect. The length of the pea-growing season in France is six to eight weeks. But the activity of the firms is normal for only 20 to 25 days, for, at the beginning and the end of the season, it is impossible to get enough material. The measurements therefore relate to the middle of the season. The limiting dates of the period varied, however, according to climate, the average being about the 1st July in Brittany and the Paris area, and about 15th July in the north of France.

In the French studies on footwear and workmen's clothing, and in the English studies on cotton spinning and footwear, the problem took on a different aspect. The period of study was not limited by any difficulty in obtaining data. The four-week period was adopted only because it seemed long enough to eliminate chance variations.

In the studies on footwear, care was taken that the periods of study in each factory should coincide as closely as possible, owing to the markedly seasonal character of this industry.

The work of the British Cotton Board was entirely different for it was intended to bring out the changes which had taken place in the productivity level of the British cotton spinning industry, between May 1939 and November 1947.

A period of one week was thought sufficient to eliminate chance variations within the industry as a whole, since it could be assumed that anomalies arising in individual firms would be counterbalanced.

The last typical case is that of the Netherlands study of the footwear industry. A special method of obtaining the information was used: a complete record of the physical data of the operations analysed (see page) was compiled by the investigators themselves. Every time a batch of Goodyear footwear was produced, the investigator noted the time of beginning and ending work for each operation.

Twenty-five to thirty such observations were taken in each case, which, as analysis showed, was sufficient to give significant results. This work, for which an investigator had to spend from two to four weeks in each factory, was carried out between 10th March 1952 and 10th April 1952.

IV

THE MEASUREMENT OF PRODUCTION

So far as production is concerned, the studies made in Europe seem to have followed rather different lines. Some of the studies related to the manufacture of a particular product (cigars, Goodyear footwear for men, canned peas). The others were made within the wider framework of the various production stages in a given activity (foundrywork, softwood sawmills, workmen's clothing industry, brick and tile-making).

When the measurements taken are examined, however, it is clear that the first group of studies is not so simple as one might have supposed. In the examples given, the studies covered several types of cigars, several styles of footwear and several sizes of cans. The difference, therefore, between the first and the second group of studies is only one of degree since the products studied were always found to have many characteristics in common. The Norwegian study on brick-making, for example, was directed to the combined production of bricks, tiles and drain-pipes, all of which are obtained from the same raw material and manufactured by a similar process.

Whatever the type of study, the measurements always related to products which, though similar, were never absolutely identical. The problem, therefore, was to select the products to be studied and then to calculate the quantities produced in terms which could be related to the corresponding labour input. This assumes, of course, that labour is the only factor studied. The same argument could easily be applied to the study of any other factor, but as this is very much rarer it will not be discussed until the end of the chapter.

In almost every case, a preliminary analysis was made of the types of data to be collected so as to ensure that the elements studied would be as uniform as possible.

The solutions then adopted can be classified under two heads:

1. Those in which the physical data collected were simply compared;
2. Those in which adjustments were made to make dissimilar data comparable.

The actual methods used are studied in the three sections which follow.

Section I

PRELIMINARY ANALYSIS OF DATA

Since the elements to be measured were nearly always dissimilar, an attempt was usually made to see how far the problem could be simplified a priori.

In this way, it was fairly often possible to obtain results which, though incomplete, were by no means negligible.

In fact, the three principal methods used for the purpose derive simply from an analysis of the product studied.

The first method consisted in establishing a distinction between those of the product's characteristics which were capable of influencing labour productivity and those which were not, so as to determine the actual degree of dissimilarity.

In this connection, a fairly typical example is the French study on the pea canning industry. According to the current standards, the finished product could be sub-divided into five grades, corresponding to the size of the peas. Only the first grade (extra fine) had to be considered separately, as the other four were treated in exactly the same way, the process being unaffected by the size of the peas.

After analysis, therefore, the five categories could be reduced to two. This type of simplification has proved possible in many other cases, but its application has usually been so obvious as to make it unnecessary to quote further examples.

A second possibility was offered in the particular case where all the factories made the same range of products in the same proportions.

The complete range of products manufactured constituted a unit which was comparable from one factory to another. Thus in all the studies on the footwear industry it was implicitly allowed that all the different sizes were made in the same proportions by all the factories. A fictional pair* was studied, therefore, with characteristics corresponding to the average of the sizes made. It will still be seen, however, in the last section of this volume, that variations in this average from one country to another may distort international comparisons unless taken into account.

The same method was used for the whole of the clothing industry.

In France it was used a little differently in an attempt to solve the problems presented by the diversity of sizes turned out by each food canning factory.

* With the exception of the study carried out in Norway by the Produktjonsteknisk forsknings Institutt, which was concerned with size 11,5 only.

As already stated on page 35, measurements were taken over a given number of working days (minimum 12). This made it possible to select for each factory twelve working days during which the pattern of production was comparable from one factory to another.

Though the result obtained was not perfect, the problem was simplified considerably in six factories out of eight, as shown by the following table:

Table V
PATTERN OF PRODUCTION
IN 8 FRENCH PEA CANNING FACTORIES
(to the nearest 1%)

FACTORY	% OF 1/2 CANS	% OF 4/4 CANS
A	33%	67%
B	46%	34%
C	33%	67%
D	33%	67%
E	33%	67%
F	33%	67%
G	33%	67%
H	57%	43%

There is, however, one serious disadvantage to this method; it can only be applied by a rather empirical process of selection and cannot therefore be used systematically.

Finally, a third method of simplification was used when the special characteristics of the product were attributable solely to one or more operations peculiar to its manufacture. Assimilating a particular type of production to other types can be done very simply by excluding from total production time the time taken for additional operations.

The Netherlands study on the bicycle industry offers a very simple example of the application of this method. The frames and mudguards are given one, two or even three coats of paint, depending on the model. To assimilate all the finished articles to a common type, labour times for the first coat only were considered, excluding those for the second and third coats.

Similarly, in the French pea-canning industry there are two categories of products, "au naturel" peas and steamed peas. From the labour point of view the method of production was the same in both cases with this exception, that in preparing the steamed peas one of the women workers put a piece of onion or lettuce into the cans before they were closed. It was easy to make these types of production comparable by excluding in

every case labour times for preparing, handling and inserting the onion or lettuce into the cans.

Numerous examples of the application of this method are to be found in the studies on the clothing and footwear industries, but its use is limited because of the practical difficulty of measuring the labour time.

In no case, in fact, was it possible to make the elements studied completely comparable by using the three methods just mentioned. These methods were useful only in working out how to present the data. In some cases the data measured were used directly, while in others they were adjusted to allow for differences in the components.

Section II

DIRECT USE OF DATA

To use the data directly is obviously the simplest method since it obviates calculation. For this reason it was preferred to any other method whenever it appeared to be justified.

The method took three main forms each of which will be studied in turn, viz:

1. Assuming a group of products to be comparable;
2. Dividing a range of products into comparable groups;
3. Changing the unit.

1. Assuming a group of products to be comparable

This solution consists simply in allowing that the products studied are sufficiently similar to constitute comparable units.

It was used in the German, French and Norwegian studies on the footwear industry, in the United Kingdom study on building and in the Netherlands study on the bicycle industry.

Table VI

CRITERIA OF SIMILARITY
ADOPTED IN THE UNITED KINGDOM STUDY
ON THE BUILDING INDUSTRY

-
1. Conventional type of dwelling house. Outside walls of brick or without facing. Sloping roof-tiled or slated.
 2. Three bedrooms.* Exceptionally, a few contracts for a small proportion of two or three bedroom houses were included in the sample. Houses semi-detached or detached.
 3. Inside area (excluding "offices"), 75 to 95 square metres.
-

* Plus one or two living rooms, kitchen, bathroom and hall.

Table VII
CRITERIA OF SIMILARITY
ADOPTED IN THE FRENCH STUDY
ON THE WOMEN'S FOOTWEAR INDUSTRY
 (Cement process)

FACTORY	UPPERS	SOLES	HEEL
A	Cutaway, velvet kid - Galloon edge - Leather and linen lining	Butt	Louis XV 6.5 cm.
B	Cutaway, velvet kid - Galloon edge - Second quality kid and linen lining	Butt	Louis XV 6 cm.
C	Cutaway, velvet kid - Galloon edge	Butt	Louis XV 6 cm.
D	Cutaway, Louis XV - Galloon edge - Leather and linen lining	Butt	Louis XV 6 cm.
E	Cutaway, Louis XV - Velvet kid - Piped edge - Leather and linen lining	Leather	Louis XV 5.5 cm.
F	Cutaway, Louis XV, velvet calf - Galloon edge - Leather and linen lining	Butt	Covered Louis XV 6 cm.
G	Cutaway, velvet calf - Galloon edge - Leather and linen lining	Composition	Louis XV 5 cm.
H	Cutaway, Louis XV - Galloon edge - Leather and linen lining	Composition	Louis XV 4 cm.
I	Cutaway, velvet kid - Galloon edge - Tartan linen lining	Butt	Leather 2 cm.
J	Vamp cut out, with strap - Perforated Neobuck - Sheepskin lining	Composition	Covered wood 5 cm.
L	Cutaway, false Louis XV - velvet calf - Galloon edge	Composition	Covered varnished 4.5 cm.
M	Cutaway, leather - Ballerina - Galloon edge - Leather and linen lining	Crepe and leather	"Yoyo" type covered 3 cm.

Generally speaking, it seems to have been applied not because it was technically the best, but because with the materials available it was impossible to do any better within the scheme of study selected.

The criteria of similarity adopted in the United Kingdom survey on the building industry and in the French survey on the women's footwear industry are given below by way of illustration, needless to say without attempting to assess their value.

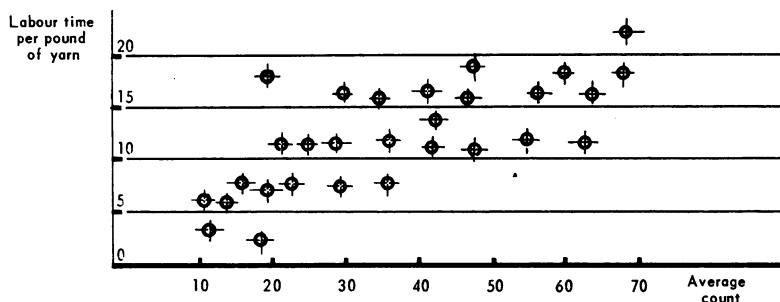
2. Dividing a range of products into comparable groups

This second method differs from the first in that, instead of taking the whole range of data into consideration, it is broken down into similar groups each of which can be used as a basis of comparison.

In other words, separate measurements are made for each of the different types of product within the range, thus ensuring a fair degree of comparability in each case.

A first example is provided by the United Kingdom study on the cotton spinning industry. The product considered was cotton yarn and it was agreed that the only characteristic which would affect labour time was the count* of the yarns spun. As the data available related to a hundred firms or so, it was relatively easy to arrange them in groups consisting of an adequate number of factories producing yarns of approximately the same average count: the following graph (Fig.3) shows clearly how this solution was applied:

Fig. 3. United Kingdom survey on cotton spinning
Presentation of results (fictional data)



The Netherlands study on the brickmaking industry offers a second example of the use of this method. The types of bricks made were not very many, but they were produced in varying proportions by each factory. The sample (which covered 143 factories) was therefore broken up into a number of homogeneous groups, the measurements being taken within each group.

* Under the metric system the count of a yarn is the number of hanks of 1,000 m. that weigh 1 kg.

Table VIII
NETHERLANDS STUDY ON BRICK-MAKING
 Breakdown of factories studied into homogeneous groups

			NUMBER OF PLANTS	
Continu- ous kiln	Clay partly or wholly extracted by machinery	No bricks larger than the Waal brick	{ (100% of bricks dried artificially) 6 Drying partly or wholly naturally 29 28	
		Bricks modelled exclusively by hand		
		Less than 5% of bricks modelled by hand		
	More than 40% of bricks larger than the Waal bricks	More than 5% of bricks modelled by hand	{ 15 7 30	
		Bricks modelled exclusively by hand		
		Less than 5% of bricks modelled by hand		
	Clay extracted by hand	More than 5% of bricks modelled by hand	{ 2 1 4	
		More than 40% of bricks larger than the Waal bricks		
		More than 40% of bricks larger than the Waal bricks		
	Non-continuous kiln			4

A similar method was used in the Netherlands survey on founding. The firms were divided into six groups with comparable types of productions:

- Group 1: 100% of products for machinery and ships.
- Group 2: 85 to 100% of products for machinery and ships, no light products.
- Group 3: Majority of products for machinery and ships, a certain number of heavy products and a maximum of 10% of light products.
- Group 4: Products for machinery and ships, including a certain fraction of special products - no other heavy products.
- Group 5: 25 to 50% of light products, the remainder consisting of heavy products, of which some for machinery and ships.
- Group 6: More than 50% of light products.

A solution based on slightly different principles was used in the canning industry in France. The method used consists, not in comparing factories with similar productions, but in collecting separate data for the different types of products turned out by each factory.

In the French pea canning industry, each factory made cans in two sizes, the 1/2 size and the 1/4 size. For certain operations (filling, sealing) it was possible to break down the labour time for each size* so that the production of each size could be considered separately and two sets of measurements taken.

The same procedure was used for the German small tool industry, each type of tool being considered separately.

One variation of this method was to study a single product forming part of each factory's production. The most typical example in this connection is that of the Netherlands footwear industry. The article chosen was a particular model of men's sports shoe, very simple, with box calf or oak leather uppers, double sole, leather heel and Goodyear welt. This type was not representative of footwear with strictly defined characteristics but significant comparisons could be made provided they were confined to the stitching and assembly shops. The most difficult problem was to isolate the labour time spent in turning out this type of product. This problem was more difficult than in the case of the canning industry because the different models were made by the same workmen, and the problem could only be overcome by setting numerous observers to record the actual times taken (see page 69).

Certain criticisms have been levelled at these methods, all of which have the disadvantage of giving results for a production which has been arbitrarily isolated. It is not certain, for

* See Chapter VI, page 72.

example, whether the productivity of the labour spent on a type of footwear which is only a part of a firm's total production does not depend on the conditions in which the remaining production is turned out.

3. Changing the unit

This method consists in dividing the production cycle into a certain number of stages, and then measuring the level of productivity at each stage by reference to a unit representative of that stage.

This method alone will not provide a synthesis covering all the articles turned out by a firm, but it can be used in conjunction with any other method.

With this method, as with the previous one, data can be obtained which are closer to reality and can be more easily interpreted by the technician.

The principle of this method can be grasped easily from the example of the Netherlands cigar manufactures. The bulk tobacco, which was a substantially homogeneous mass, underwent a whole series of treatments in the initial stage. It was therefore logical to take the kilogramme of raw material as the unit.

The leaves were then rolled to form articles of different qualities and sizes and labour input varied according to the type of cigars but was no longer directly depending on the quantity of tobacco. From this stage, therefore, it was decided to take the cigar itself as the unit of production, though this made it necessary to use equivalence coefficients.

The same procedure was followed in the French studies on the canning industry. Thus, in the case of sardine canning, it was observed that the labour time required to prepare 100 fish of a given size was substantially consistent. So the unit chosen was the sardine. For subsequent operations, however, the can was taken as the unit.

Section III

THE USE OF EQUIVALENCE COEFFICIENTS

The methods described in the preceding section do not afford a general solution to the problems involved in measuring a diversified production.

Some of these methods could be applied because the various types of products studied possessed an adequate number of characteristics in common, and the others because the field of work had been restricted to the study of a number of specific points.

But the general problem is to make data relating to different types of articles comparable so as to express the production of a firm or of a branch of industry in terms of a single variable.

The method used to do this is based on that employed by statisticians to establish indices referring to a heterogeneous mass. It consists simply in weighting the data for each article so as to obtain a homogeneous expression.

This type of method is used unconsciously whenever a production is represented by its value. In such a case, however, it is not certain that the expression so obtained can be significantly related to the measurement of the labour factor. The conditions in which weighting factors should be used can readily be understood from a simple example.

Let us imagine a factory producing in clearly established conditions two articles, A_1 and A_2 . Let t_1 and t_2 denote the man-hours corresponding to the respective productions.

It is immediately apparent that if we have the relation:

$$n_1 t_1 = n_2 t_2 = T$$

then n_1 articles A_1 correspond to the same man-hours as n_2 articles A_2 .

Therefore, if n_2 articles A_2 are substituted for n_1 articles A_1 , no change is made in the quantity of labour utilised.

In other words, if A_1 is taken as the reference unit, article A_2 will be equivalent to $\frac{n_1}{n_2}$ articles A_1 .

$$\text{Now } \frac{n_1}{n_2} = \frac{t_2}{t_1}$$

so the equivalence coefficient for A_2 and A_1 is: $\frac{t_2}{t_1}$

A production of N_1 units A_1 plus N_2 units A_2 can therefore be expressed as:

$$(N_1 + \frac{t_2}{t_1} N_2) \text{ units of } A_1$$

In this form the productivity of the labour will be expressed by:

$$\text{Productivity of labour} = \frac{P}{T} = \frac{(N_1 + \frac{t_2}{t_1} N_2) A_1}{N_1 t_1 + N_2 t_2} = \frac{1}{t_1} \text{ units of } A.$$

Other things being equal, $\frac{P}{T}$ will remain constant irrespective of the pattern of production.

By the same reasoning the formula can be extended to include a number of articles, one of which is taken as the reference unit, so that, using the same notation, we have:

$$\text{Productivity of labour} = \frac{P}{T} = \frac{(N_1 + \frac{t_2}{t_1} N_2 + \frac{t_3}{t_1} N_3 + \dots)}{N_1 t_1 + N_2 t_2 + N_3 t_3 + \dots}$$

Or, in a more applicable form:

$$\frac{P}{T} = \frac{(N_1 + \frac{t_2}{t_1} N_2 + \frac{t_3}{t_1} N_3 + \dots)}{T}$$

This expression applies moreover not only to a single operation but also to an entire production.

Moreover, between the coefficient $\frac{t_2}{t_1}$ for entire production and the coefficients for the component operations:

$$\frac{t_2^i}{t_1^i}, \frac{t_2^{ii}}{t_1^{ii}}, \text{ etc. } \dots$$

the following relation will exist:

$$\frac{t_2}{t_1} = \frac{t_2^i + t_2^{ii} + t_2^{iii} + \dots}{t_1^i + t_1^{ii} + t_1^{iii} + \dots}$$

There are a number of reservations to be made in applying such a formula to the study of the trend of productivity. The formula assumes in effect that the conditions of production do not change or at least that the ratios $\frac{t_2}{t_1}, \frac{t_3}{t_1}, \frac{t_4}{t_1} \dots$, remain constant, which is not necessarily true when productivity varies. To appreciate this, it is sufficient to consider two similar articles turned out on two separate lines. It is quite clear that any change in the equipment or methods of work on one of the lines will completely alter the value of the ratio $\frac{t_2}{t_1}$.

Man-hours depend on a number of factors: c_1, c_2, c_3, \dots , being characteristics of the article, mode of production, conditions of work, etc. We can therefore write:

$$t_1 = f_1 (C_1, C_2, C_3 \dots)$$

$$t_2 = f_2 (C_1, C_2, C_3 \dots)$$

$$t_3 = f_3 (C_1, C_2, C_3 \dots)$$

If the coefficients are to remain valid, then necessarily

$$\frac{f_2}{f_1} = k_2 \frac{f_3}{f_1} = k_3 \frac{f_4}{f_1} = k_4 \dots$$

K_2, K_3, K_4, \dots being constant.

From this, we easily obtain:

$$f_2 = K_2 f_1 \quad f_3 = K_3 f_1 \quad f_4 = K_4 f_1 \dots$$

In other terms, the function f , since it enables the production characteristics of the article to be expressed in terms of equivalent man-hours, must be the same, apart from the multiplying factor, whatever the article produced.

If we set down: $Z_1 = f_1 \quad (C_1, C_2 \dots)$

$$Z_2 = f_2 \quad (C_1, C_2 \dots) = K_2 Z_1$$

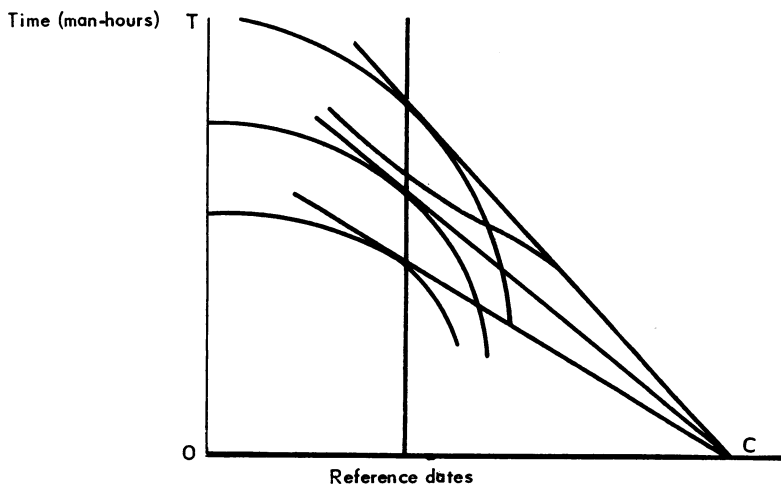
$$Z_3 = f_3 \quad (C_1, C_2 \dots) = K_3 Z_1$$

we observe that the representative surfaces (or curves) relating to a reference system of dimensions $O_Z, O_C, O_{C_2}, O_{C_3} \dots$ are all obtained

from $Z_1 = f_1$ by homothetic ratios $\frac{1}{K_2}, \frac{1}{K_3} \dots$

The following graph, giving reference dates along the X-axis and man-hours along the Y-axis, illustrates this point.

Fig. 4.
Possibility of approximative equivalence
between several fabrications



Even if the theoretical conditions are not fully observed, reasonably accurate results can be obtained to a second order approximation for small variations of productivity if at the starting point the curves Z_1, Z_2, Z_3 are such that tangents can be drawn to meet on the axis OC .

This observation, however, is very limited in its application, since the precision of the measurements is such that small variations can only rarely be established with certainty.

Nevertheless, as the following pages show, it is sometimes possible to justify the use of coefficients by the analysis of the relations between the functions F , provided that periodical checks are made.

Difficulties are experienced in trying to extend to a number of firms the results obtained in any one of them.

- a) If, in other firms, the conditions defined above are not observed in respect of the functions $F(C_1, C_2, C_3)$, it becomes impossible to establish accurate coefficients for them.
- b) Even if conversion factors can be accurately calculated in each firm, it can happen that the coefficients will not be the same throughout if the methods of work or the production processes vary.

In this case, comparisons of results expressed in standard units are liable to be unreliable.

It has been shown in effect that if two factories A and B each produce the same quantities of articles No. 1 and No. 2, the following expressions can be obtained according to the article selected as unit.

$$\begin{array}{l} \text{Production of factory A} < \text{Production of factory B} \\ \text{(expressed in No. 1 units)} < \text{(expressed in No. 1 units)} \\ \text{and} \\ \text{Production of factory A} > \text{Production of factory B} \\ \text{(expressed in No. 2 units)} > \text{(expressed in No. 2 units)} \end{array}$$

The explanation of this apparent paradox is quite simple.

C_1 being the equivalence coefficient for R_2 and R_1 in factory A

C_2 being the equivalence coefficient for R_2 and R_1 in factory B

$$\text{with } C_2 > C_1$$

R_1 being the number of units of article No. 1

R_2 being the number of units of article No. 2

the productions in No. 1 units of factories A and B can be expressed by:

$$P_1 = R_1 + C_1 R_2 \text{ (factory A)}$$

$$P_2 = R_1 + C_2 R_2 \text{ (factory B)}$$

which gives immediately:

$$C_1 R_2 < C_2 R_2$$

Therefore:

$$P_1 < P_2$$

If article No. 2 is taken as the reference unit the equivalence coefficients for R_1 and R_2 become respectively:

$$\frac{1}{C_1} \text{ and } \frac{1}{C_2}$$

The productions, expressed in No. 2 units, can be written as follows:

$$P'_1 = R_2 + \frac{1}{C_1} R_1$$

$$P'_2 = R_2 + \frac{1}{C_2} R_1$$

but

$$\frac{1}{C_1} > \frac{1}{C_2}$$

$$\text{Therefore: } \frac{1}{C_1} \times R_1 > \frac{1}{C_2} \times R_1 \quad \text{and} \quad P'_2 > P'_1$$

The relative position of the two factories would therefore depend on the reference unit selected, which is obviously unacceptable.

We can, however, study the relative magnitude of the deviation between the two modes of valuation.

In the first case, the ratio between the two productivities is expressed by $\frac{P_2}{P_1}$ and, in the second case, by $\frac{P'_2}{P'_1}$

$$\frac{P_2}{P_1} = \frac{R_1 + C_1 R_2}{R_1 + C_2 R_2}$$

$$\frac{P'_2}{P'_1} = \frac{R_1 + C_1 R_2}{R_1 + C_2 R_2} \times \frac{C_2}{C_1}$$

$$\text{Therefore: } \frac{P'_2}{P'_1} + \frac{P_2}{P_1} = \frac{C_2}{C_1}$$

The deviation is therefore directly proportional to the ratio $\frac{C_2}{C_1}$. It diminishes as C_2 approximates to C_1 .

To view the problem from the angle of labour productivity, denoting by p_1 p_2 p'_1 p'_2 the level of productivity corresponding respectively to P_1 P_2 P'_1 P'_2 , we have:

$$p_1 = \frac{P_1}{T_1} \quad p_2 = \frac{P_2}{T_2} \quad p'_1 = \frac{P'_1}{T'_1} \quad p'_2 = \frac{P'_2}{T'_2}$$

(T_1 being the operative time for Factory A)

(T_2 being the operative time for Factory B)

$$\text{Then: } \frac{p_2}{p_1} = \frac{P_2}{P_1} \times \frac{T_1}{T_2}$$

$$\frac{p'_2}{p'_1} = \frac{P'_2}{P'_1} \times \frac{T_1}{T_2}$$

Similarly:
$$\frac{P'_2}{P'_1} \cdot \frac{P_2}{P_1} = \frac{C_2}{C_1}$$

The deviation therefore diminishes as C_2 approximates to C_1 .

One fundamental difference appears, however. Instead of being reversed by the change of reference unit, the relative position of the two factories only undergoes modifications of magnitude if the deviation $T_2 - T_1$ is large enough to offset the deviation between C_2 and C_1 .*

In conclusion:

No strict comparison is possible if the coefficients of equivalence are not the same in every factory.**

Nevertheless, if the magnitude of the deviations in productivity for each article is very large and is found to be much the same tendency in different factories, then approximate comparisons are possible.

Very special consideration needs to be given to this fact in making international comparisons. It will be discussed in greater detail in the last chapter.

Other difficulties arise if the reference article is not produced by all the factories in the branch of industry. Coefficients, invariably arbitrary, may then have to be used to establish a system of functions F identical with that for the factories in which the reference article is produced.

Presented in this way, the method is difficult to use and its field of application is therefore greatly restricted. Detailed analysis, however, has shown that the method can be used in a number of sectors (foundry, footwear and clothing industries, manufacture of bricks and tiles).

Even if the conditions described above are only partly fulfilled, it seems possible to obtain approximate results for a production covering a wide range of articles.

Weighting then becomes a matter of relatively minor importance since theoretical studies on indices have shown that even when the coefficients vary within fairly wide limits there is no noticeable variation in the results.

Recent experiments in Italy seem to confirm this view and would appear to lead to the conclusion that it is possible to calculate a valid expression for production when the criteria of validity only relate to a small group of articles forming the great bulk of manufactures.

Finally, mention should be made of the fairly frequent use of weighting factors based, not on an equivalence ascertained in actual conditions, but on the possibility of the existence of an equivalence in given conditions.

* The demonstration of this fact is very simple but in the interests of brevity it is not given here.

** Extract from a yet unpublished study by D. Schenker (Bureau of Labor Statistics, United States), and J. Carrié (Centre d'Etudes et de Mesures de Productivité, France).

It is conceivable therefore that for a given technical level in industry there is an optimum of labour productivity for which corresponding equivalence coefficients can be worked out.

If such coefficients are used in calculating an industry's production, it is observed that production becomes a function of its own structure and that in particular it can increase with a greater output of articles requiring the labour times nearest to the optimum.

This view is quite different from the previous one. Without criticising its basic principle, it should, however, be stated that the fixation of the optima is somewhat arbitrary, for it is difficult to agree that it is possible to know with certainty the minimum labour time required for an operation.

The equivalence of factors other than labour, e.g. consumption of raw materials, is often much easier, for the relations between the functions F are much more constant, because of the stability of the technique.

For example, the yields from raw materials in foundry work can be studied without difficulty by using as conversion factors the weights of the parts turned out. This amounts simply to determining the ratio:

$$\frac{\text{Weight of finished articles}}{\text{Weight of raw materials}}$$

Section IV

PRACTICAL DETERMINATION OF COEFFICIENTS

The principles described were applied in a number of studies, particularly the following:

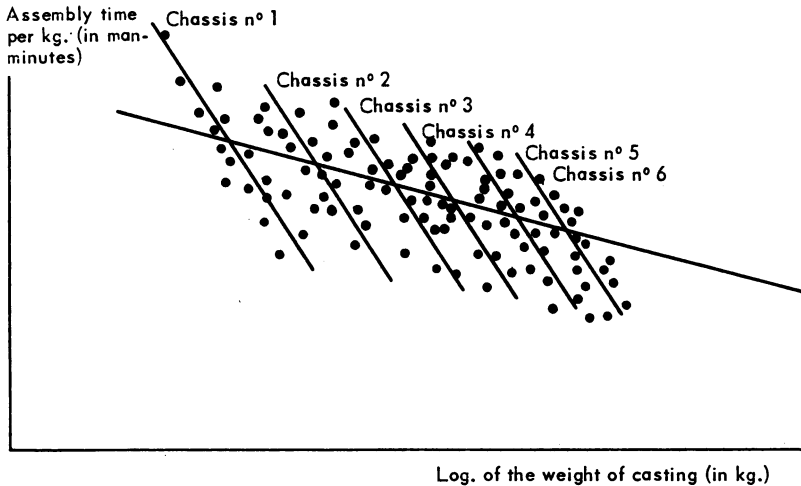
- French survey on the foundry industry;
- Cotton Board's surveys on British cotton spinning;
- Survey by the Shoe and Allied Trade Research Association on the British boot and shoe industry;
- Danish survey on the footwear and shirt industries;
- Netherlands survey on the shirt and clothing industries, cigar manufactures and tanneries;
- Austrian survey on cotton spinning.

Survey on the foundry industry

The procedure used in the foundry industry can be easily understood from the example of casting. The problem consisted in ascertaining whether, other things being equal, there was a relation between the characteristics of the products made in the course of a year and the man-hours taken to cast them.

An analysis of the data showed that for the same type of mould there was a close correlation between the logarithm of the weight of the products and the logarithm of the man-hours required to obtain 1 kg. of casting (see Fig. 5).

Fig. 5. French survey of the Foundry Industry
Differences in moulding times depending
on the weight of casting



The method of least squares can be used to calculate a relation of the form:

$$\log t = a \log p + b$$

where: t = man-hours per kg. ;

p = weight of products;

b is a parameter varying with the type of moulding box.

The series of straight lines thus obtained is characteristic of each process. Samples taken at intervals (two or three times a year) show that the slopes remain fairly constant and that only the ordinates at the origin vary when the conditions of work are modified. It should be mentioned, however, that for other operations or other production processes, adjusting the data sometimes produces a parabolic relation between man-hours per kg. and the weight of the products.

To simplify the subsequent calculations a series of categories ascending in geometric progression was established. As the slope of the lines is only slight, average times valid for each category can easily be determined.

Finally, a "standard unit of weight" was selected which could be used to express workshop production. The standard unit corresponded generally to the products most frequently manufactured. As, however, the measurements taken in the foundry were to be used for calculating output bonuses, it was

important for psychological reasons that the reference category should be such that the "corrected tonnages" were never less than the actual tonnages.

The following table, based on fictional figures, gives an example of the method of calculating the coefficients from average labour times.

Table IX
EXAMPLE OF CONVERSION FACTORS
(Foundry industry)

WEIGHT CATEGORY (KG. PER PRODUCT)			AVERAGE TIME (IN MINUTES)	COEFFICIENTS	REMARKS
1	to less than	2	12.0	6.00	
2	to less than	4	10.5	5.25	
4	to less than	8	9.0	4.50	
8	to less than	16	6.0	3.00	
16	to less than	32	5.0	2.50	
32	to less than	64	3.0	1.50	
64	to less than	128	2.0	1.00	Reference category
128	to less than	256	1.8	0.90	
256	to less than	512	1.5	0.75	
512	to less than	1024	1.3	0.65	

From the equivalences thus determined it is easy to obtain the corrected tonnages:

Table X
CALCULATION OF CORRECTED TONNAGES
(Foundry industry)

WEIGHT CATEGORY (KG. PER PRODUCT)			ACTUAL TONNAGE	COEFFICIENT	CORRECTED TONNAGE
4	to less than	8	50	4.50	225
32	to less than	64	100	1.50	150
256	to less than	512	400	0.75	300
Total			550		675

United Kingdom survey on the footwear industry

In the survey by the Shoe and Allied Trade Research Association on the footwear industry, the conversion factors were calculated from the piece rates paid by the firms and not from the labour times directly recorded.

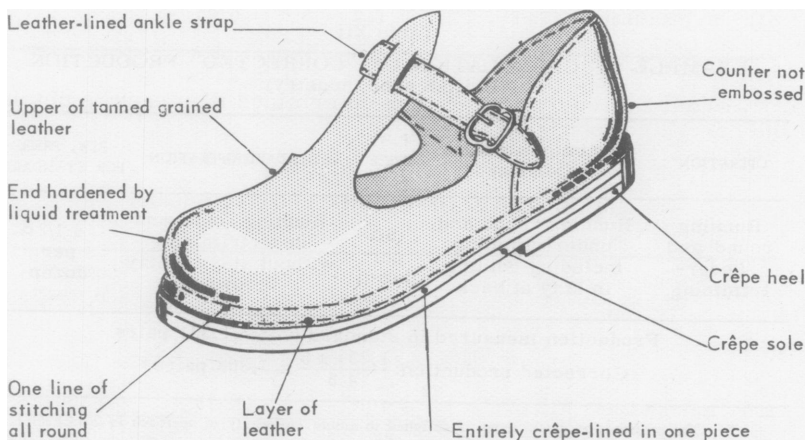
This procedure is justified by the fact that, for the same operation executed in the same factory on different styles of footwear, the piece-rates are proportional to the labour times normally required to complete the work.

Exceptions may arise, but it is hard to imagine that the employees or the manager of a firm would remain unaware for long of any injustices resulting from an incorrect calculation of rates. It can be assumed therefore that any error of this kind will not be very important.

Furthermore, as an operation is generally executed by the same operatives and on the same machines, irrespective of the style of footwear, it can be safely assumed that the corresponding labour times are proportional, at least over a short period. It is not certain, however, that this is so when the methods of work are radically modified, but this problem did not arise as the measurements were not repeated.

The first task was to select a reference model, the characteristics of which are shown in Figure 6 in connection with the study on sandals.

Fig. 6. Sample of standard model
used in British surveys
of the Boot and Shoe Industry



The reference model was as simple as possible and nearly all the operations involved in its manufacture were executed in each of the factories studied. In the subsequent analysis the other operations were eliminated. Two sets of calculations were then made to express production in standard units.

The first step was to take account of the differences in presentation between the article studied and the standard article. Accordingly, for each operation the ratio was determined between the piece-rate for the standard article, as made in the

factory, and the piece-rate for the article studied.* The production was then multiplied by the figure thus obtained.

Table XI
CALCULATION OF THE STANDARD PRODUCTION
(British shoe industry)

OPERATION	STANDARD UPPER SPC'N	FACTORY P.W. PRICE PER DOZEN FOR STANDARD UPPERS	VARIATION FROM STANDARD SPC'N	FACTORY P.W. PRICE PER DOZEN	FACTORY OUTPUT IN DOZENS	EQUIVALENT OUTPUT OF STANDARD UPPERS IN DOZENS
Running round and under-trimming	Oxford	5 d.	None	5 d.	725	725
	Oxford	5 d.	Gibson	5 1/4 d.	482	506
Total						1231

A second adjustment was made to allow for the additional work put into the shoe to improve its quality. For this, the piece-rate stipulated by the regional collective agreement for the operation in question was used. The production previously measured was then multiplied by this figure.

Table XII
EXAMPLE OF CALCULATION OF "CORRECTED" PRODUCTION
(British shoe industry)

OPERATION	OPERATION PERFORMED IN FACTORY	P.W. PRICE PAID	STANDARD OPERATION	P.W. PRICE FOR STANDARD
Running round and under-trimming	Running round and undertrimming including holding in stay at back	5d. per dozen	Running round and undertrimming without stay or stay rows	4 1/2 d. per dozen

Production measured in standard units: 1,231 pairs

Corrected production: $\frac{1,231 \times 5}{4.5} = 1,368$ pairs*

* The presentation given above is designed to ensure uniformity of approach in this Chapter. In practice the calculation was based on labour times, so that it was possible to determine a "corrected time" using the following formula:

$$\text{Corrected unit time} = \frac{\text{Actual labour time} \times \text{correction factor}}{\text{Production in standard units}}$$

which is exactly the same as:

$$\text{Corrected unit time} = \frac{\text{Actual labour time}}{\text{Corrected production}}$$

$$\text{where Corrected production} = \frac{\text{Production measured in standard units}}{\text{Correction factor}}$$

* Where the operatives were paid by the hour a direct estimate was made of the piece-rate.

Needless to say, the method of work has been analysed and no correction was made, even for a different piece-rate, unless the quality of the work was different. Thus no adjustment was made if inadequate supplies led to excessive time or if the work was done by hand instead of by machine without any difference in quality.

Danish survey on the footwear industry

The procedure followed in the Danish survey on the footwear industry was somewhat similar. The comparisons were considerably facilitated, however, by the fact that among the range of products made in each factory a model could be found which was substantially the same as the standard type both in appearance and in quality of work done.

As nearly all the operations performed were paid for under a piece-rate system, it was possible within each factory to base the coefficients of equivalence between any given type and the standard type on rates of pay. As these coefficients were comparable from one factor to another, the problem was solved.

The formula applied for any given operation was as follows:

$$P = P_1 + p_2 \frac{l_2}{l_1} + p_3 \frac{l_3}{l_1} + \dots$$

where P = production expressed in standard units.

P_1, P_2, P_3 --- production of models 1, 2, 3 ---

l_1, l_2, l_3 --- rate of pays corresponding to models 1, 2, 3 -

(model 1 being the standard unit).

Netherlands survey on the shirt industry

The methods followed in the Netherlands survey on the shirt industry presents some rather special features. Each of the factories studied turned out 10 to 20 types of shirts. A firm of consulting engineers was asked to analyse the types of shirts to determine the work load corresponding to the manufacture of each model. The work load was calculated under the following conditions:

1. Each article was manufactured in a specialised factory;
2. The machinery utilised was the best then available;
3. The raw material was faultless;
4. The operatives possessed the required skill and worked at normal speed;
5. The work was executed without abnormal interruptions;
6. The factory was large enough for the division of labour to be fairly detailed.

The work load was then expressed in points and calculated for each workshop. The type selected as standard was as simple as possible.

Coefficients of equivalence were then used which were based on the number of points, the number of points playing exactly the same part here as the rate of pay in the Danish study. Thus the formula used is practically identical with the previous one and, using the same notation, is written as follows:

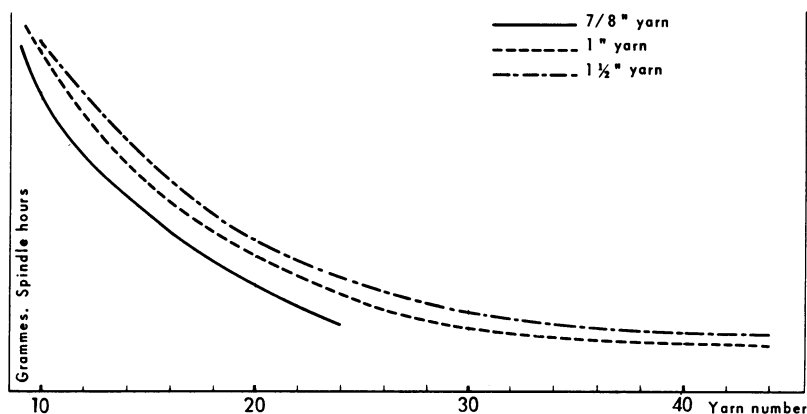
$$P = P_1 + \frac{n_2}{n_1}, \quad P_2 + \frac{n_3}{n_1}, \quad P_3 + \text{-----}$$

n_1, n_2, n_3 --- being the number of points allotted to each model.

Austrian survey on cotton spinning

In conclusion, mention should be made of the Austrian cotton spinning survey, which is presented in a slightly different form because it was necessary to calculate machine hours per unit of finished product and not man-hours. The time required to produce 1 kg. varied, other things being equal, according to the count of the yarn.* As in the foundry study, the object was to determine the correlation between the spindle hours per kg. of yarn and the characteristics of the yarn (count, type). By plotting on a graph all the data for each of the 21 factories studied in a given period of six months, a scatter of points was obtained which could be adjusted by means of a curve in the form of a hyperbola.

Fig. 7. Austrian survey of Cotton Spinning Mills
Production per spindle-hour depending on the yarn number



* Under the metric system, count is the number of hanks of 1,000 metres that weigh 1 kg.

From this it was possible to compute equivalence coefficients which were valid for the whole of the Austrian spinning industry. The values are given in Fig. 7.*

Needless to say, the computations are verified every half-year but no modifications appear to have arisen in the past three years, although in the meantime the productivity of the firms has greatly increased.

* The following relation is generally accepted: $R_{Ni} = C(N_i)^a$ $a > 1$

where R_{Ni} is the output spindle for a given count;

C is a constant;

N_i is the count (metric system) of the yarn;

a is a parameter varying with the type of yarn.

V

MEASUREMENT OF FACTORS OF PRODUCTIVITY

The methods to be discussed in this chapter are essentially concerned with the labour factor, which was indeed the basis of nearly all the measurements carried out in Europe. At the end of the chapter a few words will be said on problems relating to other factors.

Except in cost analyses, the labour factor was always expressed as labour time.

Unit

In almost all measurements the unit chosen was the man-hour or man-minute. The working day, which is a far less exact unit since its length may vary, was used only when it was impossible in practice to obtain sufficiently accurate data on labour times. The only example of the use of the working day is the Netherlands study on the brick industry.

Only days or hours of work actually performed were taken into account. In other words, days or hours paid for although no work was actually done for any reason (holidays, bad weather, sickness, power cuts, strikes, etc.) were ignored.

Uniformity of labour times

The first problem is the uniformity of labour times. It is quite clear that an apprentice and a trained worker are no more interchangeable than a woman and a manual labourer. There is therefore no a priori proof that it would be useful to consider everybody's labour times as comparable units.

In nearly all the measurements carried out in Europe, however, the labour times of the workshop personnel were added together without bothering about possible differences of skill.

The Shoe and Allied Trade Research Association study of the footwear industry is almost the only exception in this respect. The labour times of trainees and apprentices were not considered comparable with those of adults and equivalence coefficients proportionate to wage rates were used.

A partial solution adopted in the Netherlands study on foundry work was to break down labour times for certain operations into times for trained workers, trainees and apprentices.

Integration of firms

The second problem which arose relates to the comparability of production cycles and hence to the integration of the firms. The comparison of labour times is valid only if the initial and final stages of treatment are the same in all the factories studied.

It will be readily understood that a comparison of the labour times needed by two firms to construct the same type of bicycle would have no meaning if one of the firms manufactured all the parts and did the maintenance work on its machinery itself, whereas the other bought the parts from a firm of specialists and had its machinery serviced by an outside firm.

This difficulty was encountered in a number of studies and was generally fairly easily solved, in theory at least, by leaving aside the operations which were carried out in some of the factories only and analysing them separately if necessary.

There is no lack of practical examples. One of these is the French pea-canning industry, the raw materials for which are sometimes brought in the firms' own lorries and sometimes delivered by the farmers. Only the labour times for work done inside the factories and stores were therefore taken into account.

Similarly, in the Netherlands bicycle industry the nickel plating of handlebars was omitted because it was sometimes done by the firm's own workers and sometimes done outside the firm.

Finally, in the Austrian cotton spinning study, certain precautions were found necessary in order to separate spinning from weaving, which were sometimes done in the same mills. Separate data were also collected on certain jobs which were not always done by the firms' own employees (tool manufacture, repair of vehicles and machinery).

Defining the operations

Bound up with this last problem there is the question of the comparability of operations or groups of operations: current observation shows that in most cases the terminology adopted in the industry is very vague and does not correspond very closely with comparable activities.

A preliminary analysis of the working conditions in the industry concerned was almost always made on the spot; various operations could thus be carefully defined and listed.

The two lists given on next page, which were taken from the studies on the French pea-canning industry and the Netherlands footwear industry respectively, are fairly characteristic examples.

**EXAMPLE OF DEFINITIONS OF OPERATIONS TAKEN
FROM THE NETHERLANDS STUDY ON THE
GOODYEAR FOOTWEAR INDUSTRY**

*	CODE NO. OF OPERATION	OPERATION	H = HAND M = MACHINE	DESCRIPTION
B	1	Laying the sole	H or M	Fixing the sole with tacks on the last
B	2	First skiving	H	Skiving, on last, of outer portion of first sole (optional operation)
D	6	Assembly of tops	M	Machine drawing of tops, on last, and fixing of each side either with tacks or clips
D	8	Lasting	M	Drawing back and pinching by machine of the back portion of the upper. Temporary fixing with tacks
C	9	Trimming Pounding up	M	Trimming of portion trimmed on first sole. Hammering of upper to make perfect fit on last.
C	12	Retouching after lasting	M	Cutting of upper after fixing to sole.

* B : Operations common to all Goodyear footwear.
C : Operations common to all men's footwear.
D : Operations peculiar to Goodyear men's footwear with soft leathers uppers (box-calf, oak leather, etc.)

**EXAMPLE OF DEFINITIONS OF OPERATION TAKEN
FROM THE FRENCH STUDY
ON THE PEA-CANNING INDUSTRY**

OPERATION	DESCRIPTION
Feeding the filling machines	Workers place the cans in the slides which feed the filling machines and free them if they become blocked in the slides.
Filling	Supervision and operation of filling machines.
Inspection	Checking net drained weight.
Addition of liquid	Supervision of this operation and separation of piles of cans between the sealing machines.
Placing of lid	No comment necessary.
Sealing	Operation of sealing machine.
Insertion in crate	Placing cans in steriliser crate.

Note : These definitions were established from observations in eight factories. Any handling operation involving the use of labour not shown in the above list should be included in the next operation.

The British cotton spinning industry was almost the only one in which the definitions available were already sufficiently standardised to make a special study unnecessary.

Distinction between categories of labour

Finally, the distinction between the various categories of labour raises some rather delicate problems.

Almost all the studies carried out in Europe related only to the labour time of workshop hands. The time of clerical staff was, however, measured in certain Netherlands studies (retreading of tyres, shirtmaking industry and workmen's clothing industry) because it was considered that the productivity level of the workshops depended to a large extent on the preparatory work done in the office.

Distinction between direct and indirect labour

With regard to workshop hands, distinctions were normally made between direct labour and indirect labour.

The basic definitions appear to be those recommended by the Bureau of Labor Statistics at Washington.

Direct labour includes all workers whose activity is directly connected with production, i.e. all workers employed on manufacturing, assembly or finishing jobs, whether they use a tool or operate a machine.

Indirect labour includes persons employed on workshop supervision, maintenance work, reception and dispatch, handling of raw materials, various inspection duties, factory upkeep and all operations linked with production but not directly connected with it.

This classification was not often used systematically, the principal example of its application being the Austrian study on cotton spinning, the French study on flour mills and the Norwegian study on the brick industry.

For the Austrian study it was necessary to draw up an exhaustive list of the operations belonging to each of these groups, as the definition of indirect labour varied from firm to firm.

For the Norwegian brick industry, an additional sub-division of indirect labour was introduced by Professor Knut Holt (University of Trondheim).

- i) The labour time for indirect labour whose activity varies more or less proportionately to production (i.e. mainly those employed on handling jobs) is called "proportional indirect workers' labour time".
- ii) The labour time of other indirect labour is called "non-proportional indirect workers' labour time".

In most of the other studies, the distinction between direct and indirect labour was no more than implicit.

In the United Kingdom studies on the footwear industry and on cotton spinning, it was considered that the breakdown of the production cycle into separate operations was sufficiently detailed to enable anyone making use of it to regroup direct and indirect labour afterwards.

Finally, in France and the Netherlands attention was devoted mainly to the study of labour times for each workshop and each operation and only General Services (maintenance, cleaning, heating, etc.) and sometimes certain sections of the factory which made no direct contribution to production (stores, reception of raw materials, and dispatch) were taken separately.

Breakdown of labour times adopted for
the Netherlands survey on the shirtmaking industry

Cutting room;
Sewing room;
Pressing room, packing room, despatch section;
All productive sections taken together;
Other sections;
All labour.

Factors other than labour

Problems concerning other factors than labour did not often arise in the European studies.

Thus no attempt was made to express the consumption of power obtained from various sources in terms of a common unit, unless it was in terms of costs.

It should, however, be pointed out that technical experts have long since determined the thermal efficiency of engines, which is defined as the ratio between the energy actually produced and that theoretically obtainable. These calculations admittedly correspond to measurements of productivity, but the development of such techniques lies far beyond the scope of this work.

With regard to fixed capital, some enquiries were made into the utilisation of floor-space and machinery.

Examples of this are the study of the footwear industry by the Rationalisierung Kuratorium der Deutschen Wirtschaft in which the relation between floor-space and number of workers was determined for each workshop, and certain French studies (footwear and canning industries) in which similar comparisons were made.

The use of machinery was analysed mainly in the Austrian studies on cotton spinning. Running times and duration of stoppages were determined in relation to their causes (cleaning,

re-setting, repairs, maladjustments, shortage of raw materials, power cuts, absence of operator, waiting for orders).

It should be pointed out, however, that machine use has the peculiarity of not always being in direct proportion to the capital absorbed, for economy in wear and tear resulting from reduced use is often outweighed by loss of value resulting from the appearance on the market of more modern machinery.

VI

COLLECTION OF DATA

All productivity measurements are based on statistics relating to individual plants. It is therefore essential that these should be determined as accurately as possible.

This condition is often found difficult to fulfil in practice, for it means that all the firms included in the study must co-operate with complete frankness and keep detailed and up-to-date internal statistics.

Generally speaking, data concerning production are easier to collect than data on the factors of production. Naturally the more detailed the enquiry the more these difficulties increase, and it is often extremely hard to obtain exact information on the labour times corresponding to any given operation.

The methods used for collecting basic data fall roughly into three groups. They are:

- a) circulation of questionnaires to be filled in by the plants themselves;
- b) collection of workshop data by field investigators;
- c) intermediate methods consisting of on-the-spot examination by investigators of the means of extracting the required information from the records normally kept by the firm, supplemented, if necessary, by the introduction of a special data recording system and by direct observation.

Circulation of questionnaire

This method was scarcely ever used alone except for certain investigations intended to collect information on the scale of an entire sector of industry.

Such were:

- the Cotton Board survey on British cotton spinning,
- the Norwegian survey on the footwear industry by the Branch Council for the Shoe and Leather Industry;
- the French surveys on the trend of productivity in the fish and pea-canning industries,
- the cost analyses of the Statistisches Bundesamt.

A feature common to these four studies is that costs were small considering the number of firms involved.

The information required was not very detailed and there was no difficulty in interpreting it; it could therefore be obtained from each factory without difficulty.

The examples quoted call for little comment for they are based on the statistical principles traditionally used in drawing up questionnaires.

In the United Kingdom survey on cotton spinning, it was possible to obtain information on each department from the firms' own records and the terms used corresponded to the standard definitions adopted throughout the industry.

The problem of dividing up the production cycle did not arise in the French survey on the pea-canning industry. The information required related only to the complete production cycle, it was, in any case, very brief and required little explanation.

The German surveys formed a rather special case, as the information required applies only to factors entering into production costs.

It could therefore be extracted from each firm's accounts but it was necessary to make the meaning of each item quite clear if comparable data were to be obtained. In spite of these precautions, it was afterwards often found necessary to check the entries under many of the headings by correspondence.

A covering letter pointing out the importance of the study and the advantages to be derived by those taking part was sent with each questionnaire so as to encourage the industrialists concerned to reply.

Observations

This second method is based on the opposite principle of direct observation by the investigators themselves in the factories.

It was used principally in the Norwegian study on the footwear industry and in various investigations based on time-studies, such as those carried out in Norway by the *Produktjons Teknisk forsknings Institutt* on the footwear, textile and sawmill industries.

An account of the practical methods used in this last case would be outside the scope of this volume. There is a special literature on this subject, and the methods need to be applied by high qualified specialists.

Comparisons of labour times determined by time and motion studies involving rating assessments have, moreover, been severely criticised.

The method was, in particular, firmly rejected by the Joint Committee of the Institution of Production Engineers and of the Institute of Cost and Works Accountants, as a result of studies carried out in 1949 by this body.* These studies showed to what extent the subjective nature of the method could produce variations in estimates.

"The work of Kinniburgh and Vallance,** and unpublished work under Rodgers at Acton Technical College and Matthew at the University of Birmingham show wide variations between raters from the same firm and even between ratings of the same job made by the same rater, rating either live workers or films. Formallaz*** showed that a group of elderly workers tended to be allowed a longer normal time than would a group of the ordinary age distribution, though this was not done intentionally. Rodgers and Matthew both found, in addition, a significant tendency for raters from one firm to vary about a different mean from those from another, in accordance with the customary notion of a fair rate of work.****"

We shall accordingly confine ourselves here to analysis of the method used in the study on the Netherlands footwear industry.

This dealt with the manufacture of Goodyear footwear in nine factories almost all of which produced other kinds of shoes as well.

As the firms' records did not show separately for any one operation the labour time expended on a given type of footwear, it was decided to take direct observations of 47 operations done in the stitching and assembly shops.

Students from the Tilburg University Institute of Economics and Sociology were employed on this work, which formed a practical exercise for them. They visited the factories in teams of two or four and filled in the forms, one of which is reproduced below, whenever an order for the manufacture of Goodyear footwear was carried out.

The investigators noted the times of beginning and ending work, together with the content and number of the order. They also recorded the time interval between orders.

Space was reserved on the Record Card in case a second workman was assigned to the same job. This precaution was

* Institute of Costs and Works Accountants and Institution of Production Engineers, Measurements of Productivity, Applications and Limitations - London, Gee and Co., 1951.

** W. Kinniburgh and L.S. Vallance. The Accuracy of Times Studies in Bricklaying Engineering 171 (1951) p. 353, No. of 23rd March. Further particulars will be found in Report A on the Accuracy of the Times Studies, published by the Building Research Station.

*** P.F. Formallaz, Neue Untersuchungen auf dem Gebiete der Schätzung des Leistungsgrades: Industrielle Organisation 19 (1950) p. 541.

**** Extract from Dr. Easterfiel's Communication to the Productivity and Applied Research Committee of O.E.E.C. Addendum to PRA/PS.52/2, Scale 6, 15th October 1952.

deemed sufficient, for no more than two workmen were ever employed on the same job. When the work involved in any operation did not depend on the type of footwear, the labour times were, of course, recorded without reference to the model manufactured.

Fig. 8. Netherlands survey on the Boot and Shoe Industry
Job-cards used

Firm No.	Date	
Code No. of operation	Operation began	Effective labour time
Order No.	Operation ended	
Article No.		Supplementary time
No. of pairs	Next operation began	

Working on these lines, the same investigator was able to observe two or three operations and obtain times accurate to within half a minute.

The results were considered valid only when the number of observations was sufficient to give significant figures - in practice between 25 and 30.

As this condition was not always fulfilled, it was only possible to use data relating to from 30 to 45 operations in each factory.

The procedure would obviously have been very costly if paid workers had been employed to take the measurements. This will be readily understood when it is pointed out that 17,500 observations were made, of which 12,500 were actually used. No fewer than 475 man-days were needed to complete the task.

Combination of direct observation and recorded data

The second method was not very common but a combination of the first two methods was frequently used. This was done in two different ways:

- Study on the premises of the records made available by the firms, as was done in most of the Netherlands studies (brickmaking, shirtmaking, foundry work and workmen's clothing industries, etc.) and in the Building Research Station study on the British building industry.
- Supplementing the records normally kept by the firms by observations carried out directly in the workshops, with the possible introduction of a data recording system, as in:
 - the French surveys on the canning and sawn softwood industries;
 - the Belgian survey on foundry work;
 - the British Cotton Institute Research Association surveys on cotton spinning;
 - the Austrian surveys on cotton spinning;
 - the United Kingdom surveys by the Shoe and Allied Trades Association on the footwear industry;
 - the French surveys on the footwear and workmen's clothing industries.

As already mentioned, the Netherlands surveys are repeated every three months. To avoid heavy expense, they are carried out by means of questionnaires filled in by the firms, but that is only the second stage of the work.

Investigators first visit each factory, state the purpose of the study, visit the workshops and examine the available records. They work out ways of obtaining the required information and check the validity of the figures.

After this analysis it only remains to explain how the questionnaire should be filled in and to make sure that the terms used in it are not loosely interpreted. The work was carried no further except in the bicycle industry, where a standardised system of materials accounting was introduced to make up for the inadequacy of the available information. More will be said about this on page 74.

In every case this method not only produced a much higher proportion of replies than could have been hoped for if the questionnaires had been sent by post with a mere covering letter, but the quality of the information received was better, and checking and interpretation were made easier.

In the Building Research Station survey, the basic documentation consisted of the various accountable receipts for contracts already completed.

The investigators went to the sites to fill in the forms themselves. They were thus able to check the validity of the data, to obtain the necessary explanations by word of mouth and to look over the buildings.

Obviously they were not able as in the previous study to take direct observations of men at work, since this study related to completed structures. Studies of the second category

present rather different features, a typical example being that of the French studies on the pea-canning industry.

The investigators first visited the factories to analyse the firms' records which nearly always consisted of daily production sheets and workers' time-cards only. By analysing the latter it was possible to discover the labour time for the entire manufacture and for work which was always done by the same person. This information was, however, insufficient, for most of the workers went from one job to another in the same day; it was therefore often necessary to resort to a different procedure in order to discover the labour time required for a given operation.

To solve this problem, it was decided to use a simplified system of recording the time spent by the workers on each task. For this purpose, special notebooks were used in which charge-hands entered the number of persons engaged on a job at various times of the day throughout the period of study.

A copy of a double page of one of these is shown below.

Fig. 9. French survey on the Canning Industry
Notebooks used for determining labour times

Date	Sorting of peas				
		Began		Ended	
		Number	Time	Number	Time
	Enter number of hands engaged on sorting, with times of beginning and ending work				
	Morning				
	Afternoon				

For practical reasons, the notebooks were kept for only about two-thirds of the operations.

The activity of the investigators was not confined to introducing these recording methods. It also included a whole series of work done inside the workshops.

In particular, a direct record was made of time spent on one very important special operation: packing for dispatch,* which consisted of taking the tins from the crate and packing them in cardboard containers.

The method used is similar to that for the Netherlands study on the boot and shoe industry. As the packing hand had to break off her work from time to time for various reasons (waiting for tins or cases, clearing away empty racks or full tins, etc.), the working time between two stops was entered and the observation was repeated for each hand at various times during the day.

The investigator then made a detailed analysis of the working conditions in the shops, so as to be able to interpret the information collected. In particular, he worked out the output of the machines and it was found that in many factories the investigator's figures differed by 10 to 20 per cent from those supplied by the firms.

Checks were also carried out. The times observed directly, the entries on the time-cards and the output of the machines were compared with the information entered in the recording notebook. In doubtful cases, the firms were asked for explanations to discover whether it was better to correct the data or simply to omit them.

Fig. 10. Dutch survey on the Bicycle Manufacturers
Example of forms used for fabrication

Week beginning		ending			195	
Day	Manufacturing labour time (not including supervision)			Number of units produced		
	Bicycle frames	Forks	Other articles	Bicycle frames	Forks	
Monday						
Tuesday						
Wednesday						
Thursday						
Friday						
Saturday						
<p align="center">Job sheet for welding operations</p> <p><i>Total labour time for welding operations :</i></p> <p><i>Supervision</i> <i>hours</i></p> <p><i>Execution of job</i> <i>hours</i></p> <p><i>Remarks</i></p>						

* In some factories this operation occupied one-third of the total labour time required for the complete manufacturing process.

The Netherlands bicycle industry was as difficult to deal with as the canning industry. In addition to bicycles, production included other articles such as tricycles, scooters, tandems, etc.

The firm's records consisted almost wholly of invoices of purchases and sales. It was therefore impossible to discover either the manufacturing processes carried out in a given period or the corresponding labour times. A system of physical accounting was introduced on standard forms filled in by the firms each day (Fig. 10).

The same procedure was used for the productivity measurements carried out in the Belgian foundry industry, by using forms which the firms filled in each day for a month. An example of these forms is shown on Fig. 11.

The British and Austrian studies on cotton spinning and the Shoe and Allied Trade Research Association study on the footwear industry were based on somewhat similar principles. The investigators did not record the labour times themselves, as in the French study, but the data extracted from the firm's records were supplemented where necessary by the introduction of a system of labour accounting and by observation of the running of the workshops.

In the cotton spinning studies, care was taken to ascertain the running times of the machines either from special notebooks kept by the foremen (United Kingdom study) or from cards attached to the machines (Austrian study). In the Austrian study care was taken to standardise the definitions and methods used in materials accounting, but this was not necessary in the United Kingdom because standardisation was already at an advanced stage there.

The footwear industry is a rather special case. It was found that accounting entries often led to mistakes and so job cards kept by the workers themselves (or occasionally by the foremen) were used.

Operations carried out on an hourly basis were separately analysed on the premises so that piece-work rates of pay could be calculated for this type of work and used as equivalence coefficients (see page 54).

Finally, a few words must be said on the methods used in the French studies on the workmen's clothing and the footwear industries. The basis for determining the labour times of each operation was the standard time calculated by time-study methods when manufacture first began.

Actual labour times were obtained by correcting the standard times according to the mean activity index for the period under study.

This index was established for a whole workshop by dividing the actual hours as shown on the pay sheets by the theoretical number of hours obtained by multiplying standard times by quantities produced.

Such a method of calculation assumes that the standard times and actual times for the various operations are approximately proportionate, that is to say that the activity varies little from one operation to another, as was proved in the majority of cases.

There may be a few exceptions if the work is carried out by particularly skilled or particularly clumsy workers. The times then correspond in fact to an average and not an effective working time.

Measurement of production

In most cases, the quantities produced are determined from the daily production sheets kept by most firms in each workshop.

There are exceptions, however, and it is sometimes necessary to make direct observations or to request the firms to fill in special forms (French study on the sawn softwoods industry and the Netherlands studies on the footwear and bicycle industries). The method used is very much the same as that described for labour.

Generally speaking, certain precautions are necessary, however. Although the production of workers carrying out a particular operation may be fairly easily defined, this is not so for an entire factory. The activity of certain sections is only loosely connected with that of the workshops. Thus the volume of dispatches, which depends on sales, may differ considerably from the volume of production even over a long period.

It is therefore sometimes found necessary to distinguish the volume of production for each section. In this case, the production figures must be supplemented by data taken from stock books and possibly from invoices of purchases and sales.

Considerable losses may also occur between two stages of manufacture. If these vary in time or differ from one factory to another, it becomes necessary:

- to express production per workshop or per group of operations in terms of raw materials or semis (French study on the foundry industry);
- to make corrections from which a time relating to the manufacturing process as a whole may be calculated (Netherlands study on the brick industry).

VII

PRESENTATION AND INTERPRETATION OF RESULTS

The interest taken in productivity measurements largely depends on the ease with which their users (workshop management, heads of businesses, trade associations, and possibly trade unions and public departments) can understand the results and turn them to advantage.

The manner in which the data are presented is therefore of great importance to the success of a study.

As it is essential that the firms concerned should remain anonymous, the factories providing the basic data are always designated by letters or numbers.

As already described, the basic results are generally expressed as the quotient of a given factor divided by the corresponding production, i. e. the inverse of the productivity.*

In particular, labour times are related to the production unit selected.

The advantage of this method is that the data obtained are additive. Thus the man-hours for total production are equal to the sum of the man-hours for the various operations making up the total production. Likewise, the total cost per production unit is the sum of the cost of each factor.

By this method it is possible to avoid the heavy error which will result from the division of the output by the labour time in the industries where a part of semi-products is directly sold (for example, cotton spinning).

In studies which are mainly concerned with measuring the level of productivity in an industry, the results generally consist of averages for the whole sample or for certain homogeneous groups.

In comparative studies, results are shown in relation to each factory. They generally consist of data for the whole of the productions, with a more or less detailed breakdown by workshop or by operation.

* There are one or two exceptions, e.g. the German study on the footwear industry in which all the data are expressed in terms of productivity, and the Austrian study on cotton spinning in which the results for spindle operations are expressed in terms of hourly production.

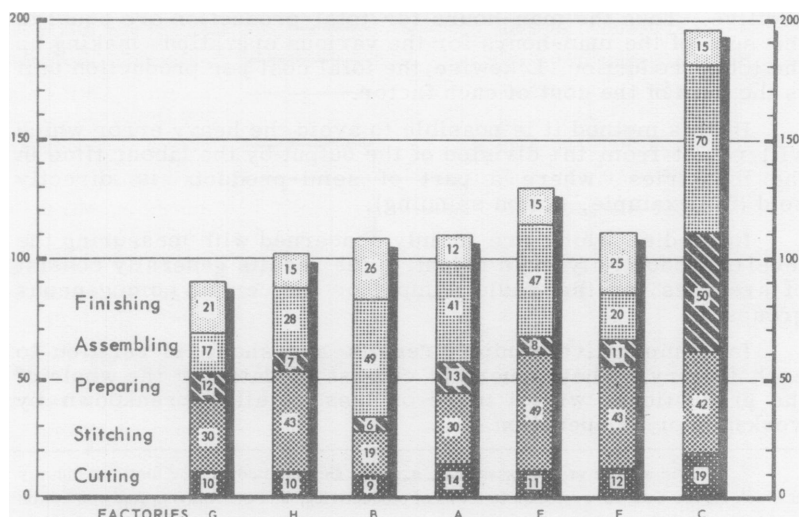
The following example, which is taken from the Netherlands study on the shirt industry, is typical of this.

Table XIII
THE NETHERLANDS STUDY ON THE SHIRT INDUSTRY
Time required to produce a standard shirt
(in man-minutes)

	4th quarter 1952															
No. of factory.....	34	36	37	30	31	44	32	35	40	33	39	43	41	38	42	
Cutting shop	4	7	6	10	9	10	9	14	9	10	12	4	15	21	18	
Stitching shop.....	42	46	48	50	54	51	58	51	59	74	76	80	76	85	96	
Pressing, packing and despatch shop .	17	20	19	18	18	21	17	25	25	20	19	24	32	32	57	
Total direct labour .	63	73	73	78	81	82	84	90	93	104	107	108	123	138	171	
Other services	14	8	15	9	16	11	13	12	11	21	14	6	12	15	17	
General total.....	77	81	88	87	97	93	97	102	104	125	121	114	135	153	188	
% of direct labour .	22	12	21	12	20	13	15	13	12	20	13	6	10	11	10	

Such data, which are the basis of all productivity measurement, are often illustrated diagrammatically. For this purpose, the so-called "column graph" is often used, an application of which is given below in relation to the study of the French footwear industry (Fig. 12).

Fig. 12. French survey on the Boot and Shoe Industry
Average times of direct labour per shop



Interpretation elements

It is also usual for some indication of the interpretative data to be given, which will naturally vary with the type of study. In a first group can be placed such general information as is given in nearly all the reports in order to establish the structure of the sample.

Information of this type mainly relates to:

- the volume of production;
- the characteristics of the articles made;
- the number of operatives;
- the geographical distribution of the firms involved;
- the manufacturing processes.

It goes without saying that the form in which such data is presented is sufficiently general for it to be impossible to identify any of the firms. An example of the way in which this type of data can be presented is given in Table XIV.

Table XIV
FRENCH STUDY ON THE FOOTWEAR INDUSTRY
(CEMENT PROCESS)
Characteristics of factories

FACTORIES	NUMBER OF OPERATIVES	ANNUAL PRODUC- TION IN 1,000 PAIRS	RANGE OF PRICES EX-WORKS (ALL TAXES INCLUDED) IN '000 FR.						PROCESSES USED
			1.0	1.5	2.0	2.5	3.0	3.5	
A	300-400	150-200							Cement and mixed
B	300-400	150-200							Cement and Goodyear
C	400-500	150-200							Cement, California and Goodyear
D	400-500	200-300							Cement - Goodyear
E	100-150	50-100							Slip lasting
F	300-400	300-400							Cement - Mixed - Goodyear
G	500	400-500							Cement - Slip lasting
H	150-200	100-150							Cement - California Mixed
I	200-300	200-300							Cement - Mixed - Kneipp - California
J	200-300	200-300							Cement - Slip lasting
L	100-150	100-150							Cement - Mixed - California
M	150-200	100-150							Cement - Goodyear - Slip lasting

Information on the material used and the conditions under which each operation is carried out can be classified in a second category.

This information is given in varying degrees of detail, but not for all the studies. It is found particularly in the British studies on cotton spinning and the footwear industry as well as in various Danish, Austrian and French studies.

The studies mentioned above always give information on the material used and, in particular, on the quantities consumed when these are constant, as is the case particularly in spinning mills and food preserving factories.

Moreover, in the latter two industries, care has been taken to note idle machine time and to analyse the causes of such stoppages.

It is thus possible to form an idea as to the amount of time wasted and the ways in which the material is used. It may be mentioned in this connection that the French studies give a definition of "capacity factor" ("coefficient d'utilisation").

This coefficient corresponds to the ratio of the figure for actual output and the output which would have been obtained if the machine had functioned without interruption during the whole of the time that the workers spent in supervising its running.

Therefore:

$$\text{Coefficient of utilisation} = \frac{\text{Production}}{\text{Machine output} \times \text{time taken by operatives}}$$

When machine output is constant for any given operation, the variations in this index are proportional to the variations in labour. By analysing such variations, therefore, the reasons for the differences noted can be ascertained.

In addition to information on the type of machinery, data are often provided on the characteristics of the work done in each case and on the arrangement of the work stations. From these data manufacturers can gain a fairly clear idea of the reasons for the differences between their own times and those of other manufacturers.

Before leaving this subject, it is appropriate to mention some interpretative data included in the Netherlands study on footwear.

To understand how they were used, it should be remembered* that labour times were recorded in the workshops by the investigators themselves. All the data used were average values for a series of manufacturing operations varying in number between 25 and 30.

By analysing these different samples, which had been selected at random, it was possible to calculate an interval

* See Chapter V, page 69.

of confidence so that it would be established whether the difference recorded between two factories for one given operation was significant or not.

Furthermore, the data on labour times were in every case considered in relation to the mean deviation value corresponding to the observations made for the same operation at the same work station. When this value is high it can be taken to mean that the operatives' rhythm of work varies greatly from one moment to another and that, in consequence, improvements are possible if the causes of irregularity are eliminated.

Finally, labour times were divided into two parts, the first of which, called "productive time",* corresponds to the actual execution of a series of operations, and the second, called "complementary time",** represents the delay between the end of one series of operations and the beginning of the next.

In this way, the manufacturers were able to calculate the saving they could obtain from work organisation which would reduce the delay between two series of operations to a minimum.

A number of studies on the measurement of productivity, in particular the studies carried out by the Netherlands Centraal Bureau voor de Statistiek, were limited to a numerical analysis of existing conditions and, where necessary, to the explanation of the deviations observed. Other studies went further and contained recommendations as to how to obtain the best recorded results.

This last point, which is mainly a question of methods engineering, will not be discussed here.

* In Dutch "bewerkingstijd" (B.T.).

** In Dutch "overige tijd" (O.T.).

VIII

USE OF RESULTS

Productivity measurement would be of somewhat limited interest if the data assembled were nothing more than an intellectual past-time.

They are certainly more than that, for, as stated in the introduction, the results obtained lend themselves to a great many uses, not only by the firm, but by all bodies concerned with technical or economic questions: suppliers of industrial machinery, research centres, trade unions and trade associations, universities, government departments, etc.

To avoid overburdening this paper, only six examples of actual applications at the level of the plant will be given here.

1. General information of the plant director

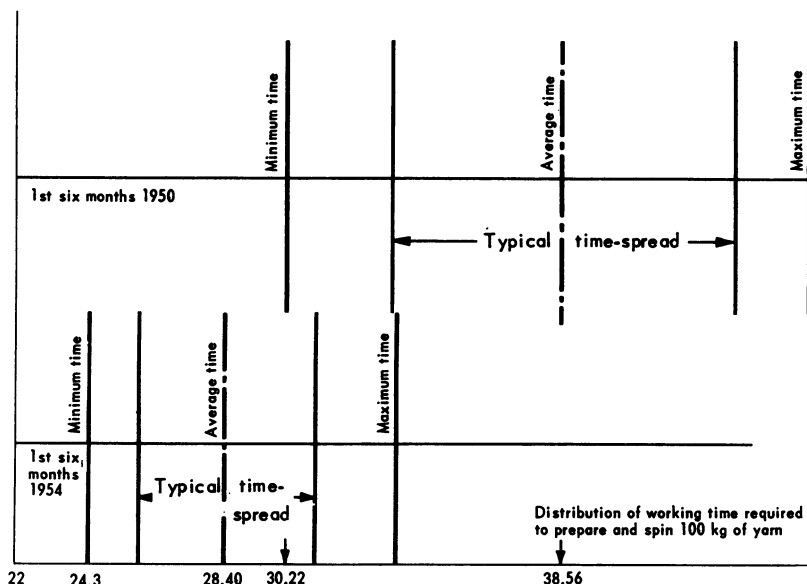
Generally speaking, the results of measurement enable the manufacturer to ascertain his position in relation to his

Table XV
TREND OF PRODUCTIVITY
IN AUSTRIAN COTTON-SPINNING MILLS

	TOTAL PRODUCTION (EXPRESSED AS TONS OF NO. 20 YARN)	SPINDLE OUTPUT (GRAMMES OF NO. 20 YARN PER SPINDLE-HOUR)	KILOGRAMMES OF YARN PER MAN-HOUR	PRODUCTIVITY INDEX
1st half 1950	7,619	17.25	2.59	100
2nd half 1950	7,683	17.92	2.74	105.8
1st half 1951	8,452	18.48	2.82	108.9
2nd half 1951	9,114	18.50	2.93	113.1
1st half 1952	8,215	18.78	2.95	113.9
2nd half 1952	6,781	19.12	3.06	118.1
1st half 1953	8,424	19.44	3.27	126.2
2nd half 1953	9,255	19.65	3.46	133.6
1st half 1954	10,165	20.01	3.52	135.9
2nd half 1954	10,266	19.85	3.59	138.6

competitors. He can thus form some idea of the progress required in the firm as a whole and pick out the most urgent problems in the light of the details supplied to him.

Fig. 13. Distribution of working time required to produce 100 Kg. of yarn



It is, of course, difficult to find out how manufacturers actually effect the improvements which the reports show to be necessary, as discretion rules in this field. On the other hand, when the measurements are repeated, an appreciable rise in productivity can usually be observed.

Thus, the communication to the Austrian cotton-spinning mills of the results of the half-yearly studies carried out by the "Oesterreichisches Produktivitäts Zentrum" undoubtedly stimulated the branch as a whole to increase its productivity by 38 per cent in five years, while variations between different factories were considerably reduced.

2. Fixing of targets

The fixing of targets which can be reached by all firms without alteration to existing machinery is no doubt one of the most effective spurs to competition. In every case, the targets are based on the best results recorded during the survey, but their method of determination varies widely.

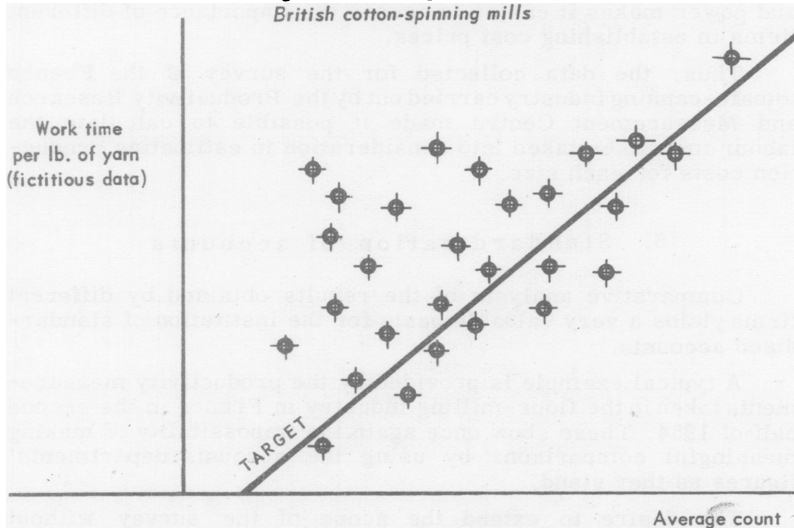
In the measurements taken by the Shoe and Allied Trade Research Association in Great Britain, the target for each

operation was fixed by taking the average of the three best results observed, allowance being made for any abnormally high output which could only be accounted for by special circumstances.

On the other hand, in the French survey of the pea-canning industry, it was considered that the best times recorded might act as targets for firms working in uniform conditions. This led to the division of factories into several categories, a minimum work time being fixed for each.

An intermediate solution was adopted in the B.C.I.R.A. survey of British cotton-spinning mills. A graph was prepared, in which the times for the 25 mills (1/4 of the sample providing the best results), were shown vertically, and the corresponding yarn counts horizontally.* The mean line obtained from the scattered points showed the target to be reached, which varied with the average count manufactured.

Fig. 14. Fixing of targets



3. Deciding which questions require particularly careful study

4. Measurement of progress made through the introduction of new machinery

The British Cotton Industry Research Association studied, in this connection, a cotton-spinning mill before and after re-organisation by a firm of methods engineers. In the same way, the Wool Industries Research Association measured productivity

* See Chapter IV, page 42.

in the British wool-spinning mills before and after the introduction of new methods of work.

5. Facilitating the preparation of production plans and costing

- Production programmes are normally drawn up from estimates or forecasts based most often on an incomplete study of the problems involved. They can generally be improved by using the figures obtained from the systematic measurement of productivity.

The measurements taken by the British Cotton Industry Research Association are now being combined in a form which should make it easy to determine the best conditions for regularity in the functioning of the firm (number of employees, number of machines, rate of operation of machinery, etc.).

In the same way, information on the productivity of labour and power makes it easier to assess the importance of different items in establishing cost prices.

Thus, the data collected for the survey of the French tomato-canning industry carried out by the Productivity Research and Measurement Centre made it possible to calculate the labour costs to be taken into consideration in estimating production costs for each size.

6. Standardisation of accounts

Comparative analysis of the results obtained by different firms yields a very valuable basis for the institution of standardised accounts.

A typical example is provided by the productivity measurements taken in the flour-milling industry in France in the second half of 1954. These show once again the impossibility of making meaningful comparisons by using the accounts departments' figures as they stand.

The desire to extend the scope of the survey without incurring the considerable expense of separate studies on the spot led, very logically, to a plan for the standardisation of the firms' paper-work, going far beyond the mere planning of accounts.

Standardisation, based on the accurate analysis of methods of work and administrative operations, enabled the working of the firm to be observed both from the financial standpoint, and from that of commercial and industrial efficiency. It also facilitates comparison of results shown by different factories.

Lastly, the proposed plan for standardised classification and paper-work is likely to be the more readily adopted by employers inasmuch as they can assess beforehand the advantages to be reaped from it.

Part II

COMPARISON OF RESULTS OBTAINED IN DIFFERENT EUROPEAN COUNTRIES

IX

GENERAL REMARKS ON INTERNATIONAL COMPARISONS

The first part of this volume showed by what methods it had proved possible to measure productivity at plant level.

The following chapters compare the results obtained for the same industry in various European countries in order to bring out differences and explain their causes wherever possible.

Research can be directed either to differences in productivity occurring at a particular moment or to differences in rates of development.

The value of this kind of research scarcely needs emphasising as it enables each country to benefit from the progress achieved by others.

Unfortunately it is not yet possible to carry out very many surveys in this field, as it is unusual at the present time to find a particular industry which has been subjected to productivity measurement in several countries.

The only industries in which this has been done are:

The boot and shoe industry (studied in Belgium, Denmark, France, Germany, the Netherlands, Norway and the United Kingdom);

The cotton spinning industry (studied in Austria, France, Germany and the United Kingdom);

The foundry industry (studied in Belgium, France, the Netherlands and the United Kingdom);

The brick industry (studied in France, Norway and the Netherlands);

The shirt industry (studied in Denmark and the Netherlands).

Most of these studies concentrate on the level of productivity at a particular period. Only in the foundry and cotton-spinning industries is it possible to study developments over a longer period of time in several countries.

Moreover, present comparisons entail serious technical problems.

In the first place, there is no question of comparing the level or development of productivity in a particular industry as a whole: as stated in Chapter II, valid measurements can rarely be applied to an entire branch of industry. The level of productivity or changes in productivity can therefore only be compared with reference to groups of firms in various countries.

In the second place, there are serious difficulties in connection with the comparability of data.

It is often difficult to select production units which enable adequate comparisons to be made within the same country and it will be readily understood that the difficulty is even greater when the data compared relate to reference units whose selection has not been co-ordinated.

This is generally the case, as European research has usually been aimed at securing results which can be used at national or regional level and sometimes even within the still narrower limits of a group of plants.

Reduction to a common unit involves problems which become more complex as the range of products widens, not only because of the variety of consumer tastes to be found within the same country, but also because of the different economic structures reflected by the characteristic features of the products manufactured.

For example, there is no doubt that average height, which often varies considerably from one country to the other, has an important influence on the range of sizes in the clothing industry.

As regards labour, which is the factor most frequently analysed, the problem is at first sight less difficult to solve as a man-hour (or man-minute) can be accepted as comparable from one country to another. This is not the case when the results are expressed in man-days or man-weeks.

Furthermore, comparisons should never be made without great care as there may be a difference in the definitions adopted.

As a general rule, labour time represents the actual hours worked by an operative, but this is not always so. It may refer to the number of hours on which wages are based or a theoretical period determined by time and motion study.

The degree of integration of firms may also vary considerably, i.e. in one country the only components used may be ready-made while in others they may be manufactured in the works.

This means that comparable data can often only be obtained for individual operations or groups of similar operations.

Other complications arise when operations are studied closely owing to the diversity of the methods used: despite identity of terms the scope of a particular job may vary according to the basic concepts adopted. Similar difficulties are met with in distinguishing between direct and indirect labour.

It is therefore essential to refer to the definitions adopted in each survey.

Finally, corrections are difficult as the results analysed generally relate to surveys already completed and this makes it virtually impossible to obtain the additional details required.

For these various reasons the significance of any differences recorded are almost always subject to the strictest reservations. Nevertheless, differences between levels of productivity are often sufficiently wide to enable valid conclusions to be drawn.

The analyses in the following chapters are merely attempts to show the value of the results which it will be possible to obtain when methods of measurement have been standardised.

Furthermore, this field of study is limited, as regards productivity levels to:

- the shirt industry
- the boot and shoe industry
- the cotton spinning industry

and as regards the development of productivity to:

- differences between one region and another in the French boot and shoe industry.

Possibilities of comparison may well increase considerably in the future and it may then be possible to reach conclusions of the very greatest value for a large number of industries.

X

THE SHIRT INDUSTRY

Comparison of results obtained in the Netherlands* and in Denmark

Productivity measurements have been made in the shirt industry in two European countries: The Netherlands and Denmark (see Chapter IV).

The Danish study was carried out in 1952 by the Productivity Service of the Ministry for Trade (Handelsministeriets-Produktivitets Udvalg). The data compiled relate to the first quarter of 1952; they were analysed in June 1953 in a publication entitled *Produktivitets Undersogelser inden for skjorten industrjen*. The Netherlands study was started at the same time and was carried out by the Central Statistical Office (Centraal Bureau voor de statistiek). A new survey was carried out every quarter and the results have been published in two pamphlets entitled: *Overhemden industrie 1°, 3° and 4° Kwartal 1952*; they relate to the four quarters of 1952.

For the Netherlands, the period to be studied had to be either the average of the first three quarters or the fourth quarter of 1952. The latter was found to be more suitable as more detailed information was available for that period. Furthermore, the level of activity in the fourth quarter of any year is about the same as that in the first quarter of the following year. Thus, although slightly different, the two periods studied would seem to afford sufficient material for comparison.

The first problem to be dealt with concerns the comparability of the products for which labour times were determined.

The Danish studies were carried out on a type of shirt which varies slightly from one factory to another. The differences noted were, however, so slight that in most cases their effect on labour times was negligible, as least if the operations of each workroom were considered as a whole.

In the Netherlands, a fairly wide range of models was manufactured, and it proved impossible to find a single sufficiently representative type. Conversion coefficients established by a firm of consulting engineers were therefore used and the

* Just before the printing of the Volume II, the Centraal Bureau voor de Statistiek has published a study on this subject, *Overhemden Industrie-Internationale Vergelijking 1955*.

volume of production was calculated by this means and expressed in standard units. *

The reference model used as a basis was very similar to the type of shirt chosen in Denmark (Fig. 15), as can be seen by comparing the two lists below.

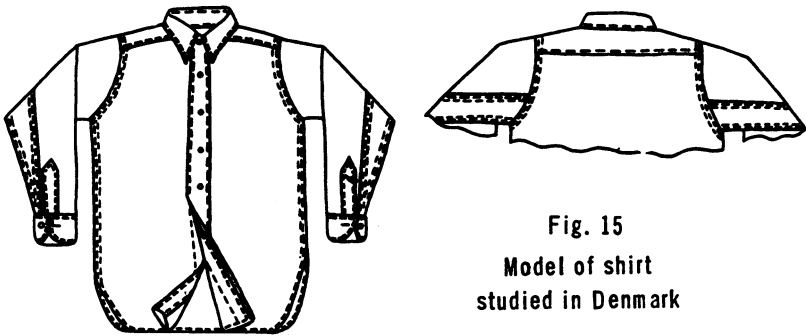
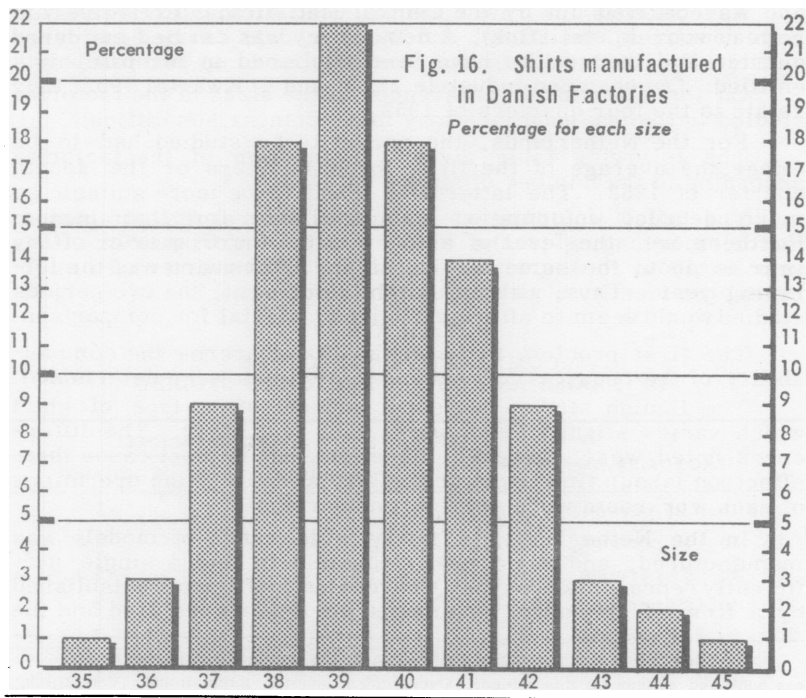


Fig. 15
Model of shirt
studied in Denmark

The Netherlands did not make a special study of the percentage of shirts manufactured for each size, but it appears from the experts' estimates that the figures for each of the various sizes do not differ greatly from those noted in Denmark



* See Chapter IV, page 57.

Table XVI
DETAILED COMPARISON
OF SHIRTS STUDIED IN THE NETHERLANDS AND DENMARK

DUTCH SHIRTS	DANISH SHIRTS
1. Attached collar, stiffened	1. Attached collar, not stiffened
	2. A single collar button and buttonhole
3. Stitched yoke	3. Inset yoke
	4. Single cuff (one button)
	5. No spare collar
	6. No spare cuffs
	7. No pockets
	8. Sewn-on label
	9. Five buttons and buttonholes
	10. Gore sleeve, inset
	11. Cuff with band finish

(see Fig. 16). The average size is, however, definitely bigger than that noted in other countries (France, for instance).

As cotton is the raw material used almost exclusively in both countries, the Danish and Dutch models can be considered sufficiently similar for useful comparisons to be possible.

On the other hand, differences in the sizes of the factories studied in the two countries may make comparison difficult.

The following table gives a breakdown of the factories according to the number of staff employed.

The ideal would be to compare the results obtained in factories belonging to the same group. Unfortunately, it is impossible to do this without supplying information which might reveal the identity of certain Dutch factories.

Table XVII
COMPARATIVE STRUCTURE
OF DANISH AND DUTCH FACTORIES STUDIED

FACTORIES EMPLOYING	NUMBER OF FACTORIES	
	DENMARK	NETHERLANDS
Less than 25 persons	-	2
25 to 49 persons	2	3
50 to 99 persons	2	5
100 to 199 persons	2	2
200 to 499 persons	-	3
Total	6	15

It is therefore unavoidable that the two sets of factories to be compared should be rather different in structure. It should, in particular, be noted that the Dutch factories employ an average of 120 persons, whereas the Danish factories employ an average of only 73.

Finally, the measurement of labour time calls for certain comments.

In both studies labour time is defined in the same way, i. e. actual hours worked* and not hours paid.

The studies carried out in the Netherlands give less detailed results than do the Danish studies. Labour times were calculated only for the following:

1. Total work of each factory (including clerical work);
2. Cutting room;
3. Stitching room;
4. Finishing, packing and despatching room.

Only these four items, therefore, are strictly comparable. However, although the two studies give very similar definitions for the cutting and stitching rooms, this is not so for the other

Table XVIII
DANISH AND DUTCH FACTORIES
(in man-minutes per shift)

FACTORY	CUTTING ROOM	STITCHING ROOM	TOTAL STAFF (ESTIMATE)
Danish factories			
A	5	34	56
B	8	42	67
C	7	34	55
D	5	44	68
E	6	29	47
F	8	38	58
Dutch factories			
1	4	42	77
2	7	46	81
3	6	48	88
4	10	50	87
5	9	54	97
6	10	51	93
7	9	58	97
8	14	51	102
9	9	59	104
10	10	74	125
11	12	76	121
12	4	80	114
13	15	76	135
14	21	85	153
15	18	96	188

* See Chapter V, page 61.

**COMPARISON OF LABOUR TIMES IN DANISH AND DUTCH FACTORIES
IN MAN MINUTES PER SHIRT**

Fig. 17.. Total Staff

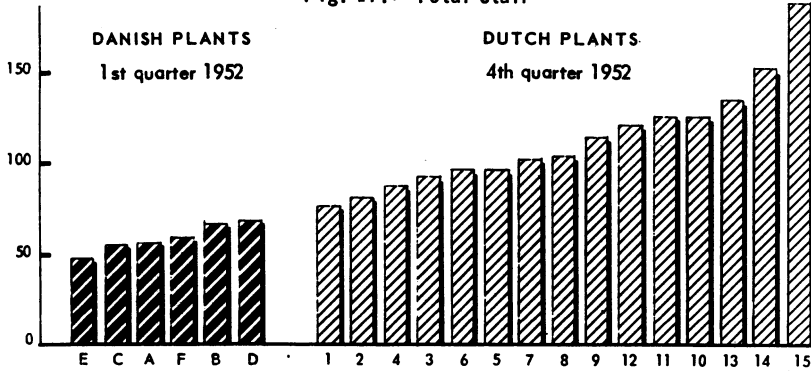


Fig. 18. Cutting Room

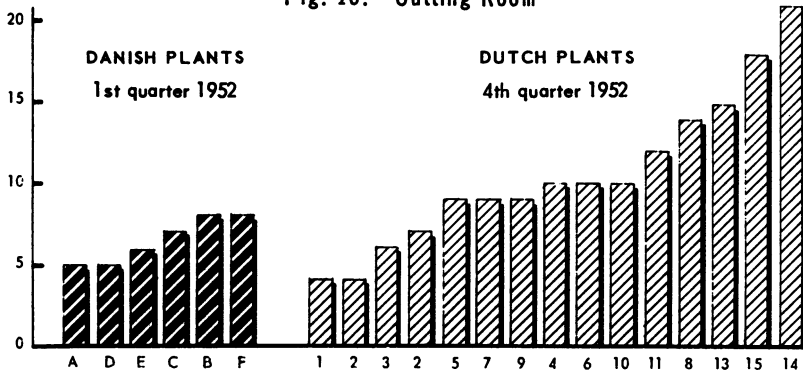
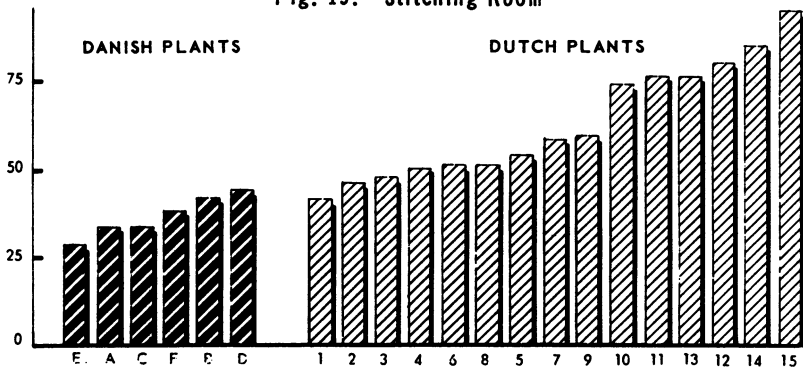


Fig. 19. Stitching Room



two items. The Danish study does not give any data which could be used to calculate the man-hours spent on the finishing, packing and despatching operations as a whole, the girls responsible for despatching the goods being regarded as indirect labour.

Furthermore, any comparison of data relating to the activity of the staff as a whole raises a number of difficulties as the labour time of the office staff was not taken into consideration in the Danish studies. It can be estimated however, if it is assumed that office hours are the same as those of the work-rooms. The labour time obtained in this way can, with some reservations, be compared to that of the Dutch factories.

Thus, for items 1, 2 and 3 useful comparisons can be made.

Table XVIII and diagrams 17, 18, 19 give the results in man-minutes per shirt. Some comment is necessary. In general, the Danish factories seem to show substantially better times than the Dutch factories.

For the labour time as a whole (see the reservations mentioned above), the difference seems particularly marked.

The best times noted in the Dutch factories are about 15 per cent better than those noted in the least efficient Danish factory. A comparison of the best times noted in the two countries shows a difference of as much as 200 per cent.

Furthermore, the disparity between the various Dutch factories is far greater than between the Danish factories; the former vary by about 1 to 2.4, whereas the latter vary only by 1 to 1.4.

The differences between the two groups of factories are rather less marked for the cutting room.

The best time noted in the Netherlands is not as good as the best Danish time. On the other hand, the slowest Dutch time is more than 150 per cent slower than the slowest time noted in the Danish factories.

In the stitching room, the best time noted in the Dutch factories was about the same as the lowest time noted in Denmark. The lowest Dutch time is more than twice as low as the lowest Danish time.

In conclusion, the differences noted between the Danish and Dutch factories appear to be fairly substantial; they are, however, smaller in the case of the cutting and stitching rooms.

The total time for these two work rooms is about the same in three Dutch factories as in certain Danish factories, but the total time of these factories as a whole is very much longer.

It seems, therefore, that where the disparity is greatest this is due to the general services of the factory and to the finishing, packing and dispatching rooms.

Finally, it should be noted that the relative size of the office staff as compared with the rest of the staff is about the same in the Netherlands and in Denmark (about 10 per cent).

XI

THE BOOT AND SHOE INDUSTRY - GOODYEAR

Comparison of results obtained in Denmark, France, the United Kingdom and the Netherlands

Productivity measurements have been made in the boot and shoe industry in many European countries: Germany, Belgium, Denmark, France, the United Kingdom, Norway and the Netherlands.

Only Denmark, France, the United Kingdom and the Netherlands have, however, made special studies of the manufacture of Goodyear welt footwear. This comparison will therefore be confined to these four countries. Only the most notable points will be dealt with as some very detailed studies have already been published on this subject, for instance, Chapter 6 (Internationale Produktivitetssammenligninger) of the Danish report on the footwear industry and the Dutch study "Onderzoek Goodyear - Welt Herenschoenen Internationale vergelijking",* which should be consulted for additional details.

The Danish study was carried out in 1952 by the Productivity Service of the Ministry of Trade (Handelsministeriets-Produktivitets Udvalg). The results relate to the third quarter of 1951 and were published in "Produktivitets undersogelser indem for skotojsindustrien".

The French study was carried out at the same time by the "Secrétariat Général du Comité National de la Productivité". The data relate to periods of four consecutive weeks varying according to the factories, but all included between 15th October and 15th December 1951. Details will be found in the report: "La Productivité en France dans l'industrie de la chaussure".

The English studies are rather older for they refer to a period of four weeks in the last quarter of 1948. They were carried out by the Shoe and Allied Trade Research Association. The results were circulated only to members of the Association. This body has, however, as a special concession, kindly authorised the publication of the figures given below.

* The information given in the tables has been translated into English. A very full summary is also given in English.

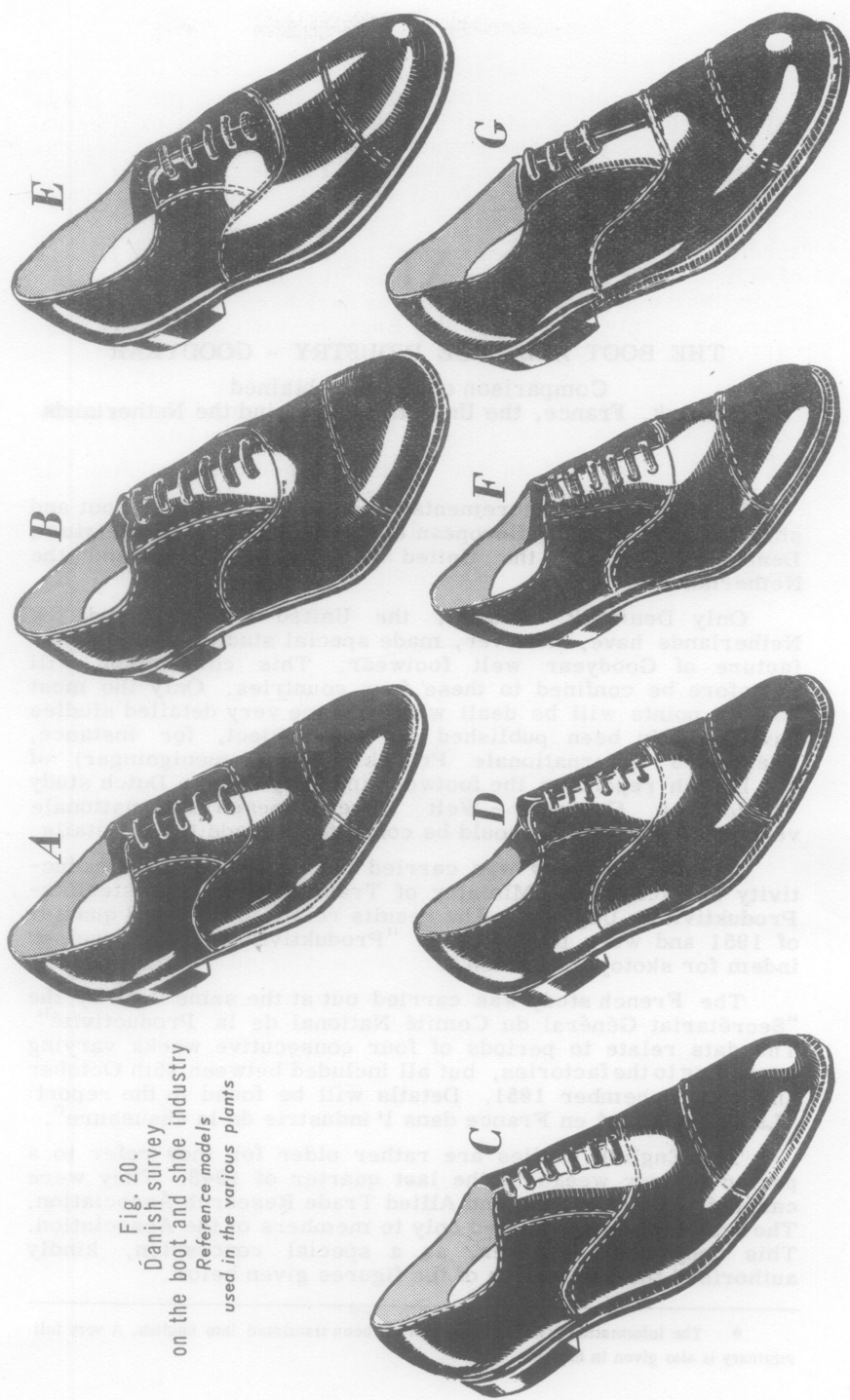


Fig. 20.
 Danish survey
 on the boot and shoe industry
 Reference models
 used in the various plants

The Dutch study relates to March and April 1952. It was carried out by the Centraal Bureau voor de Statistiek (Central Statistical Office at The Hague) which published two reports in that connection: "Schoenindustrie Enkelen voorlopige uitkomsten" and "Onderzoeken Goodyear-Welt herenschoenen 1952".

The data analysed relates to rather different periods. It should, however, be noted that all the studies deal with periods of full activity and any development that may have taken place since 1951 and 1952 is not likely to have been very substantial. This can hardly be said of the English studies as these were carried out four years earlier. This point should be borne in mind in order to assess the data given below correctly.

The first point to be considered is the comparability of the products to which the data given in this chapter relate.

In Denmark and in the United Kingdom, production is expressed in standard units.

The reference model on which the Danish studies were based was very simple. A series of shoes closely resembling the model in most particulars was made in each factory (see Fig. 20).

The standard type chosen in the United Kingdom was as follows:

"Black calf or side (not grained) upper; fibre stiffener; cotton vamp lining; celluloid toepuff, normal welt (not reduced; bottom filled forepart only; seat lift; single 3/4-sole, channelled; stitches 7-10 per inch; stitches pricked up, outside heel to inside waist; leather heel outside attached; leather top-piece Cutlan nailed; edge under 20 irons, square all round; black bottom; seat wheeled; one stamp on sole; heel sock".

In both cases figures were converted on the basis of the piece rate; the method used has already been described in detail on page 54 and subsequent.

In France, the articles studied were selected with the aim of:

1. Representing a large proportion of the industry;
2. Providing a good sample, from the productivity point of view, of factories manufacturing Goodyear products;
3. Supplying a relatively simple and conventional model which the factories had been manufacturing for a sufficiently long time.

As can be seen from Table XIX the models selected were sometimes rather different. The article chosen in Factory I, in particular, is in the luxury category and is therefore difficult to compare with the others. It has not been included in this analysis.

In the Netherlands, the studies on each factory were confined to a very simple sports shoe with a soft leather upper, double sole and leather heel.

The models studied thus vary considerably, as was not the case with shirts. As for sizes, it should be noted that the average French size is smaller than the average in Denmark, the Netherlands or even Great Britain.

It would thus be of little use to compare the results of the four studies without taking many precautions.

Table XIX
MAIN CHARACTERISTICS
OF THE ARTICLES STUDIED IN FRANCE

FAC- TORY	TYPE	UPPER	SOLE	HEEL	WELT	MISCELLANEOUS
A	Derby	Box	Single leather	Leather	Beadwelt	Blocked toe cap
B	Derby sports	Box	Double leather	Leather	Fancy	Steel tips
C	Derby sports	Box	Butt	Sewround	Beadwelt	Steel tips
D	Derby sports	Box	Butt	Leather	Beadwelt	Steel tips
H	Derby	Box-calf	Double leather	Leather	Notched leather	Steel tips
I	Derby	Box	Double leather	Sewround	Beadwelt	Steel tips

It is, in any case, very difficult to assess the data correctly as little information is given on the structure of the sample of factories chosen by each country. The only data available are those given in Tables XIX and XX which it was

Table XX
BREAKDOWN OF FACTORIES
ACCORDING TO NUMBER OF STAFF EMPLOYED

FACTORIES EMPLOYING	DENMARK	FRANCE *	UNITED KINGDOM	NETHERLANDS
Less than 100 people	2	1	"	"
100 to 199 people	2	3	"	"
200 to 299 people	2	3	"	"
300 people and over	-	1	"	"
	6	8	12	9

Average daily output of the factories studied, in pairs of shoes:

Denmark: 550 - France: 320 - Netherlands: 324

* Not including factory I.

found impossible to complete without running the risk of revealing the identity of the factories studied.

Labour time

Labour time is defined in the same way everywhere, i.e., actual hours worked. *

It should, however, be noted that in the Netherlands, three kinds of labour time were studied:

1. The time taken to fulfil an order (Bearbeidings tijd BT).
2. The time interval between two orders (Overige tijd OT).
3. The total of the two times (total tijd TT).

The times considered here are total times (TT).

In all four studies, the results relate to separate operations some of which are suitable for comparison between one country and another.

On the other hand, labour times for each workroom, and total productive time (excluding office staff) are recorded only in the French and Danish studies.

Care must be taken, however, in comparing these two sets of figures owing to differences between the models manufactured in the two countries.

It therefore seemed preferable, in working out a general classification for the factories, to use an extremely ingenious method devised by the "Centraal Bureau voor de Statistiek" in the Netherlands.

Labour times were measured for only a fraction - varying according to the factories - of the operations carried out in each workroom.

A clear picture of the working of a factory cannot be obtained merely by adding up the times taken for each operation. A method had to be found whereby each plant would be fairly represented.

The arithmetical average of the times taken for a specific operation in different factories was therefore calculated. (This figure was given the name of "tabelle Gemidelde" or T.G. in the Dutch publications).

For each factory, the following calculations were made:

1. The sum of the labour times noted for the operations studied.
2. The sum of the average times (T.G.) obtained for these operations.

The index was obtained by taking the ratio 1 : 2. Table XXI shows the application of this method to five operations and five factories.

* See page 61.

Table XXI
LABOUR TIME FOR EACH OPERATION
(Factories V, W, X, Y, Z and operations 1, 2, 3, 4, 5)

FACTORY	OPERATIONS				INDICES FOR OPERATIONS 1, 2, 3, 4, 5 COMBINED
	1	2	3	4	5
V	V ₁	*	V ₃	*	$\frac{V_1 + V_3 + V_5}{TG_1 + TG_2 + TG_3} \times 100$
W	W ₁	W ₂	W ₃	*	$\frac{W_1 + W_2 + W_3 + W_5}{TG_1 + TG_2 + TG_3 + TG_5} \times 100$
X	*	X ₂	X ₃	X ₄	$\frac{X_2 + X_3 + X_6}{TG_2 + TG_3 + TG_4} \times 100$
Y	Y ₁	Y ₂	Y ₃	Y ₄	$\frac{Y_1 + Y_2 + Y_3 + Y_4}{TG_1 + TG_2 + TG_3 + TG_4} \times 100$
Z	Z ₁	*	Z ₃	*	$\frac{Z_1 + Z_3 + Z_5}{TG_1 + TG_3 + TG_5}$
Average TG	$\frac{V_1 + W_1 + Y_1 + Z_1}{4}$	$TG_2 = \frac{W_2 + X_2 + Y_2}{3}$	$TG_3 = \frac{V_3 + W_3 + X_3 + Y_3 + Z_3}{5}$	$TG_4 = \frac{X_4 + Y_4}{2}$	$TG_5 = \frac{V_5 + W_5 + Z_5}{3}$
* Information not available.					

Methods based on the same principles were used to compare the times noted in the various countries for the operations involved in lasting, finishing and shoe-room work.

An index was established by making the average of the results obtained in the Dutch factories equal to 100. It was decided not to use the figures given in the French and Danish reports for the various workrooms.

The factories were grouped by countries. The letters A to F were used for the Danish factories, A to L for the British factories and A to H for the French factories.*

The results are given in Table XXII below. The number of operations on which the calculations were based is indicated in each case.

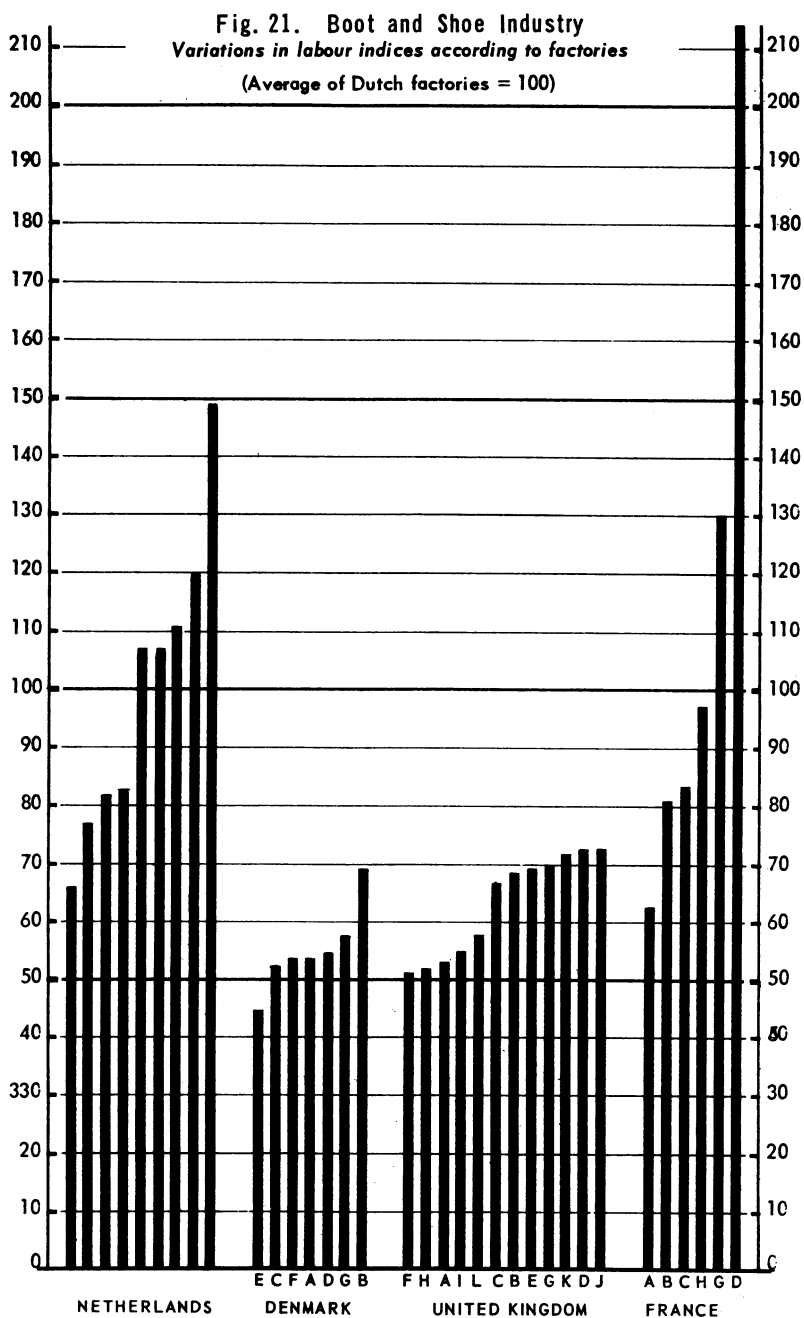
Table XXII
VARIATION IN LABOUR INDICES ACCORDING TO FACTORIES
Average of Dutch factories = 100

NETHERLANDS			DENMARK			UNITED KINGDOM			FRANCE		
FAC- TORY	LABOUR INDEX	NO. OF OPERA- TIONS	FAC- TORY	LABOUR INDEX	NO. OF OPERA- TIONS	FAC- TORY	LABOUR INDEX	NO. OF OPERA- TIONS	FAC- TORY	LABOUR INDEX	NO. OF OPERA- TIONS
A	66	35	E	44	24	F	51	33	A	63	32
B	77	40	C	52	24	H	52	33	B	81	27
C	82	30	F	53	24	A	53	33	C	84	31
D	83	34	A	53	24	I	55	35	H	97	15
E	106	42	D	54	24	L	57	35	G	130	16
F	106	38	G	57	24	C	66	32	D	212	13
G	111	39	B	69	23	B	68	34			
H	120	38				E	69	34			
I	149	29				G	70	33			
						K	72	34			
						D	73	33			
						J	73	34			

The average index for each country is shown in Fig. 21 by a dotted line. It is important, when studying this graph, to remember that the times noted for the Danish factories relate to piece-rate operations. It would therefore seem advisable to raise these figures a little to make them comparable to the rest.**

* Five factories mentioned in the French report proved unsuitable for inclusion in this study: the information provided on four of these was not detailed enough and the model manufactured by the fifth differed considerably from the rest.

** See page 74.



SOURCE : Centraal Bureau voor de Statistiek, La Haye.

As it is not possible to give results for all the forty separate operations involved, four have been given merely as examples.*

Considerable differences are apparent not only between factories in different countries but also within each country.

The most efficient factories in certain operations are, moreover, very much less efficient in others. There would thus appear to be room for improvement even in the best factories.

The way in which the data was obtained may, moreover, explain certain differences noted between two countries. In the

Table XXIII
THE GOODYEAR FOOTWEAR INDUSTRY
VARIATIONS IN LABOUR TIME FOR CERTAIN OPERATIONS
(Man-minutes and hundredths of a man-minute
per 10 pairs of Goodyear shoes)

NETHERLANDS	DENMARK	UNITED KINGDOM			FRANCE
		PIECE-RATE	HOURLY WAGES	COMBINED	
Lasting, quarters					
8.0	E 4.7	F 8.23	-	8.23*	G 9.0
8.6	F 4.8	A 9.80	18.15	10.08	H 9.8
8.7	G 4.8	I 10.35	-	10.35	C 13.7
12.9	A 5.6	H 10.44	-	10.44	A 17.1
14.6	D 7.0	C 10.93	12.10	11.02	B 26.2
19.8	C 10.2	E 11.11	-	11.11	D 30.0
20.1	B 10.8	K 12.22	16.59	12.78	
23.6		B 13.47	-	13.47	
		G 13.09	18.57	13.67	
		L 9.82	17.82	14.38	
		J -	-	14.98	
		D 6.03	15.03	15.01	
Average:					
14.5	6.8	10.50	16.38	12.13	17.6
Stitching, welt					
10.8	C 6.6	H 8.96	9.62	9.39	A 6.9
12.7	G 6.7	F -	-	10.45	H 11.6**
13.3	E 6.9	C 11.51	-	11.51	C 15.0**
14.3	D 8.4	A 11.73	-	11.73	B 15.3
14.3	E 9.2	B 11.77	-	11.77	**
23.7	A 10.8	I 11.07	20.80	12.75	G 40.0**
25.2	B 11.8	E -	-	13.05	F 66.5**
27.9		G 12.33	19.93	13.34	
		J 13.65	-	13.65	
		L 9.93	18.27	14.29	
		K -	-	14.60	
		D -	-	16.88	
Average:					
17.8	8.6	17.37*	17.16*	12.78**	25.6

* Including finishing of welts and soles.

** Applies to stitching of sole all round shoe.

* Comparative results for 39 operations are given in the Dutch study: Onderzoek Goodyear - Welt herenschoenen Internationale vergelijking.

Table XXIV
THE GOODYEAR FOOTWEAR INDUSTRY
VARIATIONS IN LABOUR TIME FOR CERTAIN OPERATIONS
(Man-minutes and hundredths of a man-minute
per 10 pairs of Goodyear shoes)

NETHERLANDS	DENMARK	UNITED KINGDOM			FRANCE
		PIECE-RATE	HOURLY WAGES	COMBINED	
Trimming after stitching					
5.4	C 2.9	B 3.13	-	3.13*	A 3.9
6.5	D 3.3	F 3.39	-	3.39	H 4.4
7.5	B 3.5	H 3.48	-	3.48	B 4.6
7.6	E 3.5	I 3.65	-	3.65	C 4.7
9.5	A 4.5	D 3.83	-	3.83	G 5.8
9.9	G 4.5	A 4.10	-	4.10	
	F 5.3	G 4.13	-	4.13	F 32.4
		C 4.31	-	4.31	
		K 4.66	-	4.66	
		L 4.72	-	4.72	
		E 5.31	-	5.31	
		J -	6.03	6.03	
Average: 7.7	3.9	4.06	6.03	4.23	9.3
Heel Cutting					
5.5	E 3.4	L 3.34	-	3.34	G 5.4
6.4	F 3.6	F 3.38	-	3.38	B 5.6
8.5	A 4.0	K 3.52	-	3.52	
12.8	C 4.7	A 3.68	3.75	3.68	A 8.1
13.8	G 4.8	G 3.90	-	3.90	H 9.4
	B 4.9	H 4.18	-	4.18	C 10.5
	D 5.8	E 4.39	-	4.39	D 15.0
		C 4.63	-	4.63	F 50.1
		I 3.88	6.36	5.38	
		B 5.49	-	5.49	
		J -	7.73	7.73	
		D -	8.15	8.15	
Average: 9.4	4.5	4.04	6.50	4.81	

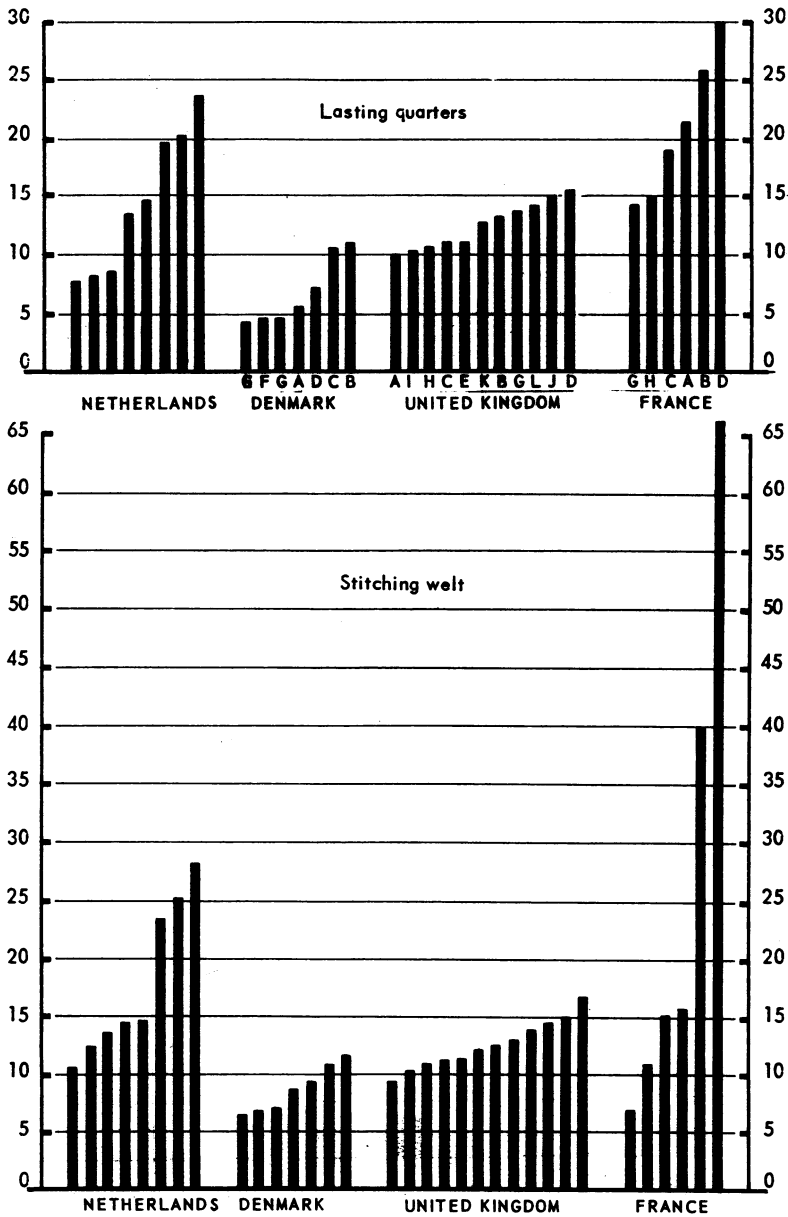
* Operation carried out by a young worker.

case of Denmark, the piece-rate may be too low. This would mean that output has been over-estimated for each operation and that the figures adopted give too favourable an impression of the productivity of the factories in that country.

In the United Kingdom, a distinction was drawn between senior and junior workers* and a reduction coefficient was applied to the number of hours worked by the latter. This should be taken into account in any comparison between the British figures and those noted in the other countries, for this system results in systematically underestimated times.

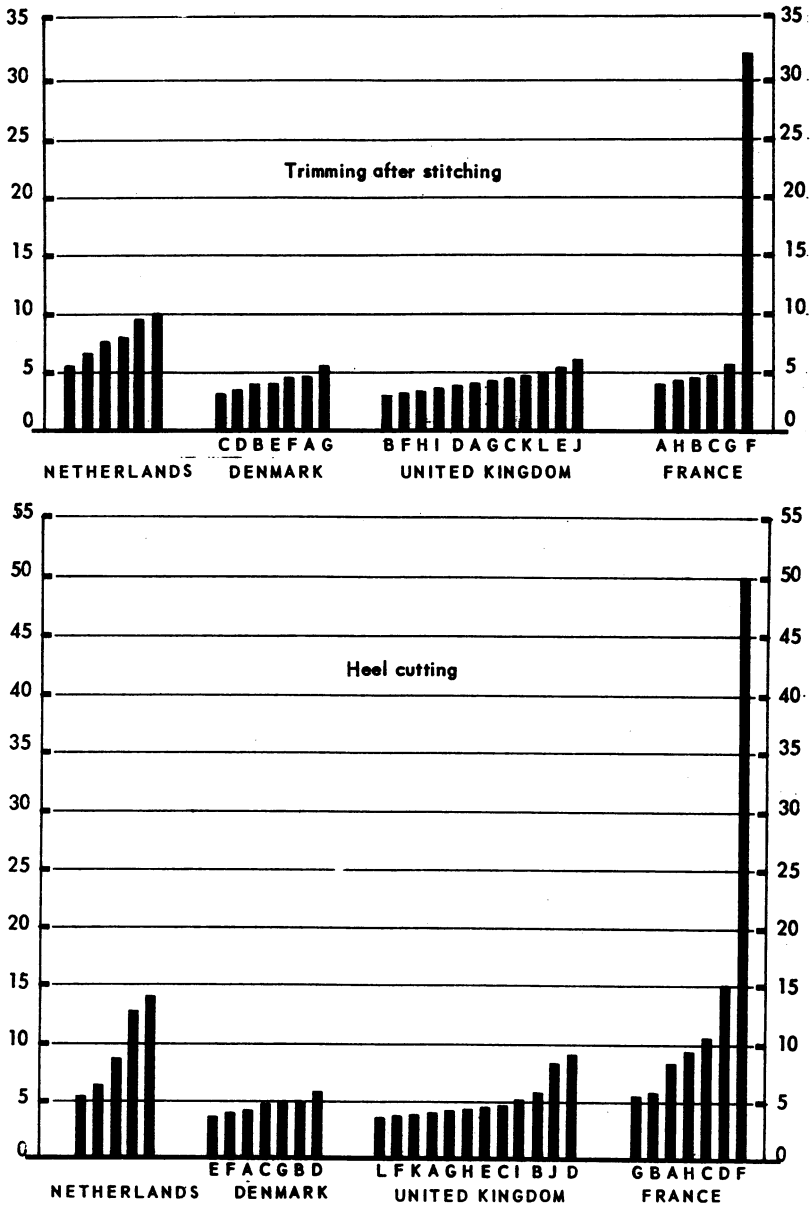
* See page 61.

Fig. 22. Boot and Shoe Industry Goodyear
Variations in labour times for certain operations
 (Man minutes per 10 pairs)



SOURCE : Centraal Bureau voor de Statistiek, La Haye.

Fig. 23. Boot and Shoe Industry Goodyear
Variations in labour times per operation
 (Man minutes per operations)



SOURCE : Centraal Bureau voor de Statistiek, La Haye.

1,302 people, 74 of whom were young workers, were employed in the lasting and finishing rooms in 12 British factories. The method of calculation adopted does not, therefore, make much difference as regards productivity as a whole, but it can have a decisive influence in the case of operations generally carried out by young workers.

The proportion of young workers varied according to the factories; the highest proportion was found in factories D and E, where it reached 27.5 per cent and 20 per cent respectively in the lasting room. The productivity of these two factories is therefore slightly lower than would appear from the figures. In general, however, the times noted in Denmark and the United Kingdom appear to be better than those noted in the Dutch and French factories.

It should be borne in mind moreover that in some countries the sample of factories chosen is not strictly representative. This is particularly the case in France and Denmark where the factories studied are better organised than the average factory. This does not apply, however, to the Netherlands where almost all the factories manufacturing this type of shoe were included in the sample.

Factors affecting productivity

The data given in the various publications reveals that a number of factors influence productivity. British studies seem to show that productivity is higher in the factories which apply piece rates than in the others. The authors maintain that this is not so much due to any greater speed on the part of the workers as to better organisation in the workrooms in which piece rates have been introduced.

An examination of the two countries for which data on wage rates have been supplied reveals that in the best British factory and the best Danish factory the percentage of employees working on piece rates is very high.

On the other hand, the connection between productivity and the size of the factories appears to be only slight, but this does not mean that this factor can be completely neglected in any international comparison.*

The size of the series made does, however, play a fairly important part, because of the time wasted in switching over from one article to another. This factor, in particular, may provide a partial explanation of the difference noted between the French and Danish factories, for the former all manufacture to order, some of them (B and D) sometimes making no more than a single pair of shoes of a given model.

* See page 102 and Table XX illustrating the structure of the sample of factories studied.

In Denmark, on the other hand, two factories out of seven manufacture shoes solely for stock and three others sometimes for stock and sometimes to order.

It is not possible to give a full explanation of the differences noted with no more than the factors described above to work on. To give a full explanation, a detailed analysis would have to be made of all factors involved, but that is beyond the scope of this study.

XII

COTTON SPINNING INDUSTRY

Comparison of results obtained in Western Germany, Austria, France, and the United Kingdom

Productivity measurements have been made in cotton spinning mills, as in shoe factories, in many countries: Western Germany, Austria, France, the United Kingdom, Norway, the Netherlands and Switzerland. The available information is not very complete, however, as most of the studies have been carried out by private bodies and the data obtained have therefore not been intended for wide publication.

A comparative study on Germany, Austria, France and the United Kingdom was carried out in 1953 by the Österreichisches Produktivitäts Zentrum (Austrian Productivity Centre). As it is impossible to obtain data for any other countries, the results of the above study only will be summarised here.

The Österreichisches Produktivitäts Zentrum has, since 1950, undertaken a series of productivity measurements repeated every six months in some 20 spinning mills.

In the United Kingdom, two sets of studies have been carried out by the British Cotton Industry Research Association on about 100 factories. One covers the period 1946-49 and the other the period 1951-54.

Finally, studies have been carried out at fairly regular intervals in Germany and in France by the trade associations.

It is thus possible to compare the results obtained at roughly the same time in Western Germany, Austria and France. Only the British figures relate to an earlier period.

The quality of cotton yarn depends to a great extent on the count.

The metrical count of a yarn is the number of hanks of 1,000 m. that weigh 1 kg. The English count is the number of hanks of 840 yards that weigh 1 lb. Conversion from one unit to the other is simple.

The comparison of yarns of different counts raises rather a difficult problem. Production could conceivably be expressed in terms of standard units of specific count. But as the correlation

coefficients vary somewhat from country to country, as well as within countries, this method might lead to erroneous results, as explained in Chapter V. It therefore seems preferable to adopt the system of comparison used by the British Cotton Industry Research Association, i.e. to compare only results relating to average fairly similar counts.*

The data available are not very detailed; it is in fact possible to compare labour times only for preparation and spinning operations proper or for output per machine hour. The results obtained can be seen directly from Figures 24 to 28 below.

The difference noted between the French and Austrian factories seems to be due in large measure to preparation, to which French manufacturers have no doubt in many cases paid more attention than their Austrian counterparts (see Figure 24). The latter seem, on the other hand, to have laid greater emphasis on the modernisation of their spinning mills. It should, however, be borne in mind that the Austrian figures do not include packing and supervision operations.

In general, the German spinning mills seem more efficient than the French and Austrian mills.

Output per spindle hour does not appear to differ substantially between the German and Austrian factories: French factories are well behind.

Two last remarks are called for:

First, the figures are not absolutely reliable as no information is available on the structure of the sample of mills studied in each country nor on the twist of the yarn nor on the kind of spindles used (ring or mule):**

Table XXV
TREND OF LABOUR TIME AND SPINDLE OUTPUT
IN AUSTRIAN MILLS
(averages for 17 mills)

PERIOD STUDIED	PREPARATION (MAN-HOURS PER KILO OF YARN)	SPINNING (MAN-HOURS PER KILO OF YARN)	OUTPUT OF SPINDLES (GRAMMES OF YARN PER SPINDLE HOUR)
1st half 1950	17.43	21.13	
2nd half 1950	16.74	19.76	17.58
1st half 1951	16.97	18.48	18.34
2nd half 1951	16.25	17.84	18.48
1st half 1952	16.35	17.54	18.77
2nd half 1952	16.21	16.43	19.74
1st half 1953	15.11	15.41	19.43
2nd half 1953	14.14	14.76	19.66

* See page 42.

** It should be noted that the Austrian mills do not use mules.

Fig. 24. Austrian, British and French Spinning Mills
Differences in labour times in Cardroom operations
 (Hours and hundredths of hours per lb. of yarn)

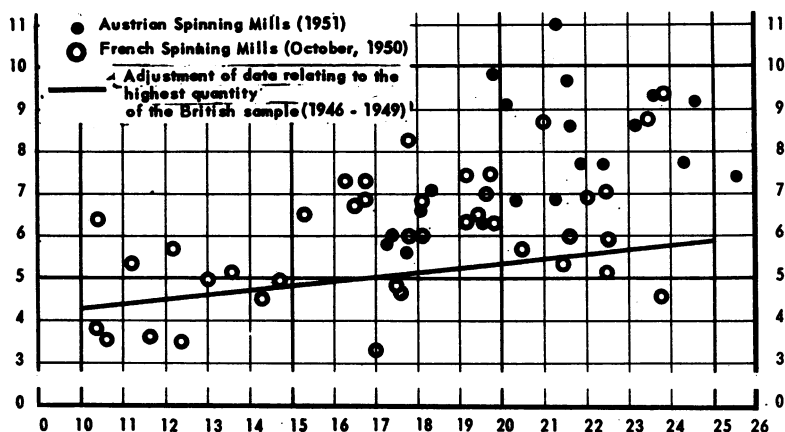
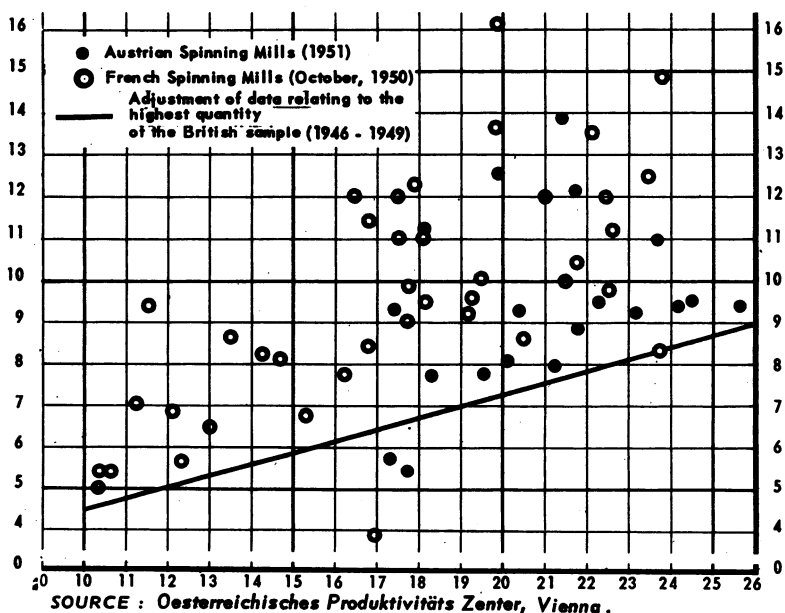


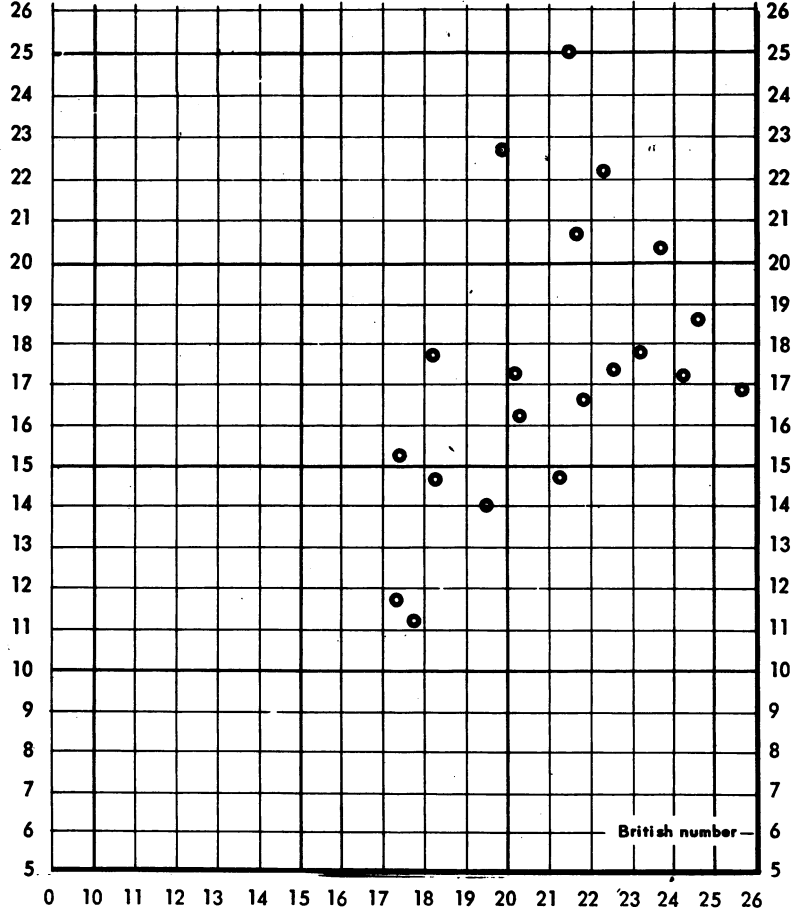
Fig. 25. Austrian, British and French Spinning Mills
Differences in labour times in spinning operations
 (Hours and hundredths of hours per 100 lb. of yarn)



SOURCE : Oesterreichisches Produktivitäts Zenter, Vienna .

Secondly, the data on Austrian spinning mills for the latter half of 1951 are no longer up-to-date owing to the considerable variations which have taken place since then, as can be seen from the table below. This probably applies to the three other countries also, but no data can be given on subsequent developments.

Fig. 26. Austrian Spinning Mills (1951)
Differences in labour times during the whole production process
(Hours and hundredths of hours per 100 lb. of yarn)



ORIGIN : Oesterreichisches Produktivitäts Zenter, Vienne.

Fig. 27. German, British and French Spinning Mills
Differences in labour times in the Total Production Process
including packaging and supervision
 (Hours and hundredths of hours per 100 lb. of yarn)

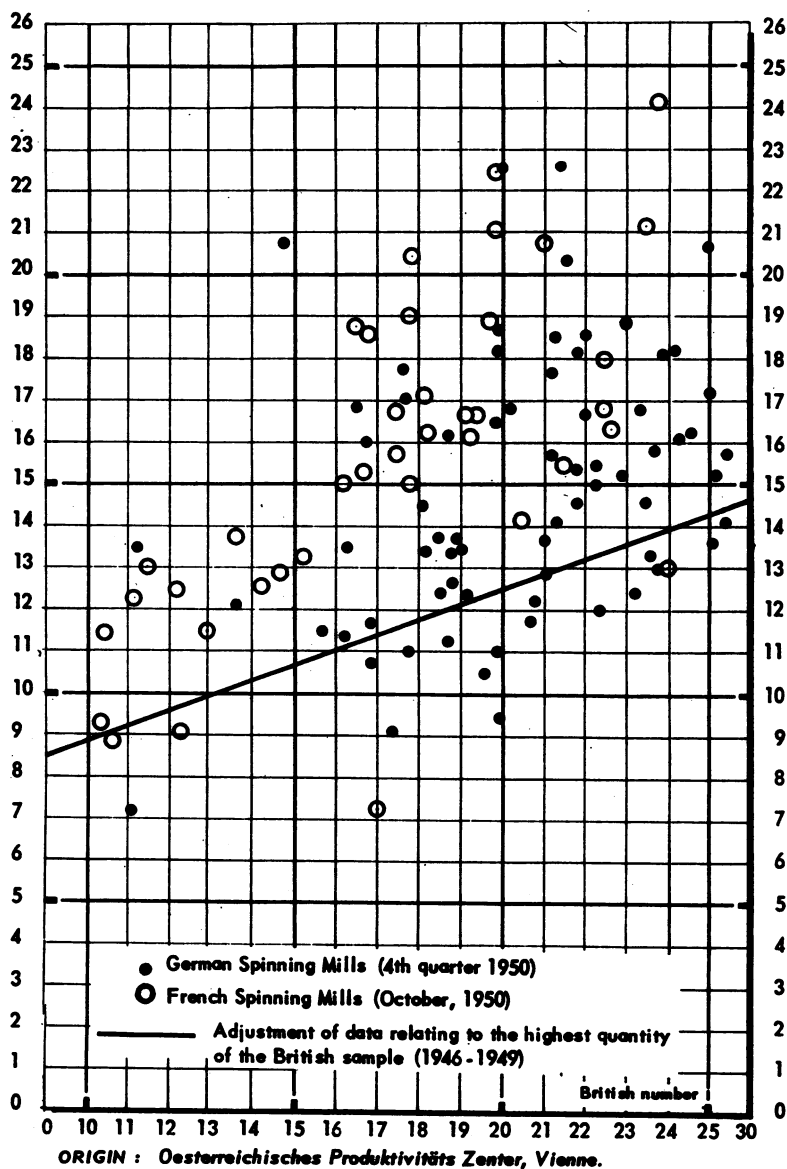
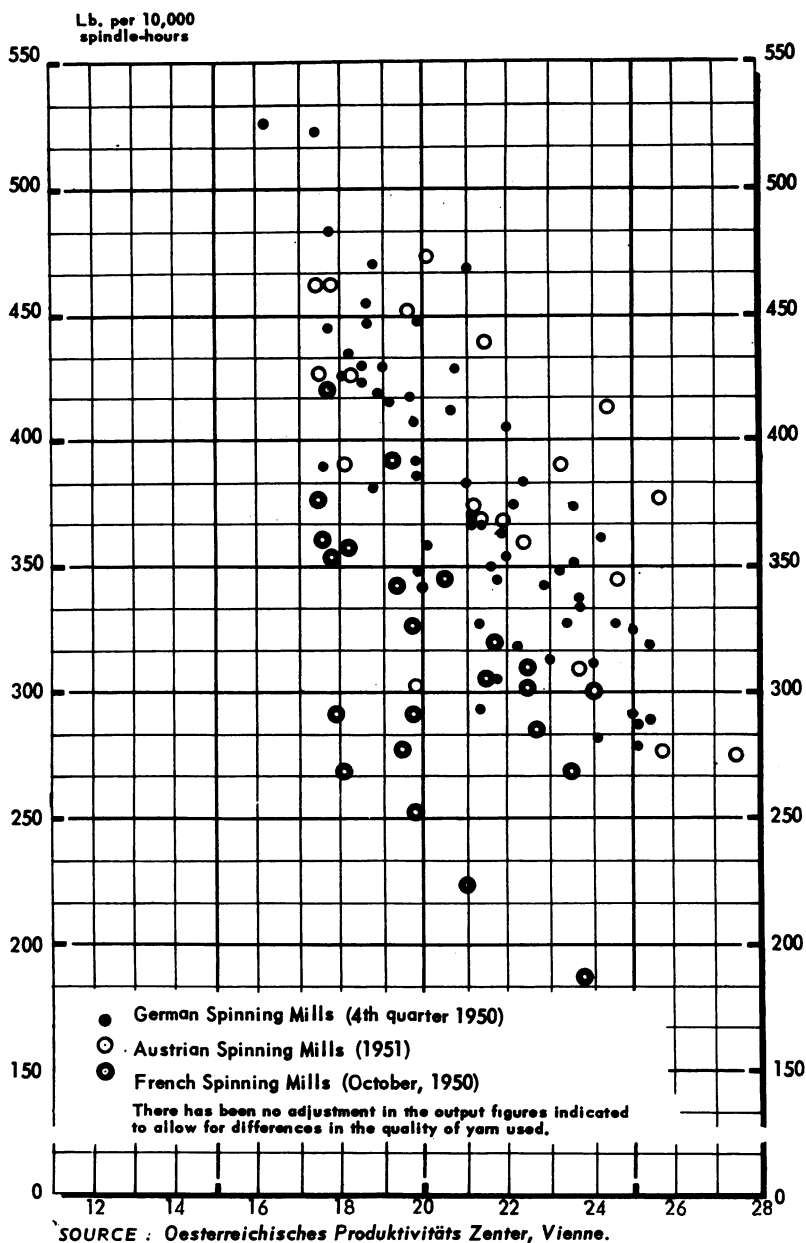


Fig. 28. German, Austrian and French Spinning Mills
Differences in output per spindle



XIII

COMPARATIVE DEVELOPMENT OF PRODUCTIVITY RATES BOOT AND SHOE INDUSTRY

The data published so far are not sufficiently detailed to permit any comparison of the rate at which productivity has developed in the various countries in the manufacture of any specific product.

Nevertheless, it was thought that it might be of interest to supply some information illustrating the way in which productivity has varied according to the different regions in the French footwear industry.

In 1953, the "Centre d'Etudes et de Mesures de Productivité" undertook to analyse the questionnaires completed by factories for the quarterly surveys of the "Fédération nationale des industries de la chaussure". The results were published in a pamphlet entitled "La Productivité en France dans l'industrie de la chaussure - Résultats généraux 1947-1951".

The data analysed relate to about 300 factories employing more than 50 people, which can be regarded as a sufficiently representative sample of the industry. The period studied is 1947-1951. The volume of production is expressed in terms of standard units corresponding to one pair of adult's shoes of a current type. The other categories (junior, boy's, child's, special and various others) are considered equivalent to half one standard pair.

The purpose of this adjustment is to eliminate as far as possible the error which would occur in comparing different regions or different years, owing to the difference in the range of sizes. It was moreover found on making a statistical analysis of the data, that this rough equivalence did, in general, correspond to the position in factories working in an identical way and manufacturing one or other of these two categories. Nevertheless, factories manufacturing a mixture of both categories thereby incur an appreciable loss of productivity, which varies according to the respective proportions of the two categories. The equivalence would be about 1 : 1.8 instead of 1 : 2 for the non-specialised factories in one category as a whole. The coefficient 1 : 2 can nevertheless be adopted as a very rough approximation.

The data on labour relate to the staff as a whole (including office staff); they are calculated in terms of man-years. The difference between "annual productivity" and "hourly productivity" appears to be slight for the period under consideration, judging by the results given below, taken from an analysis of the department of Ile et Vilaine.

Table XXVI

AVERAGE WEEKLY LABOUR TIMES

1947.....	39.8 hours
1950.....	39.6 hours
1951.....	39.7 hours

France is divided into eight regions as indicated on the map below. Table XXVII gives details of each sample.



Fig. 29. French survey on the Boot and Shoe Industry
Areas covered by the survey

Table XXVII

REGION	NUMBER OF FACTORIES 1947	AVERAGE NUMBER OF EMPLOYEES IN EACH FACTORY 1947	AVERAGE OUTPUT, PER WORKER AND PER ANNUM IN 1947 (STANDARD PAIRS)
Paris-Centre	54	140	468
North	16	110	572
East	28	270	580
South-East	54	210	477
South-West	57	120	527
West	95	110	554
France as a whole .	304	150	520

To assess the average variations in output per capita and per annum since 1947 in each region, the following procedure was adopted.

For 1951, for instance, the factories chosen were all those which had submitted replies both in 1947 and in 1951. Average output, per worker per annum, in 1947 and in 1951 was calculated for these factories as a whole. The 1951 index (1947 = 100) was obtained by dividing one result by the other.

Two remarks are called for:

1. By this method, equal importance is attached to each factory;
2. Only 126 factories out of the 283 selected for 1947 submitted replies in 1950 and 1951, i. e. less than half. This smaller selection is no doubt less representative than the earlier one and the data obtained seem to indicate that it consists mainly of factories in which productivity has developed more favourably than in the branch as a whole.

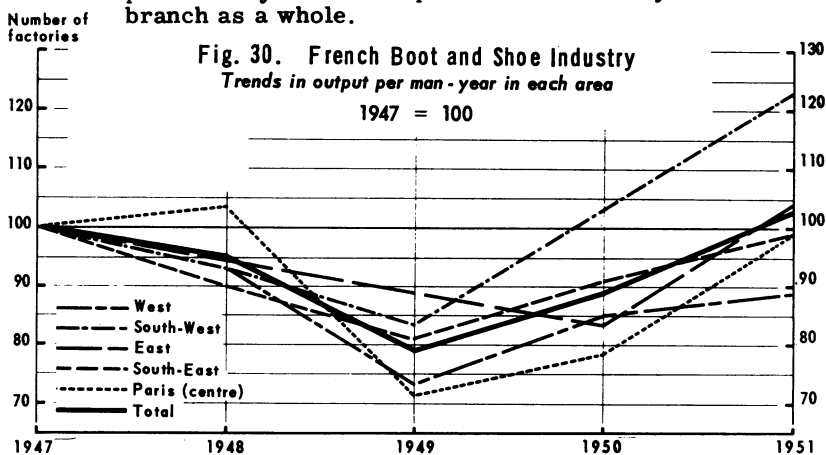


Table XXVIII
FRENCH FOOTWEAR INDUSTRY
Trends of output, per worker per annum, in the various regions
(Index base: 100 in 1947)

REGION	1948	1949	1950	1951	NUMBER OF FACTORIES*
Paris-Centre**	103	71	78	99	29
East	***	***	84	104	8
South-East.....	90	81	91	99	31
South-West	94	84	102	123	28
West.....	94	73	85	89	35
France as a whole**..	95	79	89	103	135

* Used in calculating the 1951 indices.

** Including the north region, which in 1951 was represented by four factories.

*** No information available.

Table XXVIII of which Figure 30 is an illustration, shows the following data:

- a slight fall from 1947 to 1948 except for the Paris area;
- a considerable fall from 1948 to 1949. Productivity was lowest in all regions in 1949; this lowest level was, on an average, 20 per cent below the 1947 level for France as a whole; the two extremes were: the South-West (16 per cent) and Paris-Centre (29 per cent);
- steady progress from 1949 to 1951;
- for the country as a whole, the average 1951 level was roughly equivalent to the average 1947 level;
- the same applies to Paris-Centre and the South-East region;
- the most important variations noted from 1947 to 1951 are as follows:
 - South-West and North, approximately + 20 per cent and + 10 per cent respectively;
 - West, approximately 20 per cent;
- as compared with 1949, the progress made amounts on an average to about 28 per cent, the minimum being 12 per cent (West) and the maximum about 50 per cent (South West, the region least affected by the 1949 crisis);
- only the West appears to have been stationary or to have shown a decline from 1950 to 1951; all the other regions show a definite improvement.

ANNEXES

Annex I

ANALYSIS OF FACTORS AFFECTING PRODUCTIVITY The Studies of the British Cotton Industry Research Association

The information contained in this volume may be usefully supplemented with a brief description of the attempts made to determine the influence of certain factors on the firm's level of productivity.

The analysis may be concerned either with variations in productivity over a period of time in a given plant, or with variations in productivity between different plants at a specific moment of time.

In the first instance, a large number of data can be obtained, as the observations can be repeated for each new manufacturing cycle.

In the second instance, with which this paper is exclusively concerned, the number of data depends on the size of the sample. Some guidance can, however, be obtained from observations made in the plant and from technical experience.

Surveys in this field are somewhat rare, as the number of mills in which observations are made is nearly always too small for statistical analysis.

A typical example is, however, provided by the work of the British Cotton Industry Research Association, dealing with about 100 cotton-spinning mills.* This has been repeatedly referred to in this volume (see pages 42, 85 and 113).

The data to be studied were expressed in either:

Man-hours per 100 lbs. of yarn, or O.H. P. (operative hours per unit of production);

Man-hours per 100,000 hanks of 840 yards of yarn, or O.H. Y. (operative hours per unit of yarn).

As the English yarn count equals the number of hanks of 840 yards corresponding to 1 lb. of yarn, we get:

$$\text{O.H. Y.} = \frac{\text{O.H. P.} \times 1,000}{\text{Yarn count}}$$

Neither of the two units is entirely suitable for use in statistical analysis, but they both show the advantage of having a definite meaning which is easily understandable by manufacturers.

In assessing the data, an endeavour has been made to give a separate calculation for the man-hours corresponding to each yarn count. This breakdown was not always possible when the counts were close; in that case an average count was taken, which introduces a slight inaccuracy, as even in a given factory, and other things being equal, the ratio between the work-time and the count does not show a strictly linear progression.

* To obtain detailed information on the statistical methods used, the reader is asked to refer to "Statistical Investigations of Labour Productivity in Cotton Spinning", by L.H.C. Tippet and P.D. Vincent, Journal of the Royal Statistical Society, Series A - Vol. CXVI, Part III, 1953.

Fig. 31. Survey of the British Cotton research Association
Variations in labour times according to number and origin of fibres

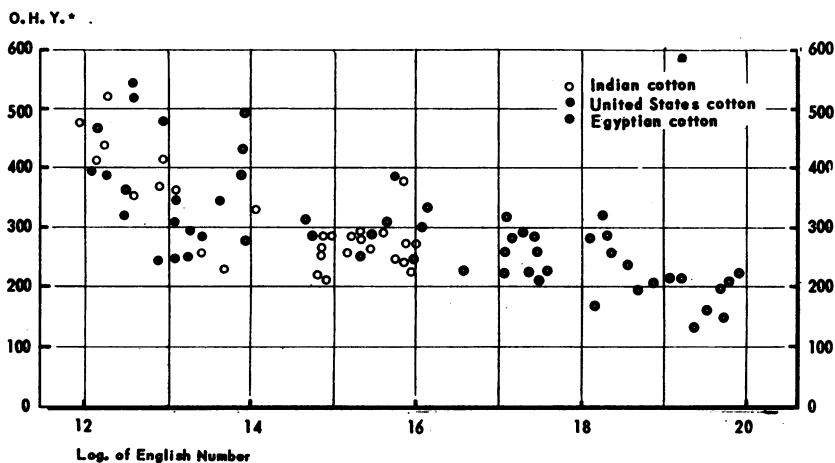
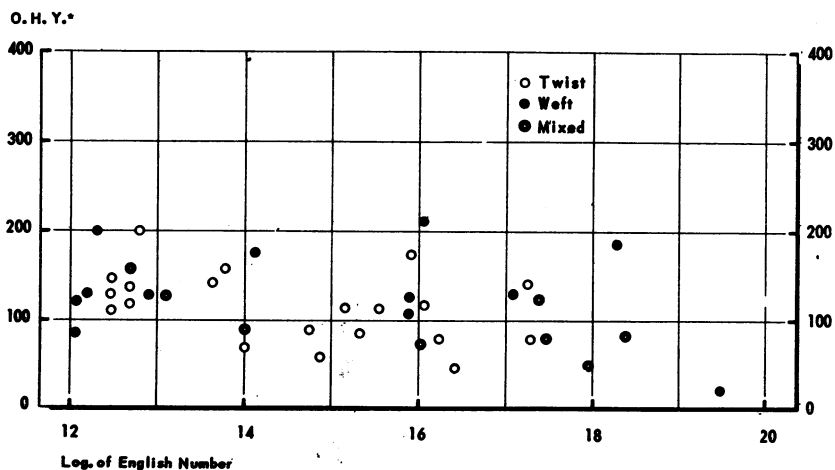


Fig. 32. Survey of the British Cotton Research Association
Variations in labour times according to number and type of yarn
 (Transport of spindles)



* O. H. Y. : Number of man-hours for 840,000 yards of yarn.

The first task was to ascertain what ratios, if any, existed between the O.H.P. and the factors liable to affect them: type of yarn (twist, weft or mixed), source of fibres (India, United States or Egypt), quality of cotton, yarn count, size of firm, etc.

The graphs will show that the times for the same count sometimes varied by as much as 100% or more, but that generally speaking, the O.H.P. tended to rise with the count.

It was also observed that for the same count there was a marked difference between the times, according to the type of machinery used (ring or mule spindles).

On the other hand, no clear ratio emerged between the O.H.P. and the other factors.

Subsequent studies showed that the O.H.Y. lent themselves better to statistical analysis than the O.H.P., as the ratio between the O.H.Y. and the yarn counts was more constant.

The results thus obtained opened the door to a whole series of research studies, as they showed that an exact knowledge of the causes of productivity variations demanded deeper study than they had hitherto received. In particular, they led to the establishment of a work index drawn up on the basis of technical factors (type of bobbins, number of thread breakages, number of spindles per operative).

Even when these technical factors were taken into account, however, it was not possible to eliminate the appreciable differences still existing between mills.

Annex II

EXPERIMENTS ON PRODUCTIVITY MEASUREMENT IN AGRICULTURE

The studies of Mr. Huraux

The measurement of labour productivity in agriculture at farm level has so far been largely unco-ordinated. It may therefore be of interest to include this description of some rather original experiments carried out in France by one individual farmer, Mr. Huraux of Crépy-en-Valois (Oise).

Difficulties encountered in this field are considerable. Some are financial, for a single farmer cannot generally afford to pay an expert. Others are technical; i. e., whereas in industry the operations measured are repeated every day under practically the same conditions and the recorded results continue to be valid over a long period of time, in agriculture, on the other hand, any one operation is generally performed only once a year for a short period under different conditions every time.

If significant results are desired, the impact of the various factors affecting the duration of an operation must be determined with sufficient accuracy and a large number of time measurements must be carried out over a certain period so that almost all the cases which are likely to occur can be taken into account.

On the other hand, the conclusions likely to be reached are much wider in scope than those obtained in the industrial sector, where every analysis is confined to one particular operation in one particular plant and cannot normally be given a general application.

In agriculture, changes in working conditions due to natural factors are more or less of the same kind in one locality and period as in another. As equipment and the working methods are similar in thousands of farms, it is often no more difficult to apply the results obtained to a large number of farms than to a single one.

Work study can therefore bring about improvements in productivity which are very high in absolute terms, not only at individual level but also on a regional and even a nation-wide basis.

The experiments carried out by Mr. Huraux were begun in 1945 in co-operation with a firm of efficiency consultants, and dealt with a wide range of subjects. They have been continued up to the present time and have provided a very large number of time measurements.

The salient feature of these experiments is the use of statistical methods of analysis for the variable factors responsible for the results observed.

The analysis of each operation falls into two parts. First of all, the time required by the farm worker to perform each of the partial operations assigned to him is measured and the factors likely to affect working conditions are recorded at the same time. The second operation is to sort and interpret the data thus collected.

The time measurement technique adopted was that used by the S.M.A.T. firm and its main principle may be briefly outlined: A theoretical time known as the "allotted value point" for each of the operations studied. This is

obtained by multiplying the time actually measured, which is evaluated to a hundredth of a minute by the speed of the worker expressed as a multiple of sixty and a coefficient representing the worker's effort. This is the standard time allowed to the average worker.

The method used for the interpretation of the data will be more clearly understood if a relatively simple example is considered, i.e., a study of the operation of picking up potatoes by hand after they have been dug up by the Lapierre potato digger.

Originally the potatoes were scattered over the field. The first stage of the worker's job was to walk along the furrow and fill the basket he held with potatoes; the second stage was to go and empty the basket into sacks prepared for this purpose.

The time taken in each of the two stages was measured and the basket weighed. The time required to pick up 100 kilograms of potatoes was then worked out by rule of three. This is the time which will be referred to hereinafter.

To carry out this analysis about 250 time measurements were taken under the most varied conditions.

Analysis of each stage

The duration of the first stage of the operation depends on several factors:

1. The average yield per acre

The higher the yield, the easier is the collection of the potatoes, as the worker's journeys are fewer owing to the larger number of potatoes he finds in the furrow.

2. The number of potatoes per pound

The higher the number, the lower is the yield from the collection as more movements are required to collect a given weight.

3. The state of the ground

If the ground is overgrown with grass, collection will take long as the pickers will have to look for the potatoes, some of which they will not at first see. However, to avoid undue complication, it has been assumed that there are in practice three different types of ground, i.e., clean, slightly grassy, very grassy.

4. Other factors

E.g., temperature, which can affect the normal speed of work, and gradient. But the influence of these latter factors is slight enough to be disregarded.

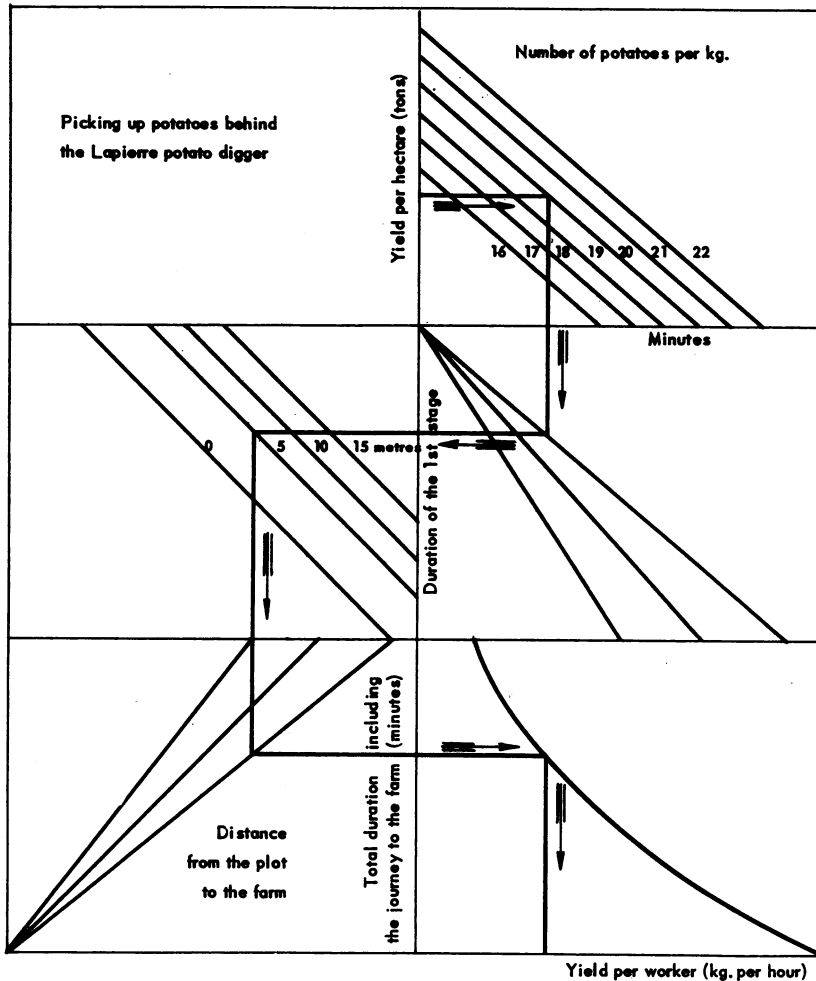
In each case the state of the ground was first assessed and the yield per hectare evaluated by sampling. The time taken was then measured. When the operation was completed the basket was weighed and the potatoes it contained were counted. The results were recorded on separate sheets of paper in each case, and these sheets were eventually sorted into three categories, each relating to a particular third of the ground.

A graph was compiled for each category, the abscissa representing the time taken (i.e. the value points) and the ordinate representing the yield per acre. The representative points were then plotted.

Those representing a constant number of potatoes per pound were linked up and a number of rectangular, parallel and equidistant segments were obtained which provided an a posteriori justification for the adoption of three types of ground.

The integration adopted in the second phase of this operation is roughly the same and therefore requires no description.

Fig. 33. Studies of Mr. Huraux
Differences in labour times according to working conditions



The method is to classify the results recorded on the basis of the variables first obtained and then study each of the categories separately.

If a satisfactory graph can be plotted, it may be concluded that no essential factor has been neglected, but failing this the analysis must be carried further to ascertain which factors have been neglected.

It may well be possible, amongst other applications, to provide a basis for productivity measurement in agriculture by using this technique which:

- a) allows the various natural factors affecting working conditions to be quantitatively evaluated;
- b) enables conversion factors to be worked out for the time taken over the same operations performed in different localities and at different periods.

Annex III

EXAMPLES OF QUESTIONNAIRES USED IN PRACTICE IN DIRECT PRODUCTIVITY MEASUREMENTS STUDIES

Four questionnaires used for productivity measurement are reproduced in the following pages.

1. Study of the Centraal Bureau voor de Statistiek (The Hague) on the tyre retreading industry

The first, which concerns the Netherlands tyre retreading industry, was drawn up in 1954 by the Centraal Bureau voor de Statistiek, The Hague. It is for completion by firms after an investigator has visited the factory and given the management verbal explanations on the procedure to be followed (see page 141).

2. Study of the Osterreichisches Produktivitäts Zentrum (Vienna) on the cotton spinning mills

The second questionnaire is the work of the Osterreichisches Produktivitäts Zentrum, Vienna. It is sent every half-year to the Austrian cotton spinning mills. With the data thus obtained the results of an initial enquiry on the spot can be brought up to date; the interpretation of these data is facilitated by periodical visits (see page 166).

3. Second study of the Centre d'Etudes et de Mesures de Productivité (Paris) on the pea-canning industry

The third questionnaire, which applies to the pea-canning industry, has been used since 1954 by the Centre d'Etudes et de Mesures de Productivité, Paris. It differs somewhat from the others, its purpose being to supply information as to the general trend of the entire sector and bring up to date the facts collected during a detailed Enquiry carried out in 1953. It is sent by post to all the factories in the sector. Since, generally speaking, these keep very scanty records, the information requested is very summary.

4. Study of the Statistisches Bundesamt (Wiesbaden) on the structure of costs in the building industry

The fourth questionnaire relates to studies on the structure of costs carried out in the building industry by the Statistisches Bundesamt, Wiesbaden, within the general framework of research on the principal economic sectors (see page 151). It, too, is sent by post to the firms concerned. As in the preceding case, it was thought helpful to attach a covering letter.

1. STUDY OF THE CENTRAAL BUREAU VOOR DE STATISTIEK ON THE TYRE RETREADING INDUSTRY
SPECIMEN OF QUESTIONNAIRE

Central Bureau of Statistics, The Hague.
Section 2B, telephone (K 1700) 184270

No. J 10

COMPARISON OF PRODUCTIVITY ON PLANT LEVEL: TYRE-RECONDITIONING INDUSTRY

Please send back this questionnaire in attached envelope before
One copy is for your files.
Read the instructions to which the notes in this questionnaire refer.

To facilitate a possible check and inquiry about the data provided, kindly keep the documents used to calculate the quantities required.

Results of the 3rd quarter 1951. (1) (2)

I. NUMBER OF MAN-HOURS WORKED IN THE QUARTER UNDER REVIEW (3)

ACTIVITIES	DIRECTORS CO-OPERATING PARTNERS AND OWNERS (4)	MANAGERS (4)	WORKMEN AND FOREMEN	OFFICE PERSONNEL	ACQUISITION PERSONNEL (COMMERCIAL TRAVELLERS AND DRIVERS)	PERSONNEL IN GENERAL SERVICE (6)	TOTAL
1	2	3	4	5	6	7	8
1. Reception and inspection							
2. Buffing and measuring							
3. Solutioning							
4. Application of rubber							
5. Curing							
6. Finishing							
7. Inspection							
8. Dispatching (6)							
9. Repair of tyres (7)							
10. Repair of inner tubes (8)							
11. Office work (9)							
12. Acquisition and transport (10) ..							
13. Various operations not mentioned under 1-12 (11)							
a. on account of the tyre recon- ditioning and the repair de- partment							
b. not on account of the recondi- tioning and the repair-depart- ment							
Total							

II. DATA CONCERNING THE PRODUCTION DURING THE PERIOD UNDER REVIEW

A. Number of reconditioned tyres (12)

	FULL CAP (RECAPPED)	TOPCAP	REMOULD	TOTAL NUMBER OF RECONDITIONED TYRES	OF WHICH REPAIRED TYRES
1	2	3	4	5	6
1. Tyres, which have passed all the sections of the reporting plant:					
a. private car tyres					
b. light truck tyres (up to 700 x 20)					
c. heavy truck tyres (750 x 20 - 1 000 - 20)					
d. very heavy truck tyres (1 100 x 20 and higher)					
e. tractor front tyres					
f. tractor rear tyres					
g. sundries					
2. Tyres, only cured for third parties:					
a. private car tyres					
b. light truck tyres (up to 700 x 20)					
c. heavy truck tyres (750 x 20 - 1 000 - 20)					
d. very heavy truck tyres (1 100 x 20 and higher)					
e. tractor front tyres					
f. tractor rear tyres					
g. sundries					
3. Tyres, only cured by third parties:					
a. private car tyres					
b. light truck tyres (up to 700 x 20)					
c. heavy truck tyres (750 x 20 - 1 000 - 20)					
d. very heavy truck tyres (1 100 x 20 and higher)					
e. tractor front tyres					
f. tractor rear tyres					
g. sundries					

II. DATA CONCERNING THE PRODUCTION DURING THE PERIOD UNDER REVIEW (cont'd)

B. Some other data about the production

	NUMBER
1. Number of tyres repaired (13).....	pieces
2. Number of inner tubes and tyre inflation hoses repaired.....	pieces
3. Quantity of canvas used.....	kg.
4. Quantity of repair rubber used.....	kg.
5. Quantity of gaskets used.....	kg.
6. Quantity of rubber-dust produced.....	kg.
7. Quantity of rubber used (14)	
a. normal rubber.....	kg.
b. quickly vulcanising rubber.....	kg.
8. Waste of unvulcanised rubber.....	kg.
9. Quantity of solution used.....	litre
10. Number of curing-tables for tyre reconditioning (15).....	pieces
11. Number of men regularly working in the curing-department (16) ...	men
12. Number of working hours of the plant (17).....	hours

C. Average curing-time per tyre (18)

	VULCANIZATION WITHOUT REPARATION	VULCANIZATION WITH REPARATION
a. Private car tyres.....		
b. Light truck tyres (up to 700 x 20).....		
c. Heavy truck tyres (750 x 20 - 1 000 x 20).....		
d. Very heavy truck tyres (1 100 x 20 and higher).....		
e. Tractor front tyres.....		
f. Tractor rear tyres.....		
g. Sundries.....		

D. Acquisition and transport (19)

1. Percentage of the total number of tyres arrived during the period under review:	
a. collected by commercial travellers and transport-personnel of the plant surveyed.....	
b. brought in by clients or third parties (transporters).....	
2. Percentage of the total number of tyres delivered during the period under review:	
a. transported by commercial travellers and transport-personnel of the plant surveyed.....	
b. transported by clients or third parties (transporters).....	
3. Number of km's driven by cars of the plant during the period under review for the purpose of acquisition and transport.....	km.

III. NUMBER OF PERSONS WORKING IN THE ENTERPRISE IN THE MIDDLE OF THE PERIOD UNDER REVIEW

	OF WHICH			TOTAL NUMBER OF PERSONS WORKING IN THE ENTERPRISE
	EXCLUSIVELY WORKING IN THE TYRE RECONDITIONING DEPARTMENT	EXCLUSIVELY WORKING IN THE COMMERCIAL DEPARTMENT	WORKING IN THE RECONDITIONING DEPARTMENT AS WELL AS IN THE COMMERCIAL DEPARTMENT	
a. Directors, co-operative partners and owners ..				
b. Managers				
c. Workmen and foremen..				
d. Office personnel.....				
e. Acquisition and trans- port personnel.....				
f. Personnel in general service.....				
Total				

EXPLANATIONS OF THE QUESTIONNAIRE

- (1) In connection with the occurrence of seasonal fluctuations, it is desirable that the data required as much as possible relate to the quarter mentioned in the questionnaire. If this is impossible, it is necessary to mention the period to which the data refer.
- (2) If the firm comprises several establishments, it is necessary to furnish data for each of these establishments separately. Questionnaires required for this purpose are available on application.
- (3) The data required in Section I should exclusively refer to the actual man-hours worked. Extra-hours have to be added, whereas non-working hours on account of holidays, illness, etc. have to be subtracted. Short pauses (e.g. daily tea-pauses) must be regarded as working hours. In most of the cases, 3 different kinds of activities can be distinguished in the plant: the tyre reconditioning department, the repair department, and the commercial department (new tyres).
 For the first 2 departments the man-hours have to be mentioned on lines 1 up to and including 13a of column 1. All man-hours on account of the commercial department have to be mentioned on line 13b. When the man-hours of people working in the tyre-reconditioning departments as well as in the commercial department can not be divided on the strength of administrative data, it is necessary to estimate the division as correctly as possible:
 e.g., a typist spends 1/3rd of the day on activities of the commercial department and the rest of the day on the administration of the tyre-reconditioning department; in this case, 1/3rd of the total number of hours she worked during the quarter under review should be entered in column 5, line 13b, and the rest in column 5, line 11. Man-hours spent on making solution or on preparing gaskets have to be mentioned on line 13 b.
 The notes (4) up to and including 11 give further information about the data required in Section I.
- (4) All staff work has to be mentioned on line 13: See note (11).
- (5) By personnel in general service is understood: firemen, door-keepers, canteen-personnel, etc. In so far as man-hours are spent on such work in general service, they have to be placed on line 13a: e.g., when a fireman tends the steam-engine part of the day and works in the curing department the rest of the day, then the total of his man-hours must be divided accordingly between line 5 and line 13a of column 7.
- (6) In the dispatching is not included the transport of tyres, but only the preparation and loading of the lots for transport, see note (10).
- (7) This includes the whole process of repair, so also the vulcanisation in sectional heaters in the repair department, but not the vulcanisation of repairs in so far as this does not take place simultaneously with the camelback.
- (8) This includes the whole process. Man-hours spent on the repair of tyre inflation hoses and inner tubes used for the machinery have to be added.
- (9) This also includes the man-hours spent on planning, store-administration, etc. The man-hours, mentioned on this line, however, may only relate to the tyre reconditioning department and the repair department.
 Office work on account of the commercial department must be mentioned on line 13b. See the example given in note (3).
- (10) In acquisition and transport are included all man-hours spent on visiting clients, or on contacting them in other ways. Man-hours of commercial travellers and transport-personnel of a certain plant must be added but not the man-hours mentioned on line 8 (dispatching). See note (6).
- (11) Line 13 is a summary of all sorts of man-hours, not mentioned on the other lines. These man-hours must be divided between 13a and 13b. As far as they are spent on account of the tyre reconditioning department, the following data should be placed on line 13a: all staff work (see note 4), all repairs of the own equipment (including those of cleaning the plant), all indirect labour as, e.g., the man-hours of firemen, canteen personnel, etc. All man-hours on account of the commercial department (new tyres) and any other side-lines have to be mentioned on line 13b, see note (3).
- (12) In column 1 of question II A, the reconditioned tyres are divided in 3 categories: 1) tyres, which have passed all the sections of the plant surveyed, 2) tyres, to which the rubber has been applied by other firms but which have been vulcanised in the plant surveyed and 3) tyres, to which the rubber has been applied in the plant surveyed, but which have been vulcanised by other plants.
 In columns 2 up to and including 4, a specification has to be given of column 5. In column 6, only the repaired tyres of which the repairs are vulcanised simultaneously with the new camelback should be entered. Repaired tyres of which the repairs are vulcanised before the vulcanisation of the camelback are not included. These tyres generally form a small part of the total number of repaired tyres mentioned in B. 1).

- (13) All tyres which have been subject to any repair regardless of the fact whether these repairs have been vulcanised simultaneously with the camelback or not should be entered.
- (14) The quantity of rubber includes both the camelback and the cushion-rubber as well as the plate-rubber, but not the repair-rubber asked on line 4.
- (15) The sectional heaters in the repair department are not included.
- (16) Enter the total number of men whose daily task is chiefly to vulcanise the reconditioned tyres. It is of course possible that these persons occasionally perform other jobs.
- (17) Indicate the total number of hours that the reconditioning-plant was in operation.
- (18) Here the average curing-time per tyre of the curing tables in the reconditioning department is asked, but not the curing time of sectional heaters in the repair department. This average curing-time is asked for the different types of tyres for the curing without and with repairs vulcanised simultaneously.
This average number of minutes must contain the average time necessary for cooling, filling and for emptying the curing table.
- (19) The percentages to be given here relate to tyres which have passed all the production-sections of the plant surveyed as well as those which have only been vulcanised. Rejected tyres must be included. The forwarding of tyres to transport-enterprises for further transport must be considered as "Transport by others" and must be mentioned sub b.

Productivity Study No. _____ from _____ to _____ 195_____ to _____

[illegible]

2. STUDY OF THE OSTERREISCHISCHES
PRODUKTIVITÄTS ZENTRUM
ON THE COTTON SPINNING
QUESTIONNAIRE

3. SECOND STUDY OF THE CENTRE D'ETUDES ET DE MESURES DE PRODUCTIVITE
ON THE PEA-CANNING INDUSTRY

Covering letter

ASSOCIATION FRANCAISE
POUR L'ACCROISSEMENT DE LA PRODUCTIVITÉ
CENTRE D'ETUDES ET DE MESURES DE PRODUCTIVITÉ

Paris,

Gentlemen,

By agreement with the F.N.C.A. we are getting in touch with you today with a view to an experiment.

The canning industry has developed very considerably during the last few years. Present circumstances give ground for assuming that, in the future, problems will arise which may not be easy to solve. Even in the immediate future, the probability of the liberalisation of trade may affect the economic trend.

It seems therefore essential to take stock of the present situation and follow the progress made over the next few years. In this way the trade can put up an effective defence in reply to any attack which may be made on it. Moreover, every canning firm will be able to estimate at low cost its position in relation to its competitors.

We have already made some studies of this kind, but it would be very valuable if we could supplement them with a small number of facts relating to the entire trade.

We are therefore sending you the enclosed questionnaire. You will have no difficulty in filling it in and it will not take you long. The analysis of the particulars thus collected will produce very valuable information on the situation of the canning industry. The results will be communicated to you in a very short time and you will be able to draw your conclusions very rapidly.

Your name will not be used in any way. An identification number in the top-left hand corner of the questionnaire will be cut out as soon as your reply is recorded. We attach, for your information, an example of the results that may be expected from the enquiry.

Detailed results will be sent to participants free of charge. With their agreement certain general results, to which no names will be attached, will later be circulated more widely throughout the trade against payment.

I trust that you will accede to our request.

Yours faithfully,

Director.

QUESTIONNAIRE

CANNED PEAS INDUSTRY

	1952	1953	1954
Number of cases (100 1/2 or equivalent) produced:			
Size 1/2			
Size 4/4			
Other sizes.....			
Total number of cases			
incl. cases of extra fine peas.			
Total number of man-hours			
(including warehouse staff and handling or labelling, but not including office staff, lorry drivers and labour used on the threshing machines).			

Do you handle:

 peas in pod only..... Yes - no
 shelled peas only Yes - no
 both types Yes - no

 If so what is the approximate percentage of shelled peas:

If any of the above information cannot be supplied, please state the reasons:

.....
.....

4. STUDY OF THE STATISTISCHES BUNDESAMT
ON THE STRUCTURE OF COSTS IN THE BUILDING INDUSTRY

Covering letter

STATISTISCHES BUNDESAMT

DIVISION II

WIESBADEN - BIEBRICH
RHEINSTRASSE

Wiesbaden, 5th March, 1954

Subject : ENQUIRY INTO COST STRUCTURE IN THE BUILDING INDUSTRY

Gentlemen,

For international negotiations (e.g. on the German contribution to common defence) and in fixing the economic policy of Government and non-governmental bodies, it is necessary to know exactly the output and the potential contribution of our country's economy. But this cannot be obtained without an exact evaluation of national income.

The Census Act of 27th July 1950 therefore laid down that there should be enquiries into cost structures in every business sector. The scheme was elaborated with the help of the Federation of German Industries, and studies have already been made in the major economic sectors.

For the building industry, the original plan was simply to use data already available but their inadequacy has shown the need for making a direct survey.

The consequent delay has led to the decision to collect data concerning 1952, and not 1950 as in the other sectors.

The resulting table would be incomplete if we learnt only the cost price and receipts corresponding to the whole of the firm's activity.

You are, therefore, requested, please, to reply to the additional questions given on page 6, insofar, of course, as your accounting records allow.

We fully realise the additional work which we are imposing upon you, but this is indispensable if the results obtained are not to be too sparse.

You are requested to complete two copies of the questionnaire, following carefully the attached instructions.

You should then :

within three weeks

return one copy to the Statistisches Bundesamt, Division II, Wiesbaden-Biebrich, Rheinstrasse 25. The second copy is for your own records.

When the study has been completed, you may obtain a copy of the results, which will take the form of averages.

The Census Act lays down that the figures you provide shall be kept strictly confidential. In order to guarantee your anonymity, your questionnaire bears only a code number, and only the German Building Federation knows the connection between this number and your trade name. We are, therefore, unable to make any identification.

I am, Gentlemen,

Your obedient servant,

Dr. Schultz
Statistisches Bundesamt

Attached :

2 questionnaires

1 copy of instructions.

QUESTIONNAIRE

STATISTISCHES BUNDESAMT

Code No.

Division II

WIESBADEN BIEBRICH, Rheinstr. 25

THE GERMAN BUILDING INDUSTRY
CONFEDERATION

FRANKFURT-AM-MAIN

Platz der Republik, 38

STUDY OF STRUCTURE OF COSTS

carried out under the 1950 Census Law (BGBl, 1950, p. 335).

BUILDING INDUSTRY

Enquiry for the year 1952

- Before filling in the questionnaire, you are requested to read carefully

the attached "instructions"

- Do not forget to refer to the notes in the questionnaire.
- The enquiry year is the financial year 1952.
- Figures should be rounded off to the nearest Deutsche Mark.
- Nil returns should be shown by a dash in brackets (-).
- As required by the law, all information given will be kept secret and will be used only for statistical purposes.

I. GENERAL QUESTIONS

1. Period ⁽¹⁾ from to
2. Activity of firm
(Show the main and subsidiary activities of the firm. Underline the main activity, e.g. construction and manufacture of concreting the equipment).
3. Legal status of firm:
Private ownership - limited liability company - joint stock company - private company.
Other:
(Underline status of firm or write in full).
4. Number of employees:
a) On 31.8.1950 (manpower census day ⁽²⁾)

(1) If the calendar year and the financial year are not the same, take the financial year ending in 1952.

(2) Including owners and members of their families actively engaged in the work of the firm.

b) Average for the financial year 1952:

	NUMBER OF EMPLOYEES
(1) Owners or partners working in the firm...	
(2) Members of their families working in the firm	
(3) Salaried staff.....	
(4) Operatives (including chargehands and foremen).....	
(5) On probation	
(6) Apprentices	
(7) Total.....	

5. Number of hours worked during the financial year 1952.

II. BALANCE SHEET HEADINGS

(not including sub-contractors) (as shown in tax returns)	BALANCE SHEET FOR	
	1951	1952
(1) Raw materials and equipment		
(a) Raw materials and supplies ...		
(b) Goods for re-sale.....		
(2) Building jobs in hand (insofar as no settlement has yet been effected) and equipment built by the firm, under construction or in stock ⁽³⁾ ...		
(3) Claims on customers for finished jobs		

III. RECEIPTS

1. Total taxable turnover as shown in land revenue returns.

DM*

Calendar year 1949

 1950

 1951

 1952

2. Does the turnover represent actual receipts or those estimated in contracts?

3. Value of jobs and sales effected in 1952 ⁽⁴⁾ DM* DM*
(neglecting actual receipts).....

(a) Total receipts (including work done by the firm for its own requirements) arising out of the activity of the firm itself, not including sub-contractors

* Figures should be given to the nearest DM.

(3) Jobs for the firm's own needs should be valued at cost price.

(4) Building jobs or manufactures to cover the firm's own needs. They should be estimated at actual cost.

(aa)	Total for jobs and deliveries (including turnover tax)	DM*	DM*
(bb)	Jobs in hand for customers and for the firm itself, where not included in (aa) (corresponding to work done between 1/1 and 31/12/1952)		
(b)	Receipts from activity of sub-contractors (including jobs in hand)		
(c)	Trading receipts (sale of finished products)		
(d)	Other receipts (e.g. architect's fees, valuations, supervision of sub-contractors, hire of plant, etc.)		
(e)	Construction of premises for the firm itself ⁽⁴⁾		
Total (a) to (e)			

IV. EXPENDITURE FOR THE FINANCIAL YEAR 1952

	DM*	DM*
A. Expenditure resulting from the activity of the firm itself		
1. Raw materials and supplies		
(a) Raw materials		
(b) Scaffolding, stays and miscellaneous accessories		
(c) Power (coal, electricity, petrol, etc.)		
(d) Other supplies (at purchase price)		
2. Work done by outside firms		
(a) Jobs done by outside firms		
(b) Repairs by outside firms		
3. Wages and salaries ⁽⁵⁾		
(Gross wages and salaries paid in cash and kind, i.e. without deduction of taxes and social insurance and welfare contributions paid on behalf of employees, but not including employers' contribution)		
(a) Wages of operatives including chargehands and foremen		
(b) Salaries		
(c) Costs assignable to wages and salaries		

* Figures should be given to the nearest DM.

- (4) Building jobs or manufactures to cover the firm's own needs. They should be estimated at actual cost.
(5) Not including remuneration of owners, partners and members of the family actively employed in the firm unless they are wage-earners, but including wages paid on public holidays and other days on which work is suspended.

	DM*	DM*
4. Social insurance and welfare contributions		
(a) Compulsory ⁽⁶⁾		
(b) Voluntary ⁽⁷⁾		
5. Salary of head of firm and remuneration of members of his family working in the firm ⁽⁸⁾		
(a) Salary of head of firm		
(b) Total remuneration of activity of members of the family working in the firm, where these are neither wage-earners nor apprentices .. (Companies need not answer this question)		
6. Business taxes (excluding personal taxes but including turnover tax and various contributions to public bodies) including capital tax		
7. Insurance premiums (covering risks due to the operation of the firm, etc.). Insurance of land work premises is not included		
8. Rent or rental value		
(a) Rent of workshops, storehouses, land, etc.		
(b) Rental value ⁽¹⁰⁾ of workshops, storehouses, land, etc., belonging to the firm		
9. Hire of mechanical plant		
10. Hire of equipment		
11. Depreciation ⁽¹¹⁾		
(a) Machines, mechanical plant, vehicles, etc. excluding buildings including depreciation of temporary strengthening equipment DM		
(b) Claims in respect of deliveries of goods and services		
12. Interest on loan capital (not including interest on mortgages on annual payments to offset the acquisition of land)		

* Figures should be given to the nearest DM.

- (6) Employer's contribution to social insurance, industrial accident, insurance and rehabilitation of the severely injured.
- (7) e.g. payments to mutual aid or family aid funds, Christmas boxes, canteen subsidies, etc.
- (9) These payments should be calculated with reference to wages which would be received by employees doing the same jobs.
- (10) Rental value to be calculated with reference to current prices of similar premises.
- (11) Depreciation allowed for taxation purposes.

13. Miscellaneous expenditure not included under IV 1 to IV 12 (transport of equipment (12) , travel of staff and management, surveying, correspondence, office equipment, telephones, telegrams, miscellaneous experts, bank charges, cleaning of premises, watchmen, miscellaneous overheads, extraordinary expenses, etc.)	DM*	DM*	
Total A.			
B. Payment of sub-contractors			
TOTAL A + B			

(12) Where not applicable to materials and supplies and not included under that heading.

Enquiry on structure of costs 1952 Code Number: Z

BUILDING INDUSTRY

Supplementary questionnaire

concerning the combined activity of the firm and sub-contractors.

You should enter here the total receipts and expenditure for the financial year 1952 (including jobs let out on contract). Do not confine yourself, as in the main questionnaire, to figures relating only to the activity of the firm proper.

	DM
I. Receipts arising from all your activity, including jobs not yet completed	
II. Average number of employees including salaried staff	
III. Total hours actually worked (operatives only)	
IV. Expenditure	
1. Materials used	
2. Jobs done by outside firms.....	
3. (a) Wages.....	
(b) Salaries	
4. Social insurance and welfare	
5. Taxes	
6. Depreciation of equipment belonging to firm	
7. Other expenditure.....	

ENQUIRY INTO COST STRUCTURE IN THE BUILDING INDUSTRY

Instructions for completing the questionnaire

PRELIMINARY REMARKS

The enquiry into cost structure is being carried out under the terms of the Census Act of 1950. It includes a study of costs in every important sector of the economy and its essential object is to establish the basic elements required for calculating national income.

Information given in the questionnaire will, under law, be kept strictly confidential. No individual piece of information will be published or communicated to any person whatsoever.

You should neither sign nor give the name of your firm. The numbering system gives every guarantee that your anonymity will be respected.

The questionnaire was based on the standard accounting system for the building industry. Firms using a different system should be particularly careful in their replies.

If exact figures are not available, firms may give estimates, provided that these are carefully made.

I. GENERAL QUESTIONS

1. QUESTION I, 2

The enquiry applies to the whole business, including sub-contractors, registered office and workshops.

2. QUESTION I, 4

Include under personnel, any employees temporarily absent, on leave or sick. Count part-time workers as though they were employed full-time.

The average personnel figure is obtained by adding together the figures at the end of each month of the year and dividing by 12.

3. QUESTION I, 5

Labour hours mean hours actually worked and not hours paid. They cover all the personnel, including apprentices, but excluding office workers and the owners of the firm.

Firms working several shifts should give the overall figure for hours worked, including overtime.

In case of stoppages of work for any cause whatsoever (holidays, sickness, breakdown, lack of raw materials or driving power, accidents, strikes, etc.) labour hours should not be counted, even if paid.

II. ACCOUNTING ITEMS

4. QUESTION II, 1

Estimates should be based on cost: i. e. cost price including expenses (freight, land transport, Customs duties, etc.), but subtracting rebates and miscellaneous reductions except payments on account.

III. RECEIPTS

5. QUESTION III, 1

For taxable turnover, the period to be considered is the calendar year. This question is included so that the results obtained may be aligned with figures from the labour census and from taxation statistics.

Please indicate whether the basis is actual income or income provided for in contracts.

6. QUESTION III, 2b

Mention here receipts relating to work done by sub-contractors, if any.

Firms associated or co-operating under contract should not be considered as sub-contractors, and the accounts should be quite separate.

Receipts for work done abroad should also be excluded.

7. QUESTION III, 2e

This heading includes constructions built by the firm during 1952 for its own needs, excluding supplies from outside. Depreciation should not be taken into account.

IV. EXPENSES

Costs should be taken to mean expenses incurred, not payments made, during 1952. Neither payments for expenses incurred during the previous 12 months nor payments in advance should therefore be included.

This applies particularly to Items 5 (overheads), 6 (sites stores and workshops) and 7 (plan for accounts for the building industry). The cost of renting materials and premises will be taken from Item 7.

Firms may use whatever method they choose, to obtain the figures requested. Present statutory provisions require, however, that accounts be kept, so that in certain cases (particularly for wages, salaries and welfare charges) information may be obtained directly.

8. QUESTION IV-A 1

Raw materials consumed mean all materials and supplies bought from outside: building materials, parts, finished products, lime, cement, sand, equipment, etc.

The cost of these should be calculated by adding together the figures for all purchases between the first and last days of the year, as defined in the reply to Question II, 1.

9. QUESTION IV-A 2a

This concerns payment for work and services by outside firms. It excludes payments to sub-contractors working for and on behalf of the main contractor which are, in fact, running expenses. Accounts relating to outside firms should be dealt with separately as was done for receipts.

10. QUESTION IV-A 3

Wages and salaries should include fixed additional charges (e.g. marriage or family allowance). Salaries should include, if appropriate, profit-sharing and payments in advance.

11. QUESTION IV-A 3c

Wage and salary costs include severance allowances and fixed allowances for transport between home and work.

12. QUESTION IV-A 4

This heading should not include payments for days or hours not worked (public holidays, sickness, marriage, meetings organised by the firm, etc.) as these were included under the heading "wages and salaries".

13. QUESTION IV-A 6

This heading should include only taxes and contributions payable by the business: taxes on wages, turnover, capital and motor vehicles, stamp registration and custom duties, road rates, etc.

The following should not be included: personal taxes, contribution to West Berlin assistance, emergency relief contribution, land-tax.

14. QUESTION IV-A 8b

Include here the rent of land and premises used by the firm, if necessary, estimated. Actual expenses (mortgage interest, land tax and other charges to be borne by the owner) are not to be taken into account.

15. QUESTION IV-A 11

Amortisations included in the balance-sheet (account No. 28 of the plan of account) are to be considered insofar as they apply to installations used for the firm's business. Amortisation of land and premises should be excluded as it will have been replaced by a fixed rent given at IV-A 8b.

16. QUESTION IV-A 12

Interest on loan capital should not include mortgage interest, nor life annuities agreed against use of land.

17. QUESTION IV-B

Expenses to be included here are for work contracted out. They correspond to the receipts given under III-2 B.

If the difference between total expenses (Question IV-A and B) and total receipts (Question III-A to 2e) does not correspond to actual profit or loss, the errors should be sought out and eliminated.

Annex IV

CHIEF FEATURES OF THE MAIN EUROPEAN STUDIES BY INDUSTRY

List of the studies included in the annex

Boot and shoe industry

- I. Western Germany
- II. Denmark
- III. France
- IV. United Kingdom
- V and VI. Norway
- VII. The Netherlands
- VIII. Italy

Cotton spinning industry

- I. Austria
- II. France
- III and IV. United Kingdom

Wool spinning industry

Norway

Shirt-making industry

- I. Denmark
- II. The Netherlands

Workmen's clothing industry

- I. France
- II. The Netherlands

Foundry industry

- I. Belgium
- II. France
- III. The Netherlands

Drop forges

Western Germany

Handtools industry

Western Germany

Bicycle industry

The Netherlands

Brickmaking industry	
I.	Norway
II.	The Netherlands
Building industry	
	United Kingdom
Tyre retreading industry	
	The Netherlands
Tanning industry	
	The Netherlands
Cigar industry	
	The Netherlands
Flour milling industry	
	France
Vegetable canning industry	
	France
Fish canning industry	
	France
Sawn softwood industry	
	France
Paper industry	
	France
Cost structure studies (industry, trade, hotels, and professions)	
	Western Germany
Trend of the productivity in single plants	
	Italy

BOOT AND SHOE INDUSTRY I

Country: Western Germany

**Survey carried out in 1953
by the Rationalisierung Kuratorium der Deutschen Wirtschaft**

Number of factories studied: 10.

The sample is representative of various models of shoes made in the Palatinate and the Rhineland provinces.

Survey period: First quarter 1953.

The survey was carried out once only.

Production unit: One pair of shoes of any model (no equivalence coefficient was used.)

Labour unit: Eight-hour day.

Chief factors studied:

Average production per man-day (including office staff) for the factory as a whole and for each department:

- Cutting;
- Stitching;
- Preparing;
- Assembling;
- Finishing and packaging.

- Use of made machinery;
- Floor-space per worker;
- Proportion of workers paid at piece rates;
- Turnover per employee.

Collection of data:

Investigators visited the factories and analysed the methods used in the various operations of the production cycle.

They then checked the data extracted from documentary material available in the firm (work-sheets, paysheets, etc.).

Presentation and interpretation of data:

The results are given in a widely circulated report. Separate figures are given for each factory.

The report contains details of methods of work; in addition, suggestions are made for possible improvements in each case. No target was fixed.

Bibliography

Schuh Industrie - Studie aus 10 Betriebe - Kurtz.
Untersuchungen in Land Rheinland Pfalz.
Rationalisierung Kuratorium der Deutschen Wirtschaft, Frankfurt
am Main, 1954.

Production measurements in the European boot and shoe industry
(Report on the Brussels Conference).
European Productivity Agency, July 1954.

BOOT AND SHOE INDUSTRY II

Country: Denmark

(Type Goodyear)

**Survey carried out in 1952
by the Handels Ministeriets Produktivitets Udvalg***

Number of factories studied: 7 factories producing models as comparable as possible.

Survey period: Third quarter 1951.

The survey was not repeated.

Production unit: One pair of standard shoes (equivalence coefficients based on piece rates were used).

Labour unit: Man-minute.

Chief factors studied:

Labour times for complete manufacture for each department:

**Cutting;
Stitching;
Preparing;
Assembling and finishing;
Packaging;**

and for each operation.

**Pattern of production;
Pattern of sales.**

Collection of data:

The investigators visited each factory. The data for each operation were either:

**Drawn from factory statistics, or
calculated from department times and piece rates.***

Presentation and interpretation of data:

The results are given in a widely circulated report. Separate figures are given for each factory. They are completed by detailed explanations and recommendations. No target was fixed.

Bibliography

Produktivitets undersøgelser inden for Skotojsindustrien Handelsministeriets Produktivitetsudvalg. Copenhagen, 1953.

* See pages 57, 99 and following.

BOOT AND SHOE INDUSTRY III

Country: France

Processes: Mock-welt and Goodyear

Survey carried out in 1952
by the Secrétariat Général du Comité National de la Productivité *

Number of factories studied: 9 for Goodyear footwear
9 for mock-welt footwear

The samples cover the main types of firm.

Survey period: 4 weeks of full employment (November-December 1951)

The survey was carried out only once.

Production unit: One pair of shoes.

No equivalence coefficient was used: the mock-welt and Goodyear types were studied separately.

Labour unit: Man-minute.

Chief factors studied:

- Labour times for total manufacture and for each department:

- Cutting;
- Stitching;
- Preparing;
- Assembling;
- Finishing and packaging;

and for each operation.

- Wage rates;
- System of remuneration;
- Use of floor-space;
- Consumption of raw materials;
- Production costs.

Collection of data:

The data were obtained by the investigators from actual records on the spot.

Times for each operation were calculated from department times and allotted times previously fixed.

Presentation and interpretation of data:

The report was openly circulated. Separate figures were published for each factory.

An indication was given of the type of equipment used and detailed information on work methods was supplied.

Targets based on the best times observed were fixed.

Bibliography

La Productivité en France dans l'industrie de la chaussure (procédé mixte et Goodyear). Secrétariat général du Comité National de la Productivité, Paris, 1952.

* See pages 74, 99 and following.

Schoenindustrie. Onderzoek Goodyear - Welt herenschoenen.
Internationale vergelijking.
Centraal Bureau voor de Statistiek, The Hague.

Cement Process

Survey carried out in 1954
by the Centre d'Etudes et de Mesures de Productivité *

Number of factories studied: 12.

Method followed: As for the mock-welt and Goodyear processes.

Bibliography

La Productivité en France dans l'industrie de la chaussure. (Procédé soudé). Centre d'Etudes et de Mesures de Productivité, Paris, 1954.

BOOT AND SHOE INDUSTRY IV

Country: United Kingdom

Various surveys have been carried out since 1948
by the Shoe and Allied Trade Research Association,**
covering different types of shoes (Goodyear walking shoes, sandals, etc.)

Number of factories studied: 6 to 12, representing all sizes of firms manufacturing fairly comparable articles.

Survey period: 4 weeks.

Production unit: One pair of standard shoes.

(Conversion coefficients based on piece rates were used to fix corresponding figures for the various models).

Labour unit: Man-minute; the times for young workers and trainees have been adjusted by a rating-down factor.

Chief factors studied:

- Labour times for a number of operations;**
- Average age of workers;**
- Wages;**
- Size of work-teams;**
- Floor-space in the workshop;**
- Wastage;**
- Labour costs;**
- Time taken by quality control.**

* See page 41.

** See pages 54, 99 and following.

Collection of data:

The schedules were drawn up by the investigators on the spot. It was often necessary to have labour accounts kept by the employees.

Presentation and interpretation of results:

The reports were circulated within the industry only. Separate figures were published for each factory.

A detailed analysis of working conditions was made for each job, stating the type of machine used. In addition, recommendations and observations were made to each firm covered by the enquiry.

A target was also proposed, based on the average results obtained by the three most efficient factories.

Bibliography

Productivity measurements in the European boot and shoe industry. (Report on the Brussels Conference). European Productivity Agency, July 1954.

Onderzoek Goodyear-welt herenschoenen Internationale vergelijking. Centraal Bureau voor de Statistiek, The Hague, 1953.

Cooper and Martin: The productivity of 12 Goodyear welt shoe factories. British Boot and Shoe Institution 4 (1950) 364.

Bailey, Martin and Murray: Productivity comparisons between 12 factories making women's shoes. Idem, page 407.

Bailey and Denton. Productivity survey of 12 closing-rooms - Men's shoes. British Boot and Shoe Institution 5 (1953), pages 11-20.

Bailey and Binders: Productivity comparisons between some factories making children's Weldtschoen footwear.

BOOT AND SHOE INDUSTRY V

Country: Norway

Survey carried out in 1951
by the Norwegian Committee for the Leather and Footwear Industries, Oslo

Number of factories studied: 52. (representative sample).

Survey period: One year.

The survey was not repeated.

Production unit: One pair of shoes.

(No equivalence coefficient was used).

Labour unit: One worker.

Chief factors studied:

Average number of pairs produced per worker;
Average value of production per worker;
Average value of equipment used by each worker;
Types of shoes produced per worker;
Characteristics of the factory buildings.

Collection of data: A questionnaire was sent to each factory by post.

Presentation and interpretation of results:

The results were given in an openly circulated report. The data published were average figures in all cases.

The figures were accompanied by comments on the causes of variations in productivity.

BOOT AND SHOE INDUSTRY VI

Country: Norway

Survey carried out in 1951
by the Produktjons teknisk forskning Institutt, Oslo

Number of factories studied: 5.

Survey period: No period was stipulated, times being determined by time-checking.

Production unit: One pair of men's shoes, size 43, of a specific model.

Labour unit: Man-minute.

Chief factors studied: Labour time for each operation in the stitching room.

Obtaining of data: Timing by specialised engineers.

Presentation and interpretation of results:

The results were communicated only to the factories taking part. Separate data were given for each factory.

The reasons for the differences observed were carefully analysed, and the methods by which the best results could be achieved in given circumstances were deduced from them.

In this way a target was fixed for each factory.

BOOT AND SHOE INDUSTRY VII

Country: Netherlands

Type: Goodyear

Survey carried out in 1952
by the Centraal Bureau voor de Statistiek *

Number of factories studied: 9.

The sample is roughly representative of the Goodyear footwear industry.

* See pages 69, 80, 99 and following.

Survey period: Sporadic observations made over two to four weeks in each factory in March and April. The survey was not repeated.

Production unit: One pair of shoes. (No equivalence coefficient was used).

Labour unit: Man-minute.

Chief factors studied: Labour times for 30 to 40 operations, according to the factory, performed in the assembling, finishing and packaging rooms.

Collection of data: The times were directly observed by the investigators, who spent two to four weeks in each factory.

Presentation and interpretation of results:

No job analysis was made. It was merely stated whether the work was performed by hand or by machinery.

In giving the time for each specific operation, the following were stated:

1. Confidence interval corresponding to the figure supplied.
2. Average variation in the observations made.
3. Duration of stoppages caused by the employee having to remain idle during the switch from one line of production to another.

The results were given in three openly circulated reports. Separate figures were published for each factory.

The figures were accompanied by some explanatory notes, but no recommendations were made.

No target was fixed.

Bibliography

Bedriffsvergelijkende meting van de productiviteit.

2 - Schoenindustrie Enkele voorlopige uitkomsten.

5 - Schoenindustrie Onderzoek Goodyear welt herenschoenen 1952.

7 - Schoenindustrie. Onderzoek Goodyear welt herenschoenen. Internationale vergelijking. Centraal Bureau voor de Statistiek, The Hague.

BOOT AND SHOE INDUSTRY VIII

Country: Italy

Survey data: Currently in progress (1955); being made by CNP (Comitato Nazionale de la Produttività) and ISTAT (Institute of Statistics) as a joint project.

Number of factories studied: 9.

The firms were selected on a basis to provide information on three quality levels, based on price determination of quality.

Survey period: Spring 1955. Seasonal peak period for shoe type selected; 4 to 8 week periods.

Production unit: Bal Oxford, black, without extra decorations. Goodyear welt.

Labour unit: Minutes per pair (or shoes per 8 hour day).

Chief factors studied:

Labour time for over 100 operations and for groups of operations
(departments defined uniformly for all plants);
Equipment used and floor space, plant layout;
Method of production scheduling;
Volume of output;
Method of wage payment.

Collection of data:

Investigators visited each factory and designed procedure to be followed by plant, based on the nature of plant records and method of production followed in each plant.

Data are to be derived from current study of time, special study made for this project by firm, or evaluated on basis of piece rates during period when production mix makes such procedure relatively safe.

COTTON-SPINNING INDUSTRY I

Country: Austria

Surveys carried out since 1950
by the Oesterreichisches Produktivitäts Zentrum *

Number of factories studied: 21.

Nearly all the Austrian spinning mills use mules.

Survey period: Six months.

The survey has been periodically repeated since the first half of 1950.

Production unit: 100 kg. of No. 20 yarn (English). (Equivalence coefficients were fixed according to count).

Labour unit: Man-hour.

Chief factors studied:

- Labour times in each department:

 - Preparation;
 - Spinning.

- Spindle output;

- Idle machine time and causes.

Collection of data:

For the first survey, the data were collected by the investigators themselves.

In some cases, labour times were obtained from individual work sheets or machine records.

Since 1951, data have been submitted directly by factories; additional details, if any, are supplied verbally.

Presentation and interpretation of results:

The results are given in reports circulated to the factories covered.

Only average figures are published. They are accompanied by explanatory notes on the variations observed.

A target was fixed on the basis of the four best results noted.

Bibliography

Betriebsvergleiche in den Oesterreichischen Baumwollenspinnereien auf Grund von Produktivitäts Kennzahlen.
Oesterreichisches Produktivitäts Zentrum. Vienna, 1951-1952-1953-1954.

Statistisches vierteljahres schrift. Band IV, 1951.

A.W. Klein - Produktivitätsmessung in der Baumwollspinnere-industrie.

* See pages 58, 113 and following.

COTTON-SPINNING INDUSTRY II

Country: France

Studies carried out since 1950
by the Productivity Centre of the French Cotton Industry*

Number of factories studied: 187, i.e. 65 per cent of all production units in the industry.

Duration of study: 4 weeks.

Production unit: 100 kg. of No. 40 yarn. Coefficients of equivalence were established, based on the gauge of the thread.

Manpower unit: 1 hour of work.

Principal elements studied: Man-hours for each stage of manufacture.

Man-hours for the preparation departments as a whole and for the spinning mill.

Average gross pay for each spinning mill.

Obtaining the data:

For the first study an investigator visited each of the participating spinning mills and noted both the man-hours entered in the pay-books and the output for each yarn number and quality.

Since 1953, most mills reply themselves to the questionnaire sent to them.

Presentation and interpretation of results:

The results are recorded under a reference number given to each mill and collected in a booklet reserved for the participating firms.

Bibliography

- "Enquête de productivité dans la filature de coton", March 1954.
- "Mesures de productivité en filature de coton".

COTTON-SPINNING INDUSTRY III

Country: United Kingdom

Surveys carried out from 1946 to 1949, and repeated from 1953 onwards,
by the British Cotton Industry Research Association**

Number of factories studied: 100.

All types of firms are represented.

Survey period: 4 weeks.

* See pages 113 and following.

** See pages 42, 85, 113 and following.

Production unit: 100 lb. of yarn.

(No equivalence coefficient was used. Each type of product was analysed separately).

Labour unit: Man-hour.

Chief factors studied:

Labour times for complete manufacture, in each department:

Preparation;

Spinning (ring frames and mules given separately);

and for each operation.

Collection of data:

The schedules were drawn up by teams of two or three investigators in each factory.

Actual plant records were used. Operating times for the machines were in many cases obtained from special records kept by the foremen.

Preparation and interpretation of results:

An analysis was made of the reasons for the differences observed between pairs of factories producing yarn of the same count, with the same machinery, but with different times.

A target was set by tracing the line corresponding to the quartile giving the best results.

Bibliography

Cotton-spinning. Anglo-American Council on Productivity, London, 1950.

Productivity measurements in the British industry - British Productivity Council, London, 1952.

L. H. C. Tippet and P. D. Vincent: Statistical investigations of labour productivity in cotton-spinning. Journal of the Royal Statistical Society, Series A., Vol. CXVI, Part III, March 1953.

L. H. C. Tippet: The study of industrial efficiency with special references to the cotton industry - Journal of the Royal Statistical Society 110 - 1947 - 108.

P. D. Vincent: Variations in the productivity between cotton-spinning mills - Journal of the Textile Institute 39 - 1948 - 407.

COTTON-SPINNING INDUSTRY IV

Country: United Kingdom

Surveys carried out in 1948 by the Cotton Board*

Number of factories studied: 114.

Roughly representative sample.

* See page 35.

Survey period: Week ending 6th May 1939, and week ending 8th November, 1947.

Production unit: 1 lb. of yarn.

Coefficients were used to convert yarn of different counts into yarn of standard count.

Labour unit: Man-hour.

Chief factors studied:

- Labour times for complete manufacture, and for each department;
- Preparation;
- Spinning (a distinction being made between mules and ring frames).

Collection of data:

A questionnaire was sent to each firm by post.

Presentation and interpretation of results:

- The results were openly circulated. Only average figures were given.
- Some comments were made on the progress of productivity.
- No target was fixed.

Bibliography

D.C. Shaw - Productivity in the cotton spinning industry - Manchester School 13-1950.

WOOL-SPINNING INDUSTRY

Country: Norway

Survey being carried out by the Institutt for Industrial Oekonomiks

Number of factories studied: 3.

Survey period: 4 weeks of full employment.

Production unit: 100 kg. of No. 10 yarn (Norwegian).

Conversion coefficients based on actual work-times were used for spinning operations.

Labour unit: Man-hour.

Chief factors studied:

- Labour times for complete manufacture and for each operation;
- Use made of machinery.

Collection of data:

The survey is being carried out by investigators on the spot.

SHIRT-MAKING INDUSTRY I

Country: Denmark

Survey carried out in 1952
by the Handelsministeriets Produktivitets Udvalg*

Number of factories studied: 6, producing sufficiently similar shirt models.

Survey period: First quarter 1952.

The survey was not repeated.

Production unit: One dozen shirts.

(No equivalence coefficient was used).

Labour unit: Man-hour.

Chief factors studied:

- Labour times for complete manufacture in each department:

 - Cutting;

 - Sewing;

 - Pressing and finishing;

- and for each operation.

- Quantities of raw materials used;

- Wastage.

Collection of data:

The investigator visited the factories. The data for each operation were either:

- drawn from the firm's statistics, or

- calculated from times for each department and from piece rates.

Presentation and interpretation of results

The results were given in an openly circulated report. Separate figures were given for each factory. They were completed by detailed explanations and recommendations.

No target was fixed.

Bibliography

Produktivitets undersøgelser inden for Skjorteindustrien.
Handelsministeriets Produktivitetsudvalg. Copenhagen 1953.

* See pages 93 and following.

SHIRT-MAKING INDUSTRY II

Country: The Netherlands

Surveys carried out since 1952
by the Centraal Bureau voor de Statistiek*

Number of factories studied: The sample is roughly representative.

Survey period: 3 months.

The survey has been periodically repeated since the first quarter of 1952.

Production unit: 1 standard shirt.

A standard model was taken, and corresponding figures for the other models manufactured were calculated by a firm of consulting engineers.

Labour unit: Man-minute.

Chief factors studied:

- Labour times for each workshop;
- Cutting;
- Sewing;
- Finishing, packaging, dispatch;
- Other services (including clerical).

Collection of data:

An investigator first visited each firm to study the quality of the data available on the spot and explain the way in which the questionnaire should be completed. The firm has since sent in the required information every quarter.

Presentation and interpretation of results:

The results were given in an openly circulated report; separate figures were published for each factory, accompanied by some explanation of the reasons for the differences observed (delays due to unsatisfactory working methods, over-slow rate of work, time lost).

No target was fixed.

Bibliography

Bedrijfs vergelijkende meting van de productiviteit.
- 3 Overhemdenindustrie, 1er 3e kwartal 1952.
- 4 Overhemdenindustrie, 4e kwartal 1952.
Centraal Bureau voor de Statistiek, The Hague, 1954.

* See pages 57, 93 and following.

WORKMEN'S CLOTHING INDUSTRY I

Country: France

Survey carried out in 1954
by the Centre d'Etudes et de Mesures de Productivité*

Number of factories studied: 13.

The sample includes all the main types of firm.

Survey period: One month in the second quarter of 1953.

Production unit: One jacket,
One pair of trousers.

No equivalence coefficient was used, each article being studied separately.

Labour unit: Man-minute.

Chief factors studied:

- Labour times for complete manufacture, for each department (sewing and finishing) and for each operation;
- Types of material used;
- Wages.

Collection of data:

The schedules were drawn up by investigators on the spot, from the firm's records.

Times for each operation were calculated from department times and pre-allotted times.

Presentation and interpretation of data:

The report was openly circulated. Separate figures were published for each firm.

The type of machinery used was stated. Detailed information was given on methods of work.

Targets were fixed on the basis of the best times observed.

Bibliography

La Productivité en France dans l'industrie du vêtement de travail.
Centre d'Etudes et de Mesures de Productivité, Paris, 1954.

WORKMEN'S CLOTHING INDUSTRY II

Country: The Netherlands

Survey now being carried out
by the Centraal Bureau voor de Statistiek

Number of factories studied: 20.

Survey period: 3 months. The survey is periodically repeated.

* See page 74.

Production unit: A standard model.

Corresponding figures for other types of clothing were calculated by a firm of consulting engineers. The results thus obtained were cross-checked against cost accounting data.

Labour unit: Man-minute.

Chief factors studied:

Labour times for complete manufacture and for each department.

Collection of data:

An investigator visited each factory to study the quality of the data available and explain the way in which the questionnaire should be completed. Information has since been supplied by post.

Presentation and interpretation of results:

The survey will form the subject of an openly circulated report.

Results are given for each factory. Comments on the figures are included, but no recommendation is made and no target is fixed.

FOUNDRY INDUSTRY I

Country: Belgium

Survey now being carried out by the
Institut de Recherches Economiques et Sociales, Université of Louvain*

Number of factories studied: 16.

Sample including firms of all sizes.

Survey period: One month (15th November - 15th December 1954).

Production unit: 1 ton of finished products.

Labour unit: Man-hour.

Chief factors studied:

Labour-times for complete manufacture and for each department:

Casting (direct labour - indirect labour);

Coring (direct labour - indirect labour);

Smelting;

Finishing (fettling, other operations).

Collection of data:

An investigator visits each factory to extract the available data from the firm's records, and sets up a standardised labour accounting system.

Presentation and interpretation of results:

The results will be openly circulated, together with comments and conclusions.

Bibliography

Rapport de méthode présenté au Groupe de Travail Fonderie de l'Office Belge pour l'Accroissement de la Productivité, Louvain, 1954.

La Productivité dans l'industrie belge de la fonderie. Université de Louvain, 1955.

FOUNDRY INDUSTRY II

Country: France

Studies carried out since 1952
by the Centre d'Etudes et de Mesures de Productivité**

Number of factories studied: 12.

Duration of study: 1 month. The study is repeated regularly.

Production unit: 1 kg. of metal. Coefficients of equivalence were established, based on the weight of the pieces.

* See page 74.

** See page 52.

Manpower unit: 1 hour of work.

Principal factors studied:

Man-hours per section of the foundry:

- Core-making;
- Trimming;
- Melting;
- Moulding;
- Sand plant;
- Chill moulding.

Obtaining the data:

The factories were visited during the first study. Data were later communicated by the firms themselves, who collected them as instructed by the measurement engineers.

Circulation of results:

The results were embodied in a report communicated only to the firms concerned.

FOUNDRY INDUSTRY III

Country: The Netherlands

Survey carried out since the third quarter of 1952
by the Centraal Bureau voor de Statistiek*

Number of factories studied: 26.

The sample covers all types of firms.

Survey period: 3 months. The survey has been periodically repeated since 1952.

Production unit: 1 ton of crude or finished products, as the case may be.

No equivalence coefficient was used, but the results were adjusted to take into account the pattern of production.

Labour unit: Man-hour.

Chief factors studied:

Labour times for complete manufacture, and for each department:

- Coring;
- Casting and smelting;
- Consumption of electricity;
- Use of surface area;
- Material use performance.

Collection of data:

For the first survey, the investigators visited each factory to explain how the questionnaires should be completed. Information has since been supplied by post.

* See page 44.

Presentation and interpretation of data:

The report was openly distributed. Separate figures were given for each factory.

Comments on the data were included. No recommendations were made, however, and no target was fixed.

Bibliography

Bedrijfsvergelijkende meting van de Produktiviteit.

8 - Ijzergietirijen - Onderzoek ijzergietirijen

3e en 4e kwartal 1952, 1e en 2e kwartal 1953.

Centraal Bureau voor de Statistiek, The Hague, 1954.

DROP FORGES INDUSTRY

Country: Western Germany

**Survey carried out in 1953
by the Rationalisierung Kuratorium der Deutschen Wirtschaft**

Number of factories studied: 11.

The sample is largely representative.

Survey period: Year 1951 for most data (one month of 1952 for others).

Production unit: One ton of raw materials, or one ton of finished products.

No equivalence coefficient was used, but a distinction was made between light, medium and heavy pieces.

Labour unit: Man-month.

Chief factors studied:

- Average output per worker (total employed and foundrymen);**
- Power consumption;**
- Machinery output;**
- Materials use performance;**
- Factor cost;**
- Collection of data.**

An investigator visited each factory, mainly to analyse and check the records available.

Presentation and interpretation of results:

The results were given in an openly circulated report. Separate figures were published for each factory. Much advice is included on methods of increasing productivity, together with two practical examples of work simplification.

No target was fixed.

Bibliography

**Gesensschmieden - Studie aus 11 Betriebs-Kurz Untersuchungen.
Rationalisierung Kuratorium der Deutschen Wirtschaft.
Frankfurt on Main, 1954.**

HAND TOOLS INDUSTRY

Country: Western Germany

**Survey carried out in 1953 and 1954
by the Forschungs Institut für Rationalisierung, Aachen ***

Number of factories studied: 24.

The sample is representative of the industry.

Production unit: Hand wrench.

No equivalence coefficient was used. Each type of wrench was studied separately.

Labour unit: Man-minute.

Chief factors studied:

Labour times for each workshop and for certain operations.

Collection of data:

Investigators visited the factories and analysed the methods used in the various operations of the production cycle.

Times were taken from the job cards normally kept for each operation. In addition, operations were usually timed, either as a check, or to fill in gaps in the information available.

Presentation and interpretation of data:

The results were given in an openly circulated report. Separate figures were published for each factory.

Methods of work were thoroughly analysed, and are described in detail to facilitate the interpretation of the data.

A target corresponding to the best time recorded was fixed for each operation.

* See page 44.

BICYCLE INDUSTRY

Country: The Netherlands

**Survey now being carried out
by the Centraal Bureau voor de Statistiek***

Number of factories studied: 12.

Survey period: Three months. The survey is repeated periodically.

Production unit: 1 bicycle (no equivalence coefficient was used).

Labour unit: Man-minute.

Chief factors studied: Labour-times for each department.

Collection of data:

An investigator visits each firm to study the quality of the data and explain the way in which the questionnaire should be completed. He also introduces a standardised labour accounting system.

Information is subsequently supplied by post.

Presentation and interpretation of results:

The survey will form the subject of an openly-circulated report; results will be given for each firm. Comments on the figures are included, but no recommendations are made and no target is fixed.

* See page 74.

BRICKMAKING INDUSTRY I

Country: Norway

**Survey carried out in 1952 and 1953
by the Institutt for Industrial Økonomisk - Trondheim**

Number of factories studied: 2. (This was a pilot study.)

Survey period: 8 weeks of full activity.

Production unit: "Norsk Standard" brick.

Equivalence coefficients were calculated from the actual labour times for this type of brick and the tiles and piping also made by the factories.

Labour unit: Man-hour.

Chief factors studied:

Labour-times for each department.

Dividing line between indirect work which varies with production and indirect work which does not vary with production.

Collection of data:

An investigator analysed the production cycle in each factory and drew up most of the data from the firm's records. Some labour times were worked out by time study.

Presentation and interpretation of results:

The results were given in openly circulated reports. Separate figures were given for each factory.

The figures are accompanied by detailed comments, but no recommendations were made and no targets were fixed.

Bibliography

**Productivitets undersøgelser Teglwerksindustrien.
Institutt for Industrial Økonomisk - Trondheim 1952.
(2 volumes with summary in English).**

**Productivitets undersøgelser i Teglwerksindustrien.
Samendrag av hoverapporten.
Institutt for Industrial Økonomisk - Trondheim, 1953.**

BRICKMAKING INDUSTRY II

Country: The Netherlands

**Study carried out in 1952
by the Centraal Bureau voor de Statistiek***

Number of brickworks studied: 145.

The sample was approximately representative.

* See pages 25 and 32.

Survey period: One year (calendar year 1951).

The study was carried out once only.

Unit of production: One million bricks.

(No coefficient of equivalence was used. Each type of product was analysed separately).

Unit of labour: Man-day.

Principal elements studied: Labour time by departments:

- Quarrying of clay;
- Moulding;
- Drying;
- Baking;
- Stocking;
- Despatch;
- Indirect work according to manufacturing processes;
- Specific consumption of solid fuels;
- Comparison of financial returns on operation.

Collection of data:

One investigator visited each brick plant; he collected the necessary data from the firm's own records.

Presentation and interpretation of data:

The study was the subject of an openly distributed report.

The results were applied to each brick plant. They were regrouped for each batch of operations according to types of products and manufacturing processes.

Bibliography

"Bedrijfs vergelijkende meting van de productiviteit".

- 6 Baksteenindustrie, 1951 - Centraal Bureau voor de Statistiek - The Hague.

BUILDING INDUSTRY

Country: Great Britain

Survey carried out in 1952 and 1953
by the Building Research Station*

Number of contracts studied: 177.

The sample is representative of small detached brick houses with three bedrooms, over the period considered.

Survey period: October 1947 to March 1951.

The survey was carried out once only.

Production unit: One house.

Labour unit: Man-hour (including stoppages of any length due to bad weather).

Chief factors studied:

Labour times and labour costs for each trade:

Masons	Painters
Bricklayers (skilled)	Glaziers
Carpenters	Electricians
Plasterers	Gas-fitters
Plumbers	Floor-layers

Collection of data:

The information was collected by a team of investigators from the contractor, sub-contractors and customers. The data were taken from pay-rolls while house descriptions were taken from estimates and plans.

Working conditions were not observed as the contracts had already been completed.

Presentation and interpretation of results:

The results were given in an openly circulated report.

Average figures only were published.

An analysis was made according to:

1. Size and type of building;
2. Proportion of work carried out by sub-contractors;
3. System of remuneration;
4. Amount of supervision by the chief contractor;
5. Contractor's professional experience;
6. Size of contract;
7. Date of construction;
8. District.

Certain conclusions were drawn concerning possible improvements.

Bibliography

- National Building Studies - Special report No. 21.
Productivity in House Building.
The Builder.
Journal of the Royal Statistical Society (in preparation).

* See pages 24 and 71.

TYRE RETREADING INDUSTRY

Country: The Netherlands

**Survey carried out in 1954
by the Centraal Bureau voor de Statistiek***

Number of factories studied: 12.

Survey period: Three months. The study is repeated at regular intervals.

Unit of production: One tyre. Coefficients of equivalence were adopted so as to be able to express production in terms of standard units.

Unit of work time: One minute of work.

Main factors studied:

- Work time for each operation and for the whole manufacturing process;
- Work time of office staff;
- Material consumption;
- Use of machinery.

Compilation of data:

Investigators visited each factory to study the available documentation and explain how the questionnaire ought to be filled in. Lay-out and interpretation of the data.

The results are published in an openly circulated report. Separate data are given for each factory. A detailed study is thus made of each process and also, in certain cases, of the relations between man-hours and machine-hours.

Bibliography

Loopvlagvernieuwingsbedrijven - 2° en 3° kwartal 1954.
Centraal Bureau voor de Statistiek - The Hague, 1955.

* See page 135.

TANNING INDUSTRY

Country: The Netherlands

**Survey now being carried out
by the Centraal Bureau voor de Statistiek**

Survey period: Three months. The survey is repeated periodically.

Production unit: One hide (a distinction being made between leather for uppers, sole leather and other types of leather). For finishing operations, equivalence coefficients based on the quality of the leather were used.

Labour unit: Man-day.

Chief factors studied:

Times for complete manufacture and for each department:

**Cleaning;
Tanning;
Finishing.**

Collection of data:

An investigator visits each firm to study the quality of the data available and explain the way in which the questionnaire should be completed. The information is subsequently supplied by post.

Presentation and interpretation of results:

The survey will form the subject of an openly circulated report. Results are given for each factory. Comments on the figures are included but no recommendations are made, and no target is fixed.

CIGAR INDUSTRY

Country: The Netherlands

**Survey now being carried out
by the Centraal Bureau voor de Statistiek***

Number of factories studied: 18.

Survey period: 3 months. The survey is repeated periodically.

Production unit:

1 kg. of tobacco for operations with loose tobacco.

1 cigar for other operations. (In this case, equivalence coefficients based on agreed rates of pay were used).

Labour unit: Man-minute.

Chief factors studied:

Labour times for complete manufacture and for each department.

Collection of data:

An investigator visits each firm to study the quality of the data available and explain the way in which the questionnaire should be completed.

Information is subsequently supplied by post.

Presentation and interpretation of results:

The survey will form the subject of an openly circulated report. Results are given for each factory. Comments on the figures are included, but no recommendations are made and no target is fixed.

* See page 45

FLOUR-MILLING INDUSTRY

Country: France

**Surveys carried out in 1954-55
by the Centre d'Etudes et de Mesures de Productivité
(Productivity Research and Measurement Centre)**

Number of mills studied: 4.

Survey period: 1 year.

Production unit: One quintal of wheat (100 kg.).

No coefficient of conversion was used.

Labour unit: 1 man-hour.

Chief factors studied:

Labour work times in each section:

- Milling, bagging and warehousing;**
- Maintenance of buildings and machinery;**
- Office work;**
- Costs of labour;**
- Costs of power;**
- Costs of raw materials;**
- Cost of each other cost price factor.**

Obtaining of data:

The investigators visited each factory, where they were able to consult all the documentary material available: pay-sheets, incoming and outgoing invoices, insurance contracts, stock records, etc. They were thus able to classify the data in exact conformity with the agreed definitions, and standardise methods of calculating depreciation. Some variable factors which did not seem to affect the level of productivity were abstracted and compared separately.

Presentation and interpretation of data:

The data were presented separately for each mill.

No recommendations were made; a plan for the standardisation of selling price factors is, however, attached by way of conclusion.

A report has been published and openly circulated.

Bibliography

La Productivité dans l'industrie française de la meunerie. Centre d'Etudes et de Mesures de Productivité, Paris, 1955.

VEGETABLE CANNING INDUSTRY

Country: France

Surveys carried out in 1953 and 1954
by the Centre d'Etudes et de Mesures de Productivité *

a) CANNED PEAS

Number of factories studied: 8.

Survey period: Three weeks of full activity.

The survey was not repeated.

Production unit:

For pre-canning operations, one ton of raw materials.

For canning and subsequent operations: 100 cans.

No equivalence coefficient was used, each size of can being studied separately.

Labour unit: Man-minute.

Chief factors studied:

Labour times for complete manufacture and for 12-15 operations, according to factory.

Use of made machinery;

Materials use performance;

Use of floor space.

Collection of data:

An investigator visited each factory. Part of the data was obtained from the firm's records.

This was supplemented by:

1. A labour accounting system introduced by the investigator;
2. Direct observations in the various departments (determination of machine output, summary work study).

Presentation and interpretation of results:

The results were given in an openly circulated report.

Separate figures were published for each factory. They are accompanied by explanatory notes on the reasons for the differences observed.

A target was fixed for each operation.

Bibliography

La Productivité dans la conserve des petits pois.

Centre d'Etudes et de Mesures de Productivité, Paris, 1954.

* See pages 35, 39, 44, 72.

b) CANNED MUSHROOMS*
(Pilot enquiry)

Number of factories studied: 4.

Survey period: 2 weeks in January - February 1953.

Method: As for canned peas industry.

Bibliography

La Productivité dans l'industrie de la conserve de champignons.
Centre d'Etudes et de Mesures de Productivité, Paris, 1954.

* See page 35.

FISH CANNING INDUSTRY

Country: France

**Survey carried out in 1953 and 1954
by the Centre d'Etudes et de Mesures de Productivité***

a) SARDINES

Number of factories studied: 14.

Roughly representative sample.

Survey period: 3 weeks of full activity.

The survey was not repeated.

**Production unit: 100 sardines
1 kg. of fish
100 cans**

according to the operation (no equivalence coefficient was used).

Chief factors studied:

Labour times for seven operations:

**Heading;
Laying out;
Brining;
Cooking;
Filling;
Oiling;
Sealing.**

Use made of machinery.

Collection of data:

An investigator visited each factory, to extract the data available in the firm's records, introduce a simplified labour accounting system and make certain direct observations (machine performance, labour times for female workers).

Presentation and interpretation of results:

The results were given in an openly circulated report. Data are supplied for each separate factory.

Explanatory notes on the variations are given. A number of recommendations were made, and a target was fixed in each case.

Bibliography

**La Productivité en France dans l'industrie de la conserve - 4 -
Conserves de sardines. Centre d'Etudes et de Mesures de Productivité.**

* See page 45.

**Pilot survey carried out in 1953
by the Centre d'Etudes et de Mesures de Productivité**

b) MACKEREL

Number of factories studied: 6.

Roughly representative sample.

Survey period: Three weeks of full activity.

The survey was not repeated.

**Production unit: 1 kg. of fish
1/4 club can (187 c.c.)**

(Conversion coefficients were used).

Labour unit: Man-minute.

Chief factors studied:

Labour times for seven operations:

**Heading;
Laying out;
Brining;
Cooking;
Filling;
Oiling;
Sealing.**

Collection of data, presentation and interpretation of results:

See sardine survey.

Bibliography

La Productivité en France dans l'industrie de la conserve de poissons. III. Conserves de maquereaux. Centre d'Etudes et de Mesures de Productivité. Paris, 1954.

SAWN SOFTWOOD INDUSTRY

Country: France

**Survey carried out in 1954
by the Centre d'Etudes et de Mesures de Productivité**

Number of factories studied: 8.

Survey period: One year or 2 weeks, according to the data.

**Production unit: 1 cu. m. of log for times in each department of
the firm.
1 m.(linear) of log for individual sawing operations.**

Labour unit: Man-minute.

Chief factors studied:

- Labour times for each department:

Timber yard;

Actual sawmill;

Sawn timber yard;

and for each operation (frame-sawing, trimming, cutting-up).

- Use made of machinery;

- Surface area;

- Costs.

Collection of data:

Investigators visited each factory to extract information on department times from the records available. Data on individual operations were obtained by the introduction of work-charts, which were filled in over a period of two weeks. Machine output was measured directly.

Presentation and interpretation of data:

The results were given in an openly circulated report. Separate figures are published for each factory.

The type of machinery used was stated. Details of work methods were given.

Targets based on the best times observed were fixed.

Bibliography

**La Productivité en France dans l'industrie des sciages résineux.
Centre d'Etudes et de Mesures de Productivité, Paris, 1954.**

PAPER INDUSTRY

Country: France

Studies carried out in 1952
by the Service Productivité de la Fédération des Syndicats
de Producteurs de Papiers, Cartons et Cellulose

Number of factories studied: 24.

The 24 factories were divided into 7 groups according to the kind of material manufactured, namely:

Manilla rose paper.....	3 factories
Glazed sulphite, cellulose and phormium papers....	3 factories
Printing and writing paper 1/2 to 3/2.....	3 factories
Printing and writing paper Afnor IV.....	3 factories
Printing and writing paper V/1 to VII/1.....	6 factories
Yellow straw pulp.....	3 factories
Paper for corrugated card or spools for the spinning industry and brown paper under 224 g.	3 factories

Study period: 4th quarter 1951.

Unit of production: Ton of paper.

Unit of labour: Hour's work.

Principal factors studied:

- Labour time for complete manufacture and for sorting operations;
- Power consumption;
- Use of machinery.

Method of obtaining facts:

Investigators visited each factory and inspected the workshops; they completed questionnaires from available records.

Presentation and interpretation of results:

A report on the study was distributed by the Fédération des Producteurs de Papier, Cartons et Cellulose. The results apply to each factory and the figures are accompanied by comments.

COST STRUCTURE STUDIES
(Industry, Trade, Hotels and Professions)

Country: Western Germany

Surveys carried out by the Statistisches Bundesamt since 1950*

Number of firms studied: 43,000.

Representative sample.

Survey period: Year 1950.

Production unit: Selling price.

**Labour unit: Man-hour
Costs**

(for other factors, costs only).

Chief factors studied:

- Labour times (for complete manufacture);
- Labour costs;
- Raw material costs;
- Other supply costs;
- Power costs.

Collection of data:

A questionnaire was sent to the various firms by post.

Presentation and interpretation of data:

The results will be given in a number of publications; some comments will be included on the figures applied.

Bibliography

**Dr. H. Bartels: Das program der Kostenstrukturerhebung 1950.
Wirtschaft und Statistik 3 Jg. N.F. Heft 10. October 1951.**

* See page 22.

TREND OF PRODUCTIVITY IN SINGLE PLANTS

Country: Italy

These studies done with the help of the National Productivity Board (CNP) measure changes over time and are not interplant comparisons.

They are strictly confidential and not for distribution.

Types of establishments:

Textiles: spinning and weaving of cotton; weaving of wool.

Wood and paper: textile industry accessories.

Metal working: electrical controls, motorcycles and accessories, grain mill machinery (for order), agricultural equipment, pharmaceuticals, machine tools, dying equipment and accessories.

Survey period: Seasonal periods or semi-annual periods for a total time period of two or three years.

Production unit: Defined individually for each plant; finished items, groups of related items, sub-parts and departments.

Study based on time study records for periods covered or use of conversion factors based on labour time or related cost factor.

Other material studies: Various, but not conclusively or systematically in all plants in the same way.

Collection of data: Investigator, after study of plant operations and characteristics of accounting records available during the full period of study, outlined procedure to be followed by each plant.

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