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PRODUCTIVITY

NATIONAL PRODUCTIVITY COUNCIL JOURNA

Trends in Productivity

This is an *interim*[1] Special Issue on the Measurement of *Productivity*[2], *published partly because we had substantial material to offer*, but mainly because it is *time to rake up the fundamentals*, and open up the basic issues for public debate, for the Trends in Productivity, over the last few years, have been intriguing : statistically, productivity continues to increase, as in the glorious days before the Chinese Assault, but the constituent elements — the numerator of output and the denominator of input — show diverse trends, with the result that the *increase in welfare, normally associated with an increase in productivity, is not markedly evident on a deeper analysis.*

Certain broad statistics will easily clarify the position and the minds of the econometricians of the cobwebs of dogma. Broadly, from 1951 — when Economic Planning began — to around 1965 — when the Recession began, industrial output increased by more than 155 per cent, whereas industrial employment increased by about 62 per cent: consequently Industrial Productivity,

1. A full-scale Special Issue on Measurement of Productivity is planned for publication during 1969, in connection with an APO Seminar on the subject. Competent persons who have done work in the line are invited to write research pieces on any aspect of the subject of which they have knowledge and experience : the theory and its applications in various contexts and circumstances; Labour Productivity, Capital Productivity, Raw Materials Productivity, Productivity of Fuels, Total Productivity, etc. etc. ; Trends in Productivity in various countries: India, Japan, China, Burma, Ceylon, Pakistan, Indonesia, Malaysia, Thailand, Australia ; Britain, France, Germany, USSR, Czechoslovakia, Poland, Hungary, Yugoslavia, Italy, Spain, Portugal ; Israel, Greece, Egypt, Iran, Iraq, USA, Canada, Mexico, Brazil, all other countries not specifically mentioned; International Comparisons of Productivity ; Industry Studies including Productivity in Mining in various countries ; Work Measurement, Mechanisation and Productivity ; Productivity and Profitability ; the Nature of Cost, Cost Studies ; Marketing and Productivity; Productivity in the Public Sector ; Construction of Productivity Indices ; Inter-Firm Comparisons ; etc. etc. Those who intend to write on any of these subjects may kindly communicate with the Editor, at the earliest.

2. Commencing from page 224, this issue of the Journal contains several substantial pieces on the subject of Measurement : Productivity and its Measurement at the Work Centre by Prof. Russel W Fenske ; Measurement of Productivity (Concept & Methodology) by AK Ahuja ; Reflections on Two Productivity Concepts by V Lakshmana Rao ; How Far Size Affects Productivity by Mukherjee & Dass ; Wage Productivity Differentials in Indian Industries by Ahluwalia & Sharwan Kumar ; BTRA Study of Labour and Machine Productivity in Spinning; Institute of Economic Growth Research on Wages and Productivity in Cotton Textiles.

taking employment as a broad indicator of input in the industrial economy, increased by 58 per cent over the 14-year period to 1965.

This increase in Productivity was a decisive increase in welfare, being associated with a massive increase in output, alongside a fairly substantial increase in employment, causing an increase in incomes of all classes of people, particularly those who were suffering from unemployment prior to Independence. So the net increase in welfare must have been substantial : larger vol of goods, larger employment, larger incomes.

Of course, there were tensions in the economy, but they were *Tensions of Growth.* Since then the economy has undergone a sea change. Recession started sometime in 1965, affecting particularly the engineering goods industries, and then spreading generally, excepting areas in which Government continued to invest, for certain projects were still in middle stages. New private entrepreneurial investment (except in the case of pre-existing collaboration arrangements) practically came to a dead stop.

All this caused a fairly substantial fall in the volume of industrial employment. On the other hand, industrial output did not on the whole fall, for the decline in certain lines was compensated by increases in other lines. In fact, industrial output, as between 1965 and 1967 continued to increase but at a slower rate ; and it was only towards the end of 1967 that the industrial growth rate became rather stationary. The overall level of industrial output never actually declined, statistically ; whereas the input (the denominator of the Productivity Ratio) as measured by employment, continued to fall, and in large parts of the country, fairly substantially. The result was a statistical increase in Productivity, with the numerator of output continuing to increase or remaining stationary, and the denominator of input, fast declining.

Very obviously, the statistical increase in productivty during the 1951-1965 period, and the statistical increase in productivity during the 1965-67 period, are therefore not on par, and need a deep, critical analysis, for in the one case (1951-65) both output and employment increased—and welfare therefore substantially increased ; whereas between 1965-67, output did not decline, but employment actually declined; hence there was a net decline in welfare, despite the statistical increase in productivity.

Coming to the present times, which alone are significant because people live in the present, there has again been a shift in the main parameters of economic life. From the beginning of 1968, when it became clear that Government would continue pumping money into the economy, business expectations have brightened, and though the relevant statistics are not yet available, it is reasonable to presume that entrepreneurial investment has in a measure commenced ; and this will have, over a period, a favourable influence on the volume of employment. Actually, however, while the declining trend in employment has been reversed, the volume of industrial employment continues to be somewhat stationary at the relatively low levels attained towards the end of 1967.

On the other hand, there are clear evidences that industrial output has gathered momentum and the current levels would be 5-6 per cent higher than the levels of last year. The overall increase achieved during 1968 may well be in the region of around 8 per cent. There has been an increase in national income of over 9 per cent largely on account of the abundant harvests of last year, and this is likely to prove a booster to the industrial economy.

Converting this data into terms of productivity it would amount, during 1968 as compared to 1967, to an increase in industrial productivity of around 8 per cent, with output increasing by that magnitude and employment remaining about stationary. While therefore the situation has certainly improved in terms of welfare as compared to the recession period of 1965-67, the increase in productivity during the current year is not comparable in welfare terms to the real growth period of 1951-65.

It is against this background that the trend in crude productivity indices needs to be evaluated.

INDEX NUMBERS OF INDUSTRIAL OUTPUT, EMPLOYMENT AND PRODUCTIVITY[3]

Year	Production	Factory Employment	Producitvity
1951	100	100	100
1952	104	104	99
1953	106	102	104
1954	113	104	108
1955	122	107	115
1956	133	117	114
1957	137	119	115
1958	140	117	119
1959	152	125	122
1960	170	129	131
1961	181	135	135
1962	207	141	147
1963	223	150	148
1964	238	157	152
1965	256	162	158
1966	262	161	163
1967	266	153	174
1968	287	156	124

[3]. Index numbers of industrial output have been calculated on the basis of statistics given in the Monthly Statistics of the Production of Selected Industries in India, published by the Central Statistical Organisation, Government of India. Factory employment statistics have also been obtained from the CSO Statistical Abstract of India. Some of the recent statistics are still officially provisional but past experience shows that the magnitude of revision is never so substantial as to cause a material change in the ultimate calculations. The Productivity Index has been calculated by dividing the Index of Industrial output by the Index of factory employment. In cases where latest statistics are not available, projections have been made on the official assumption of an increase of around 8 per cent in industrial output during 1968 ; and a conservative estimate of a fall of around 5 per cent in industrial employment during the recession of 1966-67, followed by a small increase of around 2 per cent employment during 1968 (the period of recovery).

Productivity & the Constitution

It is clear that the framers of the Constitution knew the basic weakness of the Indian economy and the only means by which it could be made stronger and the citizens of this great democracy given the benefits of fundamental economic rights. These Directive Principles not only specify the productivity of the economy as the limiting factor to the realisation of these rights, but they do also specifically relate to the very heart of the controversy in productivity thought, namely, the problems that centre round Sharing the Gains of Productivity. Very obviously, practically all the policies laid down in these Directive Principles imply clearly that in Sharing the Gains of Productivity, the working class shall have a sort of pre-emptory right on the gains of productivity till a living wage level is attained : "The State shall endeavour to secure, by suitable legislation or economic organisation or in any other way, to all workers, agricultural, industrial or otherwise, work, a living wage, conditions of work ensuring a decent standard of life and full enjoyment of leisure and social and cultural opportunities" (Article 43). Obviously the text of this Article is stronger than even the statement of Article 41 already referred to. But if Article 41 is limited by "economic capacity and development", Article 43 would be much more so. Consequently *it's not the Non-Justiciability of the Directive Principles but the Non-Productivity of the Economy that stands in the way of the realisation of a Socialist State.*

From **Productivity**
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The table printed above gives a very broad picture of the industrial economy, since the inception of the programme of Economic Development. While *the broad statistical trend in productivity is satisfactory*, it needs to be carefully interpreted for each period of economic change, for *social productivity is that which is good for the common people.* If, however, a statistical increase in productivity conceals certain elements injurious to the welfare of the common people, then it is not bonafide productivity, though the statistical increase may appear fairly large. *The National Productivity Council is vitally interested in this increase of productivity which is conducive to the welfare of the people.*

Basically, productivity must be an elevating, liberating force, not a depressing force. For overcrowded areas such as India, massive increases in employment opportunities are an essential element in the Productivity Drive. Where this does not occur, a mere increase in output, (though welcome by itself) unassociated with increase in employment, simply means an addition (and that also at a diminishing rate) to the welfare of those who are already well off, whereas in *social productivity* in the sense in which we understand it, the *numerator (output) and the denominator (employment) must both move massively upwards*, enormous increases in output going alongside massive increase in employment opportunities, *for we are* 530 *million people at the time of writing*; *and they can only be better off with wider employment opportunities.* The people of course require a large volume of goods as the first imperative but they equally well need as large a volume of employment, for without that they will not have the purchasing power to buy the larger volume of goods that the industrial economy produces, and we shall again be compelled to deflate, which does no good to anybody including the Government.

In terms of productivity, it is also essential that people get value for the money invested in industry. The fixed capital in industry has increased from Rs. 275 crores in 1951 to around Rs. 6,000 crores.[4] *It is the productivity of this capital*[5] *which is of vital importance to the welfare of the Indian people.*

Due to recession and other factors there has been a marked decline, in recent years, in the utilisation of fixed capital investment ; and *a broad estimate would not put the overall utilisation of industrial capacity at more than* 30 *per cent.* This means that *the investments that we have made in industry since Independence are capable of producing nearly* 3 *times the volume of goods, produced at present.* Naturally, a three-fold increase in the volume of output would cause a fairly substantial increase in the volume of employment[6] : and this could well mean a phenomenal increase in industrial productivity, statistically speaking, and also a *significant increase in the welfare of the Indian people.*●●●

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4. According to the CSO Census of Indian Manufactures (now called the Annual Survey of Industries), fixed capital of registered factories in India was estimated at Rs. 275 crores in 1951. By 1964, a level of Rs. 3,962 ·es had been reached. During 1963-64, there was (in the peak year of the Third Plan) an increase in fixed ·estment of Rs. 1,178 crores. Counting the period since 1965 as one of recession, with Government trying consolidate its financial position, and private entrepreneurs concerned to make the most of their existing investments, it would be reasonable to assume a substantial fall in the growth rate of fixed capital. In the four years from 1965 to 1968, it has been assumed that there was an aggregate increase of around Rs. 2,000 crores in fixed investment during the entire period, thus increasing the fixed investment from the 1964 level of Rs. 3,962 crores to around Rs. 6,000 crores by 1968.

5. In a signed article (An Essay on Measurement of Productivity), the Editor of this Journal had calculated that capital productivity had for a fairly long period increased by less than 1 per cent per annum !

6. Assuming one-and-a-half times increase in industrial employment, consequent on a three-fold increase in industrial output, this would mean a 200 per cent increase in industrial productivity. With this magnitude of increase in industrial production, resulting from full utilisation of existing equipment, real economies of scale on a pretty large scale would be realised; there would also be a considerable spread over of overhead costs over three times the existing output. Thus a substantial fall in the aggregate costs of production will take place, which is another important and significant aspect of the basic productivity idea.

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Productivity

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Productive Development of The German Economy†

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In a free economic system, entrepreneurs and managers have always developed good ideas for adaptation of operational management and decisions to a given situation, even a difficult one. This also happened in financing the reconstruction of the West-German economy in the period of the last 15-20 years. This period may be considered a stimulating example for both the adaptation of management to the financial situation and the experience on how to rebuild a modern economic system which was almost destroyed. To handle the refinancing of the German economy, new methods had to be invented and the traditional methods had to be applied in a changed manner.

ECONOMIC RECOVERY COULD NOT START UNTIL a reformed monetary system had been instituted (in West-Germany twenty-first of June' 48, in West Berlin first of April '49).

†Considerable research has been done on this subject, popularly known as the German Miracle, by which a vanquished country has risen sphinx-like to a position of economic dominance in Europe. Prof. Ludwig Erhard, who initiated the relevant economic policy, and who subsequently became the Chancellor, himself wrote a Book on the subject. Dr. Hartmann, who has been good enough to write this special article for us, has something significant to say, which would prove of value in its application to economic policy in India. In a covering letter addressed to us, he says : "....The methods of financing may contribute to a better understanding of economic development and also may be adapted to the industrial development of India."

*Dr Hartmann is Professor at the Technical University, Berlin-West. He has been intimately associated with the NPC, for he conducted for us a number of highly successful programmes on Electronic Data Processing. We had requested him to furnish us specialised material on Computerisation, which he has so graciously done. Special articles on this subject by him and his colleagues and friends all over the world, will appear in the next issue of the Journal.

A. STARTING SITUATION IN 1948 (MACRO-ECONOMIC)

In the years right after the war, from 1945 to 1948, the economy was utterly depressed due to the lack of food and raw materials which caused the development of black markets. During this time goods were rationed by several government laws, and there were price ceilings on, practically, all goods.

The West-German monetary system was about the worst in the world because of the war and post-war situation: no goods could be exchanged for money except extremely high-priced goods of inferior value on the black market. Instituting the new currency was, however, successful. Cash was exchanged in the ratio of about 20 to 1 (later on exactly 100 to 6.5). It had to be quite drastic: the changed cash was paid to the people in rates; all the cash in banks became void, and the new monetary system was compelled to start without any stocks of gold or foreign currency. The initial balance sheet of the new banking system was extremely simple: the newly issued bank notes in the amount of about

6 billion marks (later on increased to the amount of 9 billion to compensate for the addition of West-Berlin and the Saar-Country to the banking system and to improve private deposits somehow) were balanced by claims of the Central Bank against the government. As counterpart to this claim, the government had received the cash money from the Central Bank to be issued to the people. The institution of the new currency was associated with two essential provisions :

i. The elimination of all price ceilings, and

ii. The elimination of rationing on all goods.

These two measures, which seem to be rather simple, have been sufficient to revive the economy. The energy and ingenuity of entrepreneurs and managers had free play again, and the reconstruction of the economic system, as we know it today, was due to them. We have to consider the fact that *freedom of decision making in business had ceased to exist since 1934* (beginning of rationing system, price ceilings beginning of 1936).

The government was wise not to stick to any planning system or to socialistic economic ideas. This was the idea of Professor Erhard who realised this concept and did not deviate from it *despite the influence of so many economic advisers who advocated planning systems.*

Certain conditions were necessary, however, to make West-Germany's economic recovery possible. Since initially raw materials and food were not available in sufficient quantities, a loan offer of 2 billion dollars from the U.S. Government helped greatly. The West German Government was thus enabled to purchase raw materials and food, which it sold to business firms and their payments were used as long-term credits, particularly to small business firms.

West-Germany's speedy economic recovery may be demonstrated by some data. The gross national income in 1950 was about one hundred (100) billion marks, and five years later it approached nearly 300 billion. During the same period, the total yearly investment in fixed assets rose from 20 billion marks to 70 billion. From 1950 up to now, total investments in fixed assets have reached approximately 1000 billion marks. Approximately 250 billion of this amount was invested in fixed assets of industrial firms, particularly the big industrial stock companies. The growth of the individual business firm, however, varied greatly: some grew very fast and some quite slowly.

In the period of approximately 10 years, after 1948, the continuously prospering economy served its customers with more goods, including goods of the best quality they could ever purchase in any country in the world. If a customer wants goods which are not produced in Germany or not sold in the desired quality or quantity, he may purchase them abroad in any country in the world.

Nowadays, with complete convertibility of currency, no restrictions on foreigners or residents in any way are the main characteristics of the German economy. Any monetary transaction by residents and foreigners to any country in the world may be undertaken. The same holds for businesses. Consequently, many firms from the United States have chosen to establish subsidiaries in Germany for their European market.

There are also some other West-European countries which had a post-war revival period. Those examples are not quite so good for economic studies because their war damages were less severe (fortunately) and their monetary system remained intact. Thus, these countries were able to start with their economic recovery almost in 1945.

The West-German model of economic recovery and prosperity is not fully adaptable to underdeveloped countries, for the fixed assets, especially the machinery, do not work automatically yet. *The most important thing in an economy is the trained and experienced personnel and also a certain mentality of the people who are used to hard work.*

B. FINANCING OF BUSINESS FIRMS (MICRO-ECONOMIC)

(a) General Situation

Now let us see how the financial aspects of reconstruction have been realised in the business firms, beginning with the new monetary system, June'48. Nearly all the firms had to start at zero point. Most of the fixed assets had been destroyed or damaged; the rest was mostly obsolete. Current assets were very low; stocks of raw materials and products existed only in very small quantities, and the finished products were inferior. While account receivables were very low due to small sales, wholesale firms and retail stores had no merchandise, and the trucking firms had no trucks. Old trucks were running with charcoal or wood. Banks had lost their capital, their deposits in other banks and their cash on hand.

The revival of the business firms demonstrated that the essential values were not the fixed and current assets, but goodwill values which are not being recorded on the balance sheets, especially

i. the quality of top and middle management,

ii. the trained personnel with their experience and know-how.

All values on the balance sheet of a firm can be reproduced by the two items mentioned above. Almost all balance sheets in 1948 showed very low values. In the following years, thousands of business firms from East Germany arrived without any measurable assets at all. They started with their old proprietors, managers and some of their good employees. The experience in many thousand business firms demonstrated that you have to merely adjust the initial capital to the good will items for rebuilding the firms within a few years. The initial capital funds couldn't be lent by private banks on account of lack of adequate values in the business firms. In this period long loans were either granted or given by the government.

Later on, the need for capital increased according to the growth of the firms. The process of gaining own capital by earnings was much slower than the increasing need for capital. Many outside sources of capital had to be discovered, and the creditors' equity had to be increased much more than the standard financial ratios would allow it. Consequently, the financial structure of German business firms today is characterized by very low proprietary equity and overemphasis on creditors' equity.

Now let us see how the financing worked out in detail.

(b) Proprietary Equity

1. *Capital Stock :* At the starting point of 1948, capital stock and surplus were very low due to the fact of high damages, lack of raw materials and loss of cash and receivables (they were changed at the ratio of 10 to 1). The capital market was closed until 1955. Issues of private investments were prohibited and also interests on credits were fixed at a too low level. The capital market reached its full working capacity not before 1958, when the tax on cash dividends of corporations were reduced to 15% (51% on retained earnings). Beginning with 1958 the very low stock market prices rose remarkably to the normal international standard of today. Even now, proprietary equity is very low; creditors' equity has been preferred because it is cheaper with respect to tax rates.

There do not exist any statistics of all business firms as to their sources of capital (the number of industrial firms is about 90,000, wholesale firms about 60,000 to 80,000, retailers about 500,000, craftsman's own business about 400,000, and trucking firms about 70,000). The statistical data are available for the big corporations, about 2,500 firms, which have to publish their balance sheets because their shares are sold at the stock exchange. A few hundred of these firms put out a large percentage of the total economic volume of goods, but their financing methods are not typical for all other firms. In these big firms the proprietary equity amounts to

40 % of all the assets, while the percentage of long-term creditors' equity reaches 20 %. In comparison, the industrial corporations in the U.S. have approximately 60 % of proprietary equity.

The fixed assets should be financed by proprietary capital. This old standard of financial ratio couldn't be maintained up to now. Therefore the degree of financial security of the business firms is not very high.

Industrial investments in shares and long-term credits sold at the stock exchange were only 0.6 billion marks for the three-year period from 1948 to 1951, three billion for the period from 1952 to 1954. After eliminating the prohibition on issuing stock shares in 1955, the new investments amounted to 7.5 billion marks for the period from 1955 to 1958, 9 billion from 1958 to 1960 and 11 billion from 1961 to 1963, most of them being long-term credits.

The volume of long-term credits given by banks to business firms was not more than 1.2 billion in 1950 and amounted to 13 billion in 1963. Medium-term credits of banks in 1950 were negligible and reached a total balance of 8 billion in 1963.

The yearly average of all investments in industrial fixed assets through the last years has reached about 10 billion. This amount was financed with only 15% by capital stock, the rest by retained earnings, paid-in surplus investment credits and accelerated depreciation allowances.

2. *Retained earnings:* During the first years after 1948, the financing by retained earnings was the most important source of capital. On behalf of the sales market the prices were very high preliminarily. The price level for customers was reduced after the Korean war (1952) when competition was increasing. In 1948, 80% of new fixed assets were financed by retained earnings and reinvestment of depreciation charges. This decreased to 60 or 70% until 1962. Today this kind of expansion is lower because of growing competition: returns on capital have substantially decreased. Normal depreciation and accelerated depreciation reached a level at which more than 50% of all fixed assets were financed by it.

3. *Financing through excessive depreciation:* Depreciation rates for fixed assets are somewhat higher in some European countries than in the United States. In the first years after 1948 the German firms used the free tax additional depreciation which amounted to 50% of the value within the first year of purchasing.

4. *Financing through reduction of fixed assets and inventories :* This financing method can be used by improving inventory systems and by reducing fixed assets which are not necessarily needed according to changes in the production programme.

Another source of financing is the reduction in the value of assets in the balance sheet. If production capacity is not augmented, the book value of the fixed assets decreases over several years, till it reaches about 50 per cent of the original value. The machinery is new at the beginning of the firm (also for each growing period) and becomes older and is replaced by and by. In the statistical average the age of machinery in a firm will be 50 per cent of their lifetime, because all the items of machinery are on the way from new to old. About 15 years ago this theory was developed in detail that with a certain capital invested in a firm the production capacity can be doubled in ten or more years. After this time, all items of the fixed aspects will have an average statistical age of 50 per cent of their lifetime and their book value altogether will also be 50 per cent of their purchasing price. This model of thinking worked in Germany, contributing to the financing of fixed assets. Literally speaking, *the model is not working exactly in reality because the new machinery has become more expensive on the one hand and it is working faster and better on the other hand.*

(c) Creditors' Equity

General Situation : Short-term credits for financing of current assets were scarcely available in the first years after 1948. These credits were urgently needed for the financing of the

increasing inventories of raw materials, semi-manufactured and finished products and also for the increasing receivables on account of growing turnover (sales). The funds for short-term credits of the banks had to be rebuilt from the beginning by new deposits of the bank customers. It took many years until the suppliers of the firms could be paid in time and more years to be paid with interest.

The total of short-term credits of all banks to business firms were not more than 6.5 billion marks in 1950, 31 billion marks in 1963 (in relation to this number the gross national income in the year was 300 billion).

On account of the lack of long-term credits, even short-term credits have been used partially for financing fixed assets, thus violating traditional solid rules of financing. Entrepreneurs had to decide whether operational management should be recognized and appraised as solid by financial ratios and thus lose part of their sales market, or if they should violate these rules for a couple of years like they all did. In this way the growth of the firms was related to the growing economy. Most of the entrepreneurs decided this way and finally were lucky to do so. Experience showed later on that many, many short-term credits could be converted little by little into long-term credits or proprietary capital. Nevertheless this way of financing was dangerous. It worked out successfully due to the continued growth of a prosperous economy.

1. Capital Market Situation : The capital market was not operating because of the law against the outflow of investments and interest. This situation lasted about twenty years from 1934 until 1955. The development of long-term credits has already been dealt with.

Mostly government loans with a period of 10 to 20 years have been available for the business firms in the total amount of approximately 12 billion marks. Most of this amount (8 billion = 2 billion dollars) was spent by the U.S. Government in the European recovery plan. These credits have been preferred because the growing production was most important for economic recovery.

A second important financial source was the long-term credits (notes payable) of life insurance companies.

Since 1955 industrial loans for the periods of 10 to 20 years have been issued again. In the first years after 1955 the industrial firms had to pay an interest rate of 8 per cent. Long-term credits have been preferred by nearly all business firms instead of increasing proprietary equity. The reasons for this development were :

1. No increase in influence by new shareholders,
2. No permanent commitment in financing; after making repayments for 10 to 20 years the new situation could be checked because nobody knew what future economic development would be. Certain taxes were lower for creditor's equity than for proprietary equity. In 1958 the tax rate on paid-out earnings was reduced to 15 per cent for corporations (income tax for stock companies). Tax rates on retained earnings remained at 51 per cent.

Beginning 1958 the amount of loans to industry decreased relative to the increasing amount of capital stock obtained by issuing new shares.

2. Criteria for financing by long-term credits : The huge expansion of long-term credits has been unique. Many business firms have been financing a large part of their fixed assets, often even the largest part of it, by long-term credits. Theoretically speaking, all fixed assets may be financed in this way, if certain prerequisites are given for the whole period of financing. It is self-evident that this way of financing is normally not advisable on account of the uncertainty of the firm which will increase by the amount of creditors' equity.

The following assumptions have to be realized :

(*i*) Full earning of all interest charges which should be included in the sales prices,

(*ii*) Full earning of all depreciation charges which should be included in the sales prices,

(*iii*) Interest charges and depreciation expenses must be reserved timely in the form of cash.

Nobody can ever guarantee these three prerequisites for many years in advance until creditors have been fully paid off. The first and second prerequisites could be assumed in the context of a prospering economy and the need for customers' supplies after many years of poverty. The third prerequisite is a matter of financial planning.

The prerequisites can only work under the condition that the depreciation rates are being handled in a precise manner. The depreciation rates processed in the cost accounting and price making must be similar to the rates allowed by tax laws and moreover the depreciation charges must be separated in cash. This coherance may be seen in the following scheme :

Calculated (charges) Depreciation	$\leqq$	tax law (charges) depreciation	$\geqq$	amortization rates (time schedule of repayment)

For precaution, the calculated depreciation rates should be a little bit bigger than amortization rates. On the other hand the calculated depreciation rates should be within the depreciation rates allowed by tax law. Otherwise the difference in rates would be reduced by taxes and not available for amortizing.

This equity realized due to amortization has a meaning as an average for all long-term credits used for financing of fixed assets with a life time of 10 years ; assets with a lifetime of 5 years, like motor cars, can be financed twice ; and assets with a lifetime of 3 years, like tools or small machinery, may be financed 3 times within the long-term period of 10 years. For financing of buildings, loans of 20 to 30 years amortization time will be required.

A similar equity has to be realized for the interest payments. This equity is shorter, because there is no tax restriction on paid interest :

Calculated interest	$\geqq$	interest payments (time schedule of payments)

An exact time schedule and its periodic review will be necessary for the payment of interest charges and amortization expenses; also exact cost accounting, price determination and budget control are essential. Without control all cash would be used easily for further growth of fixed and current assets.

After the repayment of the loan, the machinery has to be replaced, the investment of new machinery being financed either by proprietor's equity or new long-term credits.

(d) New Methods of Financing

Because proprietors and creditors' equities have not been sufficient for financing the rebuilding and growth of the firms, new sources had to be discovered. Only the most important kinds which have been used by nearly all firms may be mentioned. These methods of financing are to be found in nearly all balance sheets of German business firms.

The following methods refer to estimated and possible liabilities. In the legal sense they belong to the creditors' equity, but they are not paid back for many years or never. So they are used sometimes like proprietary equity, for financing (in Germany so called part-time proprietary equity or near or like proprietary equity). Certain items of estimated liabilities were increased enormously in order to cut down the earnings of the balance, thus also reducing income tax of the firms.

1. *Special reserves under the tax law :* For certain purposes (for example, supporting of exports, raising of raw material prices) reserves in certain amounts could be charged to the profit and loss account : thus taxable profits have been reduced by this method of financing, for a few years. Taxes have been deferred in a certain amount for several years

without paying interest. The deferred taxes constitute or substitute credit. After a certain number of years the amount charged to the profit and loss account has to be credited, thus increasing the taxable profit.

2. Reserves in estimated liabilities : The amount of these reserves has been enormous since 1948. High reserves have been set up especially for guarantees to customers, for example 5 to 10 years for refrigerators. Only a certain percentage of the charged amount is required. The reserves have been climbing higher and higher relating to the growing turnover and thus serving as a financial resource. Many firms have accumulated millions as reserves in their balance sheets relating to this item.

3. Estimated liabilities for retirement and pension plans : Although the social retirement scheme of the government is one of the most extensive in the world, additional payments for retirement are usual for many firms. There are many ways of financing the firms by pension funds. In Germany those ways are preferred which enable the highest financial help. Most important are :

(*i*) Estimated liability in the balance sheet,

(*ii*) Founding a separate retirement corporation owned by the firm.

Referring to the first : A certain amount is charged to the profit and loss account, thus reducing earnings. The amount is related to life insurance annuity schedules. The liabilities for retirement payments will become due in future years when employees will retire. Up to this time the amounts booked year by year are working in the form of a credit without interest payment. In the long run there will be equilibrium between increasing the funds and payment. But over many years while the funds are being built up there will be nearly no payments, until a certain percentage of employees will retire continuously year by year.

Moreover, a part of the liabilities will never become due because many employees will leave the firm, before reaching retirement age.

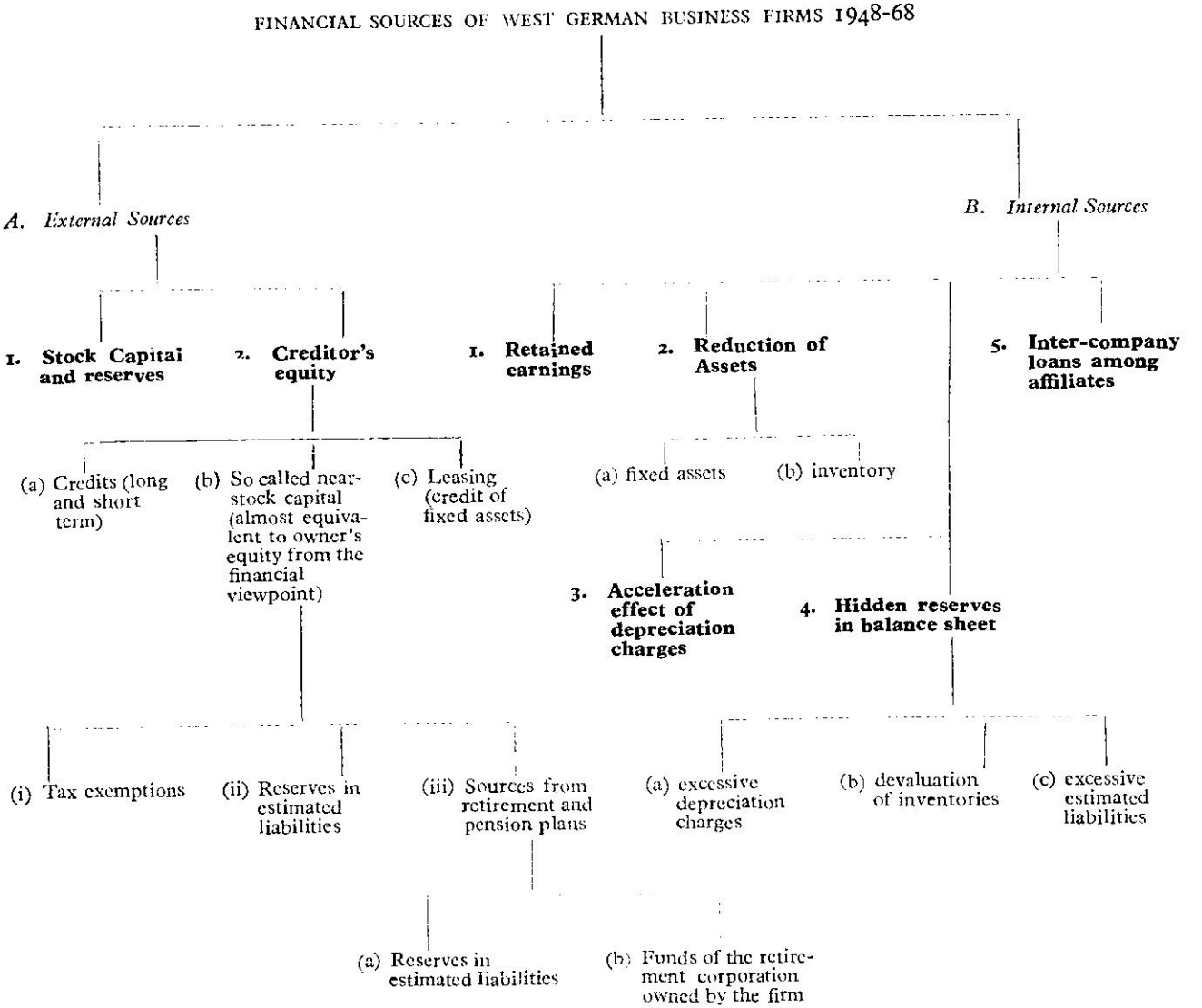
Referring to the second : Yearly donations, determined by a tax exemption schedule, are given to 'retirement' corporations, and are in turn transferred to the firm, thus serving as long-term credit. This transfer is simplified, often by crediting the donations account of the retirement corporation. Because the firm is the owner of the retirement corporation it can establish its own retirement payments or refer to an arbitrary schedule. There do exist regulations which determine if any employee is entitled to retirement payments or not, because employees do not usually contribute to the retirement fund. So the retirement payments of the firms are mere gifts to their employees.

The amount established for the two abovementioned kinds of retirement plans is approximately 10 billion marks, which exceeds the financial aid of the U.S. Government in 1948; 8 billion marks have been sufficient for initiating the economic recovery of West-Germany.

The creditors' equity referring to the retirement system can also be changed into proprietary equity. In many cases the retirement corporations have bought a part of newly issued shares of the firm. This part of the stock capital belongs to the retirement corporation, but practically (indirectly) it is owned by the firm itself.

4. Other financial sources : Estimated liability reserves are usally involved also in other kinds of liabilities. Besides, reserves to a high extent have been made by excess depreciation rates and excess devaluation of inventories. These reserves amount to several per cent of total assets. These sources of financing are merely one of the characteristics of West German business firms.

5. Leasing : Leasing arrangements of fixed assets are not very usual in Europe and Germany because it was rather unknown up to now. Some big firms started financing through leasing a few years ago. The present leasing costs seem to be a little high, although there is a good market especially for small


FINANCIAL SOURCES OF WEST GERMAN BUSINESS FIRMS 1948-68
A. External Sources
B. Internal Sources
1. Stock Capital and reserves
2. Creditor's equity
1. Retained earnings
2. Reduction of Assets
5. Inter-company loans among affiliates
(a) Credits (long and short term)
(b) So called near-stock capital (almost equivalent to owner's equity from the financial viewpoint)
(c) Leasing (credit of fixed assets)
(a) fixed assets
(b) inventory
3. Acceleration effect of depreciation charges
4. Hidden reserves in balance sheet
(i) Tax exemptions
(ii) Reserves in estimated liabilities
(iii) Sources from retirement and pension plans
(a) excessive depreciation charges
(b) devaluation of inventories
(c) excessive estimated liabilities
(a) Reserves in estimated liabilities
(b) Funds of the retirement corporation owned by the firm

business firms. If the system had been introduced in Germany 15-20 years ago, the percentage of applications would have become higher than in the United States. Leasing arrangements represent an excellent opportunity to expand capacity without major financial difficulties.

Analysing the financial position of a business firm, all long-term sources explained above are considered to be near proprietary equity from the financial view point. In Germany it is estimated quite fairly that fixed assets are financed by long-term credits. So the criterion of financing is a time schedule of the capital available (proprietors and creditors) and the usage of all these capital funds for assets referring to the time schedule of the activities.

Conclusions

The economic development of West-Germany represents a unique model showing the recovery of an industrial country which had nearly been destroyed. The financing of this recovery couldn't have been afforded either by traditional methods of financing or by using traditional financial ratios which have been justified and proven by experience in normal times regarding principles of solid financing.

The methods of financing in a case of emergency should be restricted to certain applications in a certain situation. The new ways of financing in West-Germany worked out successfully not on account of proven ideas and methods but more because of the steadily growing and prosperous economic development. So the good results have been realized not so much by solid managerial planning, but more by chance of favourable circumstances. Indeed, business couldn't have been estimated for so many years in advance.

The various financial sources described above may be put together in the scheme charted on page 192.

This scheme can work successfully in a highly developed industrial country as has been proven in West Germany in a certain situation. The economic abilities of entrepreneurs, managers and employees are much more important than the fixed assets of a business firm. If machinery has been destroyed or severely damaged, it can be reproduced rather quickly. On the other hand, the best industrial equipment won't work efficiently without the technical and economic experience of the men handling it.●●●

Business Games

The Institute of Chartered Accountants has got together with the computer firm ICT in a pleasant publicity stunt which involves budding tycoons in the sixthforms of 27 schools. Groups of three schools are rivals in marketing an unspecified consumer product and the winner has to maximise income. The "boards" meet each week, and each week receive back from the computer the results of decisions taken at the previous board meeting. The game only started this term, and the final heats will not be run off until April. So far, at least, no one has gone bankrupt. The contestants range from Kidbrooke girls' comprehensive to Eton, though most are boys' grammar schools (chosen by invitation). Only a few of these schools teach "business studies" as a subject, and it is probably all to the good if as an educational gambit it is not treated that much more seriously than Monopoly.

But everyone is having a lot of fun. The computer is set to "mild boom" conditions, which makes a change. So far these have remained constant; all the variables that the boards have to cope with are within their own control, starting from a common balance sheet. They have to allocate resources, adjust prices and so on in keeping with what they know are their costs, depreciation, orders received, share of the market, etc. Some wild fluctuations have been witnessed. It remains to be seen whether the schools with sound business traditions will emerge triumphant. King Edward's School, Birmingham, whose old boys include Mr. Aubrey Jones, did badly at first when it refused to raise its prices. It is in the same heat as Eton... —The *Economist* (London), Feb. 17, 1968

The Socio-Economic Background*

DH Butani

WE HAVE A SOCIAL STRUCTURE, LARGELY RURAL and agricultural in its background, caste and faction-ridden, with low levels of literacy and the absence of a feeling of common good. At the top of it is the historical inheritance that a *succession of foreign conquerors have dethroned the paramountcy of the public interest as the guiding principle of social life.* An imperative requirement of social policy, therefore, is to place back, by all means at our disposal, the idea of the social interest as the guiding principle in public conduct. Common ideas of public good have yet to evolve and *the society as we find it in India today is caught up between social petrifaction and individual anarchy.* The individual does not appear to be bound by any moral code towards the society in which he lives and works. To make this community productive is a herculian task in terms of political, social and economic effort.

The facts of the case are there, as a writing on the wall; these are that *the mass of the people just do not have the opportunities to be productive.* Vertical mobility for all practical purposes just does not exist. Outside a few selected occupations, the large masses of workers and technicians have to do the jobs that come their way. There is hardly any scope for the application of the elementary productivity formula: *fit the right man to the right job.* With large scale open unemployment in the urban areas and under-employment in the rural areas, a productivity consciousness in the western sense of the word or the application of productivity techniques, as they are understood in the United States, has really little social validity. Even horizontal mobility is for the most part absent: that is to say, it is hardly open to a young man or woman to move to an occupation of choice, even on the basis of the same emoluments. Among the middle classes, loss of employment is yet considered a great disaster because opportunities do not exist across the counter. In many occupations, wages are still abnormally low, far below a living, need-based wage. Even the working class knows that what is known in the western sense as a living or need-based wage is not *real politik* because the aggregate supply of labour exceeds the aggregate demand for practically every vocation. Against this background, to expect the working class to be a real and willing partner to a

*This, like the Great Tradition, published in the NPC Productivity Journal Volume VIII-IX Number 4-1, is an Introductory Chapter in the forthcoming Book on 'Productivity and Economic Development' that the author proposes to publish Preparatory to Retirement. The work will cover such fundamentals as the Choice of Technology, Productivity and the Constitution, Indian Socialism etc., etc. There will be several Policy Chapters, dealing with Planning, Public Finance, Employment etc., etc. Practically all Techniques will be covered, each exhaustively analysed in the context of the Indian Economic situation: Personnel Management, Work Study, Incentives, Quality Control, Materials Handling, Inventory Control, Inter-Firm Comparison, etc., etc. A number of chapters will analyse threadbare the whole problem of agriculture and the development of the rural economy. There will be sections dealing with Labour, Measurement of Productivity, Sharing the Gains, Industrial Engineering etc., etc. In addition, there will be a full-scale futuristic study dealing with India of the 1970's.

productivity drive in the sense of a rationalisation of industry is impracticable. It should therefore be the aim of general social and economic policy to create conditions in which employers are compelled to economise labour which they will do only when it becomes really costly. Housewives now economise on domestic service because it has become costly. At present the level of wages is of an order that employers tend to be wasteful and almost make a puerile use of manpower.

In terms of modern technology, with which broadly the western concept of productivity is associated, it is a moot question to ask as to the benefit of modern technology to the mass of the Indian people. It would not be an exaggeration to say that they have not felt its benefits in any sense of the word. The society in which we live is the *very opposite of an affluent society*. After 20 years of independence, the per capita national income is not more than a rupee a day at 1948-49 prices. At the current level of prices it will hardly buy a family dry bread and a cup of tea. The position is really far worse because this is the average. It only means that with the large disparities in incomes in India where *a few people can live like princes without the need to economise*, the large mass of people are depressed below the average level. Even so conservative a body as the Taxation Enquiry Commission recommended in strong language the need to put a ceiling on incomes on the ground that *the present disparity in incomes constitutes a serious disincentive to productive effort*.

What are the prospects of the common man having a fair income in the foreseeable future? Even after a quarter century of economic development, that is, in 1976, the per capita national income per day would not be more than Rs. 1.50 at 1948-49 prices. Is this really a prospect which should so enthuse the people that they give of their best? That is what productivity means: that every citizen should give of his best. He should be so motivated that he does so on his own. It has to be confessed that we are really far from that ideal position.

Once again the causes are very largely historical. During the British period the general masses of people lived off their capital. Most of the handicrafts were killed. Little investment took place in industry. To a small extent British capital was invested in such protected lines as railways and jute and cotton textiles. To a small extent, Indian capital took advantage of the policy of discriminating protection ; but, by and large, when the war broke out, invested capital per person was almost negligible. War did offer almost unlimited opportunities, but these were largely opportunities for graft and personal gain through sharp practices and current scarcities. There was a marked increase in employment but in terms of investment as such very little advance was recorded during war time.

During the immediate postwar period it was difficult to think of investment on a long basis, as sovereign authority was itself in a process of dissolution. Large gains were still being made out again out of current scarcities.

A real investment policy could only begin after the establishment of the Planning Commission in 1951. By that time the new Government of free India had brought the overall economic position into some reasonable balance and established the broad foundations of a stable and progressive polity. The dark and murky background of the earlier postwar period had given place to a measure of optimism in which the Indian people looked forward, of course, after considerable travail, to a modicum of comfort to which we are entitled as human beings against the background of modern technology. Industry which had been disrupted by the partition due to the cutting off of the supplies of essential raw materials like cotton and jute, disturbance in the general flow of goods and materials, had begun to pick up because *government had by the time made it clear that they were for an enterprise economy*. Private enterprise was in fact invited to come forward in all directions, and credit facilities were created on a scale which the private sector had never dreamt of. A situation had been reached when even the

most reputable firms could not enter the open market for capital: such was the state of collapse in the economy, when the country embarked on independence. Yet within a few years the TISCO request for capital from the IBRD was underwritten by the government itself. Not only the government began to enter industry on a large scale but it helped private industry to expand by every incentive that the authorities could offer. In 1947-48 industry was practically deadlocked through collapse of industrial relations, mandays lost having risen to a level of 18 million in one single year. A tripartite conference was called and an understanding arrived at that if labour kept the peace, fair wage legislation would be enacted. Mandays lost came down to one or two million. But fair wage legislation has not yet been passed.

Working class had made it clear that there must be a formula for sharing the gains of productivity. Without a formula and a de-definite understanding to respect it, an increase in productivity simply means an increase in the disposable surplus with industrial management.

In one direction probably a development is taking place which must be considered hopeful. The per capita investment during the first Five Year Plan was less than a hundred rupees. It was increased to somewhere between 150 to 200 rupees in the second Five Year Plan period. During the third Five Year Plan period it is estimated at well over Rs. 200 per capita. It is difficult to say what the investment during the Fourth Five Year Plan will be, but it is unlikely to be less than Rs. 400 per capita. *It is the increasing association of capital with human labour, either in the form of instruments of production or even better training, that is likely to increase substantially the productivity of labour in India and the prospect of a reasonable advance in its standard of living.*

In agriculture also the extension of irrigation with a consequent decline in the dependence on a capricious monsoon, a substantial increase in the supply of artificial fertilisers, a massive increase in rural credit through the expansion of banking facilities (both long-term as well as short-term credit), release of the cultivator from the clutches of the money-lender, the intermediaries and the landlord, community development and the deliberate effort to utilise idle manpower in the countryside, improved conditions for agricultural labour: all these are the many facets of a productivity drive in the rural areas, which has yet to reach its optimum level of activity ; and in agriculture, there are many stages.

The weakest link in the chain is the human factor, for here are a mass of people, hundreds of millions of them who have for ages past been denied almost the right of life, living under continuous terror of the landlord, the revenue collector, the policeman, the head of the caste and practically every man who had the smallest authority to frighten a fellow human being: an economy in which he who cultivated the land lived regularly by stealing his own crop, knowing full well that at the time of harvest, the landlord, the money lender and the *tehsildar* (the revenue officer on the spot) would not leave him a grain for his family.

In a situation of this kind, hardly any productivity could be expected, for the sole source of productivity was the cultivator himself and he had no motive of any kind to harvest a rich crop, for the richer the crop, the richer was the money-lender, more comfortable was the landlord and the tehsildar gained his "annas". All that the cultivator knew was a mystical adjustment in his accounts. Probably he was less in debt, but he did not know the mysteries of the economy by which he lived.

All this has begun to change. The landlord probably survives in one form or another, but the intermediaries for the most part have disappeared and the rural masses have come to know through the acquisition of political power and by repeated use of it that they probably have a say in their own destiny. Ministers come to them almost once in five years and sometimes oftener, seeking to get from them what has been conferred on them by the law and the constitution. The language press reports to them the Prime Minister's

speeches on the socialist pattern of society. No longer the tehsildar and the policeman ride roughshod over them, for they have come to know that courts can call to account the highest men in the land. *It is this accountability, this feeling that no man is above the law—it is this development in the broad pattern of the Indian polity that is working powerfully towards an increase in productivity, for productivity is essentially a social phenomenon.* It is a state of affairs when the whole man goes to work with his whole heart: a situation in which a man feels that he will not be cheated of the gains of his labour. Men are prepared to work either for themselves or for the community. Even workers and their representatives have begun to say openly that they are prepared to forego their claims to higher wages, provided the gains in terms of higher productivity are invested in additional equipment or facilities for the public welfare. It is a happy sign that the real secret of economic growth is being grasped by the common man : investment for economic development. Thus the social climate for economic growth, and productivity as an essential element in that economic growth may be considered as favourable.

While adequate attention has to be paid to agricultural development, the crucial role of industry is well recognised. In fact the process of economic development on which we are at present engaged means a decisive shift of population from agriculture to industry, for it is well known that agriculture is unproductive because of the pressure of population on land. In England also the industrial revolution was preceded by an agricultural revolution as an essential element in development. Here too a similar development is taking place, but the problem is more difficult because of the absolutely large dimension of the population problem and the rate at which it is increasing. A shift of population from the rural to the urban areas does mean an increase in productivity but our urban areas are not in a position to receive this large influx of population, which poses another serious problem for the planners.

The thinking on the subject may be summarised as follows : agriculture and industry are rightly looked upon as closely linked parts of the same process of development. But in this process industry has to play a leading role in securing rapid economic advance. Because of her natural resources, India has a considerable potential for industrial growth. She has good reserves of iron-ore, manganese, bauxite, coal, mica and atomic materials such as thorium ores. Surveys and explorations have already indicated the prospects of oil reserves. There is a large potential for hydro-electric power. With high grade iron ore available in considerable quantities, India is able to produce her own steel at reasonable cost. Her potential capacity to produce steel and other basic materials relatively cheaply, and the large and growing domestic market, place her in a favourable position to produce machinery and a large range of engineering, chemical and electrical goods needed for development. In turn, these will stimulate the growth of medium and small industries and expand employment both in urban and in rural areas. Thus, on foundations which have been already laid, it should be possible to build up an integrated industrial structure and expand industrial production efficiently along the lines of real comparative advantage.

It is only one step more in this analysis to realise that we must not only quicken but also broaden the pace of industrial development by the establishment of basic and heavy industries. A beginning in this direction was made in the Third Five Year Plan. This has implications which need to be realised. So far, the economy has been dependent upon imports of machine parts, which means that the mass of the people really lose the many-sided benefits of the employment multiplier released by economic development. That is the reason why industrial employment has not risen proportionately to the massive increases in output that have taken place in a very large variety of lines. This is so because we do not yet produce on a sufficiently large scale the machines which make our goods. Further, the machines that we import have a lot more

potential than we are able to utilise. This would be tolerable and even welcome, provided simultaneously employment is created through the domestic manufacture of machines. Large increases in employment potential in the advanced industrial countries were realised because the same countries produced consumer goods as well as capital goods. While the consumer goods created a small volume of employment, a very large and increasing volume of employment was created by the investment goods industries. The whole literature on economic growth and development emphasises the crucial importance of investment industries in the creation of full employment conditions. We must ourselves make the machines which will produce our goods. It is one of the happiest signs that both in civil industry as well as in defence, a massive effort is on the way in this direction. This will create employment and the necessary background for development and if we can *couple it with the right kind of social and economic policies*, we shall have laid the foundations of a really productive economy.

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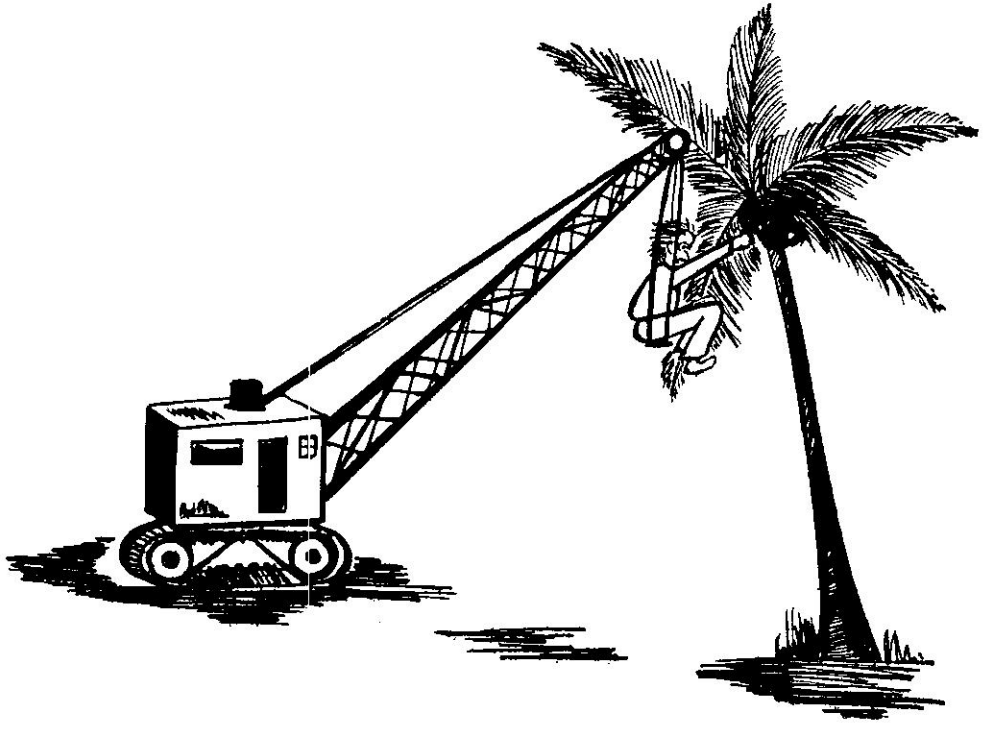

Motivation and Morale in Industry†

Narendra K Sethi*

The establishment of motivation and the maintenance of a high level of morale are of paramount importance in order that management can attain its goals of profit and growth. Innovation without which growth and survival cannot be attained is in turn dependent on proper motivation and morale.

The American College Dictionary defines motivation as "a providing of a motive and inducement." The definition of morale is "moral or mental condition with respect to cheerfulness, confidence, zeal. Morale is the working climate". It is a collective characteristic and generally refers to the state of mind of a group rather than an individual.[1]

AN INDUSTRIAL ENTERPRISE IS COMPRISED OF metal, mortar and men. The constant factors are the machines and the structure of the plant. The variable factor, of course, is human labour.

Of the two sets of factors, the fixed factors are the least important in the total scheme. Machines have a predetermined performance range. Management can buy machines that are flexible enough to accomplish an assortment of operations or specific enough to perform extremely complex or demanding operations.

Management, therefore, can purchase the means for production and receive performance in *direct* proportion to the money expended. Likewise, modern plants can be built according to the latest concepts of efficiency to contain the machinery so that the optimum use of both is accomplished. Theoretically, at least, if we have a modern plant and the latest machinery, we should be in a position to maximize profits by getting the most efficient production possible.

It is at this point that we may introduce the variable factor: the people. It is *this dynamic factor that is so variable as to make the difference between profit, loss, survival, or decay of the entire enterprise.*. It is *the unique combination and effective use of motivated labour*, motivated supervision, and motivated management that, in the final analysis, determines the course of the enterprise.

If we can maximize the performance of plant and machinery, then why is it so difficult to maximize the performance of people?

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†The author has endeavoured to present in the first section of this paper a critique of the various theories of motivation that have been advanced by a number of authorities in the area of behavioral sciences. The second section is an appendix listing the theories of motivation as set forth in the literature.

[1]Dale Yoder : 'Personnel Management and Industrial Relations' (New York : Prentice Hall Inc. 1954), p. 439.

The simple answer is that it is *not necessary nor possible to "motivate" inanimate objects* such as machines to higher performance. Conversely, people (the variable factor) will not perform effectively without motivation. If we know that *motivation is the essential ingredient in the mix of these factors*, then why should it not be a simple matter to achieve maximum production from the combination of plant, people and machines?

The answer lies in the fact that motivation has been the object of study by sociologists, anthropologists, and psychologists for centuries. In spite of the vast literature on this subject there is considerable disagreement among some of the greatest minds of our time as to what factors would motivate men and how these factors are to be applied.

It is of little wonder then that *many of our progressive enterprises employ skilled psychologists to manage the personnel division.** Yoder (1954) states: *"no physical factors—light, heat, ventilation or any other appear to be so important in affecting output as the level of morale"*[2]

REVIEW OF LITERATURE

Let us now see what some experts in the field of human behaviour have to say on the subject of motivation: Frederick Taylor felt that man's basic motive was economic. Therefore, if a man was paid a sufficient amount for his services, he would produce at his best level. The fallacy here is that *all men were considered identical units in the production process.*[3]

Elton Mayo felt that man's basic need is to *belong to a group.* This group affiliation fulfilled a basic human need and motivated workers to better performance. Mayo's ideas were supported by his famous "Hawthorne Study" conducted at the Western Electric Company in the 1920's. This study demonstrated that workers wanted to be treated as "human beings" rather than as units of production.[4]

Where scientific management had been content to assume that man's most basic motives were economic, Mayo and his "Human Relations School" made an equally oversimplified assumption that group membership and affiliation were the most fundamental and essentially the only needs of any consequence.[5]

Gellerman's view was that Mayo's findings were distorted by other factors which he did not take into account in his Hawthorne study. Gellerman claimed that some of the other important needs could be : security, esteem, intrinsic job interest, and achievement.[6]

Recently, other investigators—notably Schachter (1959), Shipley and Veroff (1952), and Herzberg, Mausner, and Synderman (1959)—have thrown new light on the affiliation motive. Research by these men showed that the affiliation motive could exist because factors such as likemindedness, anxiety, and possibility of interpersonal rejection were prevalent. The affiliation motive is strongest in individuals who have developed anxiety due to having been rejected or having the fear of being rejected. Affiliation in groups, therefore, tends to allay anxiety.[7]

Dunnette and Kirchner[8] (1965) list three other important motives in addition to affiliation. These are:

Security Motive—At certain times security could override all other motives. Evidence of this occurred in the depression of 1929. Job security became the predominant motive.

Competence Motive—People *look for approval from others to confirm their worth and competence.* If this fulfilment is *not received on the job, they may join clubs or organizations where their competence can be confirmed.*

*Not in our country—**Editor**

[2]Yoder's 'Personnel Management and Industrial Relations' p. 439

[3]Marvin D Dunnette and Wayne K Kirchner : *'Psychology Applied to Industry'* (New York : Meredith Publishing Co. 1964), p. 130

[4]Ibid p. 132

[5] ,, ,, 133

[6] ,, ,, ,,

[7] ,, ,, 135

[8] ,, ,, ,,

Achievement Motive—Achievement is a fundamental human motive. People with high achievement goals will strive harder for things that seem important and reasonably attainable. They will *tend to ignore easy goals* because attainment will not provide a sense of accomplishment. This is why structuring of jobs can be important. *Sometimes jobs can be structured so they become increasingly demanding.*

In the area of affinity or compatibility for particular types of work, research by Strong (1955) demonstrated that college students showing an aptitude for a particular type of work (lawyer, engineer, or doctor) were four times as likely to be in that profession twenty years later as those who did not show compatibility. To a lesser degree the research showed job satisfaction to go hand in hand with vocational persistency and compatibility.[9]

It is felt that if selection of employees could be accomplished scientifically, so that compatibility for certain types of jobs is known at the time of employment (or through testing at any time a change is made in specific job nature or level, after employment), the job of motivation would certainly be easier.

A significant advance in the area of motivation was made in studies by Herzberg, Mausner and Synderman (1959). The studies indicated that there were certain factors surrounding employment that tended to satisfy the employee and thus produce positive motivation. Meanwhile, there were other factors that produced negative motivation and these factors tended to override the positive motivational factors if they produced a negative response in the individual or group."[10]

The label assigned to these factors was *satisfiers* or *dissatisfiers*. To support their veiwpoint, the authors used the "critical incident method" to obtain information about unusually satisfying or dissatisfying job situations. The information was obtained from two hundred employed engineers and accountants.

Satisfiers included

1. Opportunity to experience achievement
2. Recognition
3. Sense of responsibility, and
4. Advancement in the jobs that were intrinsically interesting to respondents.

Dissatisfiers included

1. Incompetent or cold supervision
2. Poor company policies and administration
3. Criticism or blame (negative recognition) and
4. Poor working conditions.

Testing indicated that some factors were mentioned only negatively. These included such factors as good supervision, good company policies, and working conditions.

The study concluded that these factors could not be used to motivate people. They could only be used to prevent negative feelings from developing.

Job circumstances, therefore, (if Herzberg *et al's* studies are valid) must include opportunities for achieving and for gaining recognition and increased responsibility if they are to constitute a motivating state of affairs.[11]

In the area of satisfiers, structuring of jobs according to particular individuals could have a large impact on motivation. Structuring of jobs, as mentioned earlier, would consist of making jobs easier or harder to meet the "satisfier" needs of the individual.[12]

In spite of the significance of the studies, they did contain several weaknesses :

1. The Information was obtained through personal interviews and, of course, contained highly subjective accounts of job situations.

[9]*Psychology Applied to Industry*, p. 147

[10]Ibid p. 149

[11]Psychology Applied to Industry, pp. 150-151

[12]Ibid p. 152

2. The zeal of the investigator concernning his own beliefs about job motivation may be reflected in the categorizations developed from such subjective information.

3. The study included accountants and engineers who are more desirous than other employees (such as production workers) of opportunities for achieving and for gaining a sense of recognition and esteem.

4. As the study was comprised of completely subjective information, no observations or measurements of actual job behaviour were made.[13]

Regardless of the apparent weaknesses in the studies, a new area was uncovered and doubtless other studies would be made based on the pioneer work done by Herzberg, *et al.* These studies will likely contain measurable aspects of the satisfier and dissatisfier factors as mentioned above.

It is felt that if Herzberg *et al*'s studies can be supported by other studies along with more meaningful and measurable statistics, an area exists for management to *better utilize the vast expenditure of money presently expended for employees' wages and never-ending parade of fringe benefits.*

In other words, if supervision, work, environment, and company policies are responsible for negative motivation, perhaps more money could be spent in these areas than in other areas producing less in the area of positive motivation.

As an example, it is felt that modern industry should spend considerably more money than it presently does in training its first line supervisors.* Formal training programs should be a requirement whenever a supervisor is to "supervise" a group of employees. Of course, if the training is successful at the first level of supervision, its benefits will be carried up the line as the supervisor advances through the ranks to higher levels of management. The implications of this approach are that the number of autocratic managers with myopic points of view towards workers as human beings would be reduced.

Vroom (1964) maintains that there are two types of conditions that affect the likelihood that people will work:[14]

1. Demand for goods and services and therefore a demand for workers to produce. This is called an economic condition.

2. *People prefer working to not working.* When the balance of outcome expected from working is more positive than from not working, this is called a motivation condition.

In conjunction with the second proposition, Vroom lists some conditions motivating people to work:[15]

1. Provision of wages in return for services;

2. Expenditure of mental and physical energy;

3. Opportunity to contribute to production of goods and services;

4. Social interaction with other persons; and

5. Social status.

The importance of non-economic factors determining motivation to work was demonstrated by Morse & Weiss (1955)[16].

A National Sample of employed men was asked "*If by chance you inherited enough money to live comfortably without working, would you continue to work or not?*" *Eighty per cent*

[13]Ibid. p. 153

*This is exactly in accordance with the present policy of the National Productivity Council of India —**Editor***

[14]Victor H Vroom : *Work and Motivation* (New York : John Wiley & Sons Inc.)

[15]Ibid. pp. 30-31

[16]Ibid.

of 401 respondents stated they would keep on working. Interestingly, the percentage varied with the age of the respondent :

90% in the 21-34 age group said YES

61% in the 55-64 age group said YES

A higher percentage of those in skilled occupations chose to continue work although 58% of the unskilled also stated they would continue to work.

Further evidence of the desire to work without the need for its economic rewards was demonstrated by Brown (1954) who noted the cases of three workers in London who returned to work after winning enough money in football pools to live comfortably the rest of their lives. Two of the men worked on routine repetitive jobs and the third was a fitter.[17]

Hendrich (1943) proposed a modified psychoanalytic view of motivation with his concept of the "work principle". He states: "*work is motivated by the need for efficient use of the muscular and intellectual tools, regardless of secondary needs.*" White (1959) listed what he called the "Concept of Effectance Motivation." Satisfaction and a feeling of efficacy exist if an individual feels he is changing or affecting his environment.[18]

It is felt that any normal human being who has the physical and mental ability to perform work would prefer to work in order to satisfy his needs for achievement. This sense of achievement predominates over all other work satisfiers. Evidence of this is demonstrated by the "retired" man working in his garden, a scientist working by himself on a project, a painter trying to create on canvas an expression of himself. These people do not necessarily interact with other people or seek recognition from others. Their basic desire is achievement. However, in every day work life, the sense of achievement is not always enough to keep a person interested or motivated in his particular occupation. Sometimes the choice of a particular vocation or line of work was made without due consideration as to the possible negative aspects of the job. Forer (1953) stated that "the choice of a vocation is not primarily rational or logical but is a somewhat blind, emotional, impulsive and automatic process and is not always subject to practical and reasonable considerations.[19]

Vroom (1951) found that *job turnover increased as requirements for the job became less skilled.* The study demonstrated that *professional people and highly skilled people scored highest on job satisfaction. Interestingly enough, farmers, in this study scored* 80% in *job satisfaction. Conversely, clerical and sales workers scored low in job satisfaction.*[20]

Porter (1962) noted in a study of managers that *need fulfilment deficiency increased at each lower level of management.* Results imply that *greater satisfaction of higher level manager is due,* at least in part, *to greater opportunities to satisfy esteem, autonomy, and self-actualization needs.*[21]

Previous to Porter's study, Maslow (1943) stated that "a musician must make music, an artist must paint, a poet must write, if he is to be ultimately happy." "What a man can be, he must be. This need we may call self-actualization."

Maslow classified self-actualization as a higher order need. He maintained that when lower order needs such as food, water, safety, and acceptance have been satisfied, higher order needs such as self-actualization emerged.[22]

An interesting observation was made by Vroom (1961 & 1962) who noted that, if a person believes he has an ability, he will perform a job requiring the ability better than if he felt he did not have the ability. Actually, the ability might have been the same in both instances.[23]

[17]Ibid. p. 32

[18]*Work and Motivation,* pp. 37-38

[19]Ibid p. 98

[20]Ibid. p. 130

[21]Ibid. p. 132

[22]*Work and Motivation,* p. 138

[23]Ibid. p. 267

People vary greatly in what will motivate them. What motivates one will not always motivate another. However, numerous studies indicate that the general order of preference as important motivational factors by workers are

1. *Steady work*
2. *Good working conditions*
3. *Good boss*
4. *Opportunity to advance*
5. *Wages*

It is interesting to note here that *the factor most workers complain about* (wages) *is listed last in order of preference.*

The effect of culture on motivation is demonstrated by Pfiffner. He maintains that lower class negroes have such a struggle to survive that their motivation for work is less than that of middle and upper class people.[24] Pfiffner maintains that job security can be used as a motive. In this respect there are three major aspects of superior subordinate relationships:[25]

1. Atmosphere of approval
2. Knowledge of what is expected of the employee and
3. Consistent discipline.

Pfiffner claims that *people will comply with stern discipline if they feel it applies to all and that there are no favourites.* Surprisingly, Pfiffner mentions that caution should be used in giving praise. Sometimes an employee may lose the fear-stimulus formerly utilized to achieve performance.

Sayles & Strauss (1966) state as a basic premise: Some people derive only slight personal satisfaction from their jobs. They enjoy little sense of accomplishment or creativity. Further, they did not select their supervision. Also, they have no opportunity for self-expression such as the farmer or professional man.

They also claim that *boring jobs with little freedom induce stubborness and laziness.* They list five basic approaches to motivation in order to satisfy workers' personal needs and also meet the requirements of the organization.[26]

1. *Be Strong policy*—the boss is the ultimate authority — work or be fired —keep busy — labour is a commodity. In this vein, fear-motivation is sometimes effective with executives, supervisors and white collar workers where there is no union protection.

2. *Be Good policy*—this system is characterized by the paternalistic method which is somewhat outmoded today. Another method is the *Hygienic system in which workers are showered with fringe benefits, good supervision, etc.*

3. *Implicit Bargaining* — management does not use all its weapons to get production. Instead, it allows workers to do things not customarily condoned. The agreement is not in writing, but is understood by the management and the workers. It is a gentleman's type of agreement.

4. *Competition*—this method is used where there is no union. It makes workers compete for pay increases and advancement. This method produces aggression in some workers and regression in others, thus destroying the effectiveness of the participants. It is not recognized as a good motivator with the possible exception of using it in moderation with the outside sales force.

5. *Internalized Motivation*— this method employs a minimum of supervision. In this system, workers feel a sense of accomplishment and they work harder because they feel the need for satisfaction is achieved. Elton Mayo called this system "Spontaneous Co-operation".

[24]John M. Pfiffner : *The Supervision of Personnel* (New York : Prentice-Hall, 1951) p. 242

[25]*The Supervision of Personnel*, p. 248

[26]Leonard R Sayles & George Strauss : *Human Behaviour in Organizations* (Prentice-Hall) 1960 & 1966

Case Study

A good example of the paternalistic method in operation is at Schramm, Inc., makers of compressors.[27]

This company has a family style approach to management. The company feels that when it hires a person, it owes that person a life-time of work. Schramm, Inc., is not unionized and there is little likelihood that it ever will be.

A typical statement from employees is "there is nothing a union can do to improve matters at Schramm."

At Schramm, management's objective is to see things with the employee's point of view in mind. This philosophy has created a team effort that allows Schramm to compete with the giants of the compressor industry.

Among the benefits at Schramm is the profit-sharing plan in which all employees participate and receive a set percentage of sales. In addition the company adds 10 per cent to the amount for each year with the company, up to 10 years of service.

The pension plan is completely paid for by Schramm with no participation required by the employees.

Demonstrating the effects of the approach used, longevity at Schramm breaks down as follows : 91 of 300 employees have been with the company for 20 years or more and 8 have been employed for over 40 years. Very strong employee loyalty exists and as stated previously, it is unlikely that a union can gain entrance.

It appears that this is a unique case which is workable because of a relatively small labour force and because it is a single plant operation. Nevertheless, Schramm is a successful enterprise, complete with super-ordinate objectives whereby essential needs of employees and management are being satisfied at the same time. Rensis Likert states, "*Every human being earnestly seeks a secure, friendly and supportive relationship and one that gives him a sense of personal worth in the face to face groups most important to him.*"[28] Certainly Schramm, Inc. fulfills these requirements.

A somewhat different approach regarding motivation was revealed by Scott Myers writing about an interesting six-year study taken at Texas Instruments Company. He concluded that *some workers were motivatable, some were not.*[29] It was noted in the study that *during a period of rapid company growth, motivation is to a large extent self-generating. It is when the impetus of rapid growth slows down that supervisory skills in motivating people become more important.*

Other conclusions were that employees can be divided into two personality types :

1. *Motivation seekers*, and
2. *Maintenance seekers*

It was found that motivation seekers' strongest motivation is derived from achievement, responsibility, growth, advancement, work, and earned recognition. These people are motivated by the nature of the task and have a *high tolerance for poor environmental factors.*

On the other hand, maintenance seekers are motivated primarily by the nature of their environment and tend to avoid motivation opportunities. These people are chronically *preoccupied* and dissatisfied with maintenance factors surrounding the job such as pay, supplemental benefits, supervision, working conditions, status, job security, company policy and administration.

It is important to note that motivation seekers in an atmosphere lacking motivation factors tend to adopt attitudes of maintenance seekers. However, maintenance seekers working in an atmosphere with motivation seekers tend to act like motivation seekers.†

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[27] "Family Style Approach to Management", *Business Week*, July 24, 1965, p. 60

[28] Paul Pigors, Charles A Myers & P.T. Malm :

[29] M Scott Myers : *Harvard Business Review* (Jan-Feb. 1964), p. 73

† If this position is correct, it is the atmosphere and not the type of worker that is relevant to the analysis.
—Editor

If the results of this study can be accepted, it is evident that *the spiraling cost of fringe benefits in business and industry indicates that management is making misguided and futile efforts to motivate through maintenance factors.*

Texas Instruments, in order to facilitate the meeting of motivation needs for employees, had instituted a programme for supervisors entitled "Seminar in Motivation".

This programme was presented to all levels of supervision. Groups contained six to ten supervisors and the meetings consisted of a series of six 2 hour sessions.

In order to measure the quality of their supervision, Texas Instruments Company had initiated a formalized attitude measurement programme, structured around the motivation-maintenance frame of reference. Six maintenance and four motivation need areas were covered. The survey would indicate which areas need reinforcement.

It is felt that the Texas Instruments study is a major study made in recent years. The reason for this view is that the study recognizes that *most workers are motivatable under proper supervision and in an environment conducive to motivation.*

It is well to note that *supervision in many cases mirrors the influence of management.* It would do well for management, therefore, to be certain that good morale building programmes are in effect. Morale cannot be weighted on a scale like a pound of butter; it cannot be measured with a rule like a strip of carpet; it cannot be gauged with a thermometer, like the temperature of a room. Yet, although intangible, it can be measured.[30] Recent efforts in the area of measuring employee morale are: General Electrics — *Employee Relations Index*; Industrial Relations Center, University of Minnesota—*The Triple Audit*; Science Research Associates Inc.,— *The Morale Inventory.*

[30]Joseph Tiffin: *Industrial Psychology* (New York : Prentice-Hall Inc. 1952) p. 465

The first step in recording morale level is to develop a norm. Later, any deviation from the norm would indicate corrective action. Some techniques for getting indicators are: observation, appraisal, counselling, critical incidents, and occasional surveys.

The purpose of the programme is to first build morale and then maintain it; rebuild it if it declines. Many companies have found the exit interview to be an effective tool in determining the morale level of the company. Questions are selected to screen irrelevant gripes. The exit interview also helps measure supervisory effectiveness.

Professors Knowles and Saxberg of the University of Washington reflect somewhat on McGregor's "Theory X and Theory Y" regarding man's behaviour.[31] Theory X represents that man is innately lazy and unreliable. Theory Y represents that *man can be basically self-directed and creative if properly motivated.* They conclude that if we assume that man is good, we can believe that *misbehaviour is a reactive response rather than a manifestation of character.* This will lead to a search for causes in his experience rather than in his nature. *If the assumption is that man is bad, we are prone to assume that misbehaviour is caused by something within him which we cannot alter directly. We must then limit his freedom to choose and act through external curbs or controls.*

The supervisor chosen because of his production record is as likely as not to be a failure in handling men; and we might add that he will almost certainly fail unless he is given specific training in how to handle men.[32]

Douglas McGregor stated in his paper on "Conditions of Effective Leadership in the Industrial Organization" that "The outstanding characteristic of the relationship between the subordinate and his superiors is his dependence upon them for satisfying his

[31]Henry Knowles & Borje O Saxberg : *Harvard Business Review* (March-April, 1967), p. 20

[32]*Harvard Business Review* (March-April 1967), p. 20

needs."[33] He pointed out that there were two main points in the relationship:

1. The necessity for security in the work situation ; and
2. The necessity for self-realization.

The feeling of security by the subordinate is reflected not so much by what the superior does but by how he does it. The feeling of security can be accomplished only when the subordinates have the genuine approval of their superior.

McGregor further stated, "In the absence of a genuine attitude of approval, subordinates feel threatened, fearful, and insecure. *Even neutral and innocuous actions of the superior are regarded with suspicion.* Effective discipline is impossible, high standards of performance cannot be maintained." Under self-realization, McGregor listed four factors essential to a healthy superior subordinate relationship:

1. Adequate sense of security in relation to superiors
2. Opportunities to participate in the solution of problems and in the discussion of action which may affect him
3. Opportunity to assume responsibility as he becomes ready for it
4. The right to appeal over the head of his immediate superior.

The conditions listed for proper fulfilment of the subordinate-superior relationship apply to all levels from first-line supervisor-worker to the top management.

Vroom indicated that a change in supervision sometimes affected employees' attitudes toward other job factors such as job content, and working conditions, etc.[34]

Putnam (1930) maintained that first-line supervision is the single most important factor in determining the attitude, morale, general happiness and efficiency of the employee.[35]

Davis (1962) concluded that *employee-oriented supervisors tended to get better productivity, motivation, and worker satisfaction.*[36]

Pfiffner reflected that *the old concept of the tough, colourful, hard-driving boss is a thing of the past.*[37]† He felt that the important qualities of an effective supervisor were that he must have knowledge of the work and of handling of people. He must be able to coordinate work and people. *A prime quality of the good supervisor is that he be objective and tolerant.* Also a good supervisor will *de-emphasize his own ego* while building up the ego of his subordinates. Accordingly, he must be people-minded and allow workers the opportunity for ego-environment. Meanwhile, he must be firm, decisive, and objective.

Yoder stated, "Interest is related to fatigue." A job requiring sustained interest or attention is tiring. Monotony produces mental or psychological fatigue.[38]

Conclusion

1. Human beings are complex organisms with a mental make-up determined in large part by past experience. They have definite needs which must be fulfilled in order for them to be motivated.

2. Those supervisors who have been trained in human relations should be allowed to supervise any group of people due to the complexities of human nature involved therein.

3. The penalty to management for not recognizing the need for highly trained supervisors in human relations is the tremendous expense of labour turnover and inefficiency of job performance.

4. Most workers are motivatable under proper supervision and environment.

5. Motivatable workers can become maintenance seekers under non-motivatable conditions.

[33]Douglas McGregor : "Conditions of Effective Leadership in the Industrial Organization", *Journal of Consulting Psychology*, (1944, Vol. III □ 2, March-April), pp. 55-63

[34]Vroom, *op. cit. p.* 104

[35]Ibid, p. 105

†Not in India.—**Editor**

[36]Ibid, p. 161

[37]Pfiffner, *op. cit.* p. 235

[38]Ibid, p. 480

APPENDIX

Theories of Motivation

1. Theories on Motives

A. Competence Motive : Robert W White

White expands on the classical theories of Freud. He feels that Freud didn't take in the aspect of human behaviour too deeply. To White, man is an active observer and shaper of his environment. One of the main springs of motivation for man is his drive to understand and manipulate his environment. He wants to be active rather than passive.

A feeling of competence depends upon the successes and failures of man in his early life in coping with day to day problems. If his success outweighs his failures, he is apt to feel that he should not strive for anything but rather he should sit back and let circumstances come along and have their own way with him*. To White this occurs in man most crucially in the age of six to nine years. His needs of independence are just beginning.

Adults express this competence motive in a desire for job mastery and professional growth. *The job becomes for man an arena in which he matches his skills against his fellow workers and the environment.* Many lasting job satisfactions are attained through the solving of the most difficult problems. This plays a great role in effecting job success. Man will try to show that he has the initiative and the drive that will enable him not to be influenced by the environment. Rather he will try to influence the environment.[39]

B. The Affiliation Motive : Schacter

People like to be with other people, but this desire is stronger in some than in others and stronger under certain conditions. It was generally assumed that affiliation was either a means to an end or an end in itself. *People socialized either to gain an end or just because they liked to be with persons.* Schacter dealt with the latter opinion.

The reason for seeking others' company was a seeking of similar sharing of an opinion. This reassured the person that the world was not all that bad and that there is some order to it. It didn't matter if these opinions were true or false.

Schacter devised a number of experiments to determine if the discomfort of uncertainty was a motivating factor to induce affiliation. In one experiment he induced an element of fear into his subjects by saying that they would feel a slight amount of pain. Telling them there was to be a delay, he let them decide if they would like to wait alone or with another person. They chose to be with someone, proving a point of his that misery enjoys company.[40]

C. The Achievement Motive : David C McClelland

Just about everyone has an achievement motive. It varies in degree among individuals. The person with this motive is made susceptible to appeals that he try harder. They will put more effort into their work if they are challenged to do so. He will try harder and harder and demand more of himself. This trait or motive can be found in students with good grades and junior executives who are rising fast in a company.

A characteristic of this motive is that it seems to make accomplishment an end in itself. The person seems to take pleasure in winning or competing successfully with a difficult standard. In a sense, he is an altruist. It is

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[39] Robert W White : "Motivation Reconsidered : The Concept of Competence" *Psychological Review*, Vol. 66, No. 5 (1959), pp. 38-42

*This needs elucidation, for on a commonsense basis, this is likely to happen precisely when failures outweigh success.—**Editor**

[40] Saul W Gellerman : "Motivation and Productivity" American Management Association (1963), pp. 115-121

not the tangible award of the achievement that satisfies him, but the satisfaction of accomplishing what he set to do as best as he could.

Achievement motivation has a tendency of making people more realistic of themselves and the goals that they seek. They realize that big rewards do not come easy and there is a lot of hard work involved. Therefore, when an achievement-motivated person tackles a problem, he mentally digs in for a long hard battle rather than look for the lucky breaks. This is not to say that he is more gifted than the next person in organizational ability. What I am trying to say is that he is better equipped to use his capabilities. To sum up, *the achievement-motivated person is practical, ventured and determined.* When confronted with an obstacle, he does not dwell on the object itself but rather on how to get around it.[41]

II. Hierarchy of Needs : AH Maslow

According to the Theory X philosophy, the only incentive or motive by which man was encouraged on the job was by money. This was the thinking of the paternalistic autocratic entrepreneurs in the early history of big business. Today, unfortunately, however, *there are some who still entertain this outdated philosophy.* They fail to recognize that there are other motives or needs than money which compel a man to work. The following is what has been classified as the workers' hierarchy of needs.[42] They are ranked according to their importance to the worker. As one is achieved the next is sought. It must be remembered that one cannot be satisfied until those before it have been satisfied first. Also as the employee reaches another stage in the organization his needs change so that the process starts all over again. The reason is that each level has its own demands to make of its members.[43]

This theory about a hierarchy of needs is a relatively new theory. It was advanced by A. H. Maslow around the period following the Second World War. In this theory he states that there are five general types of needs:

1. Physiological
2. Safety
3. Belonging
4. Status, and
5. Self-realization.

The physiological needs refer to food, water, oxygen, sex, elimination and rest needs that are controlled by the chemical conditions of the body. These are of two types. One is a lack of something such as food and rest. The other is an overabundance and leads to a reaction such as excretion and the sex drive. These needs are exploited in advertising with such slogans as : "The pause that refreshes," and "My Sin."[44]

Avoidance of physically harmful situations is involved in the safety needs. They involve protection against excessive heat and cold, poisonous chemicals, accidents, etc. Unlike the physiological needs, the safety needs are not dependent upon the condition or reaction within the body.

Belonging needs refer to man's desire to be accepted by the other people in his group and his need to have satisfying relationships with them. His inherited traits, life-long experiences and his long dependence on his parents have made man aware that the satisfaction of his many needs comes through those about him. This arouses in him a strong desire to be liked and accepted by his group and fears its rejection of him.

Duties and privileges in a group are conferred through status. All in the group have status, but some have more of it than others. Leaders have more status than their subordinates. Status is conferred upon a person by the position he holds and *the recognition by*

[41]Ibid. pp. 122-141

[42]AH Maslow : "A Theory of Human Motivation", *Psychological Review,* Vol 50 (1943), pp. 370-396

[43]Rolland F Pellegrin & Charles Coates : "Executives and Supervisors: Contrasting Definitions of Career Success", *Administrative Science Quarterly,* March 1957), pp. 506-517

[44]Henry C Smith : *Psychology in Industry,* New York : McGraw-Hill Book Co. 1944), p. 26

the others in the group that it is a status position. It is a continuing process to maintain and improve one's status.

The need to become what one thinks he is capable of becoming is self-actualization. It is the need to do work that is in itself satisfying.

Maslow has summarized his theory of the hierarchy of needs in this way :

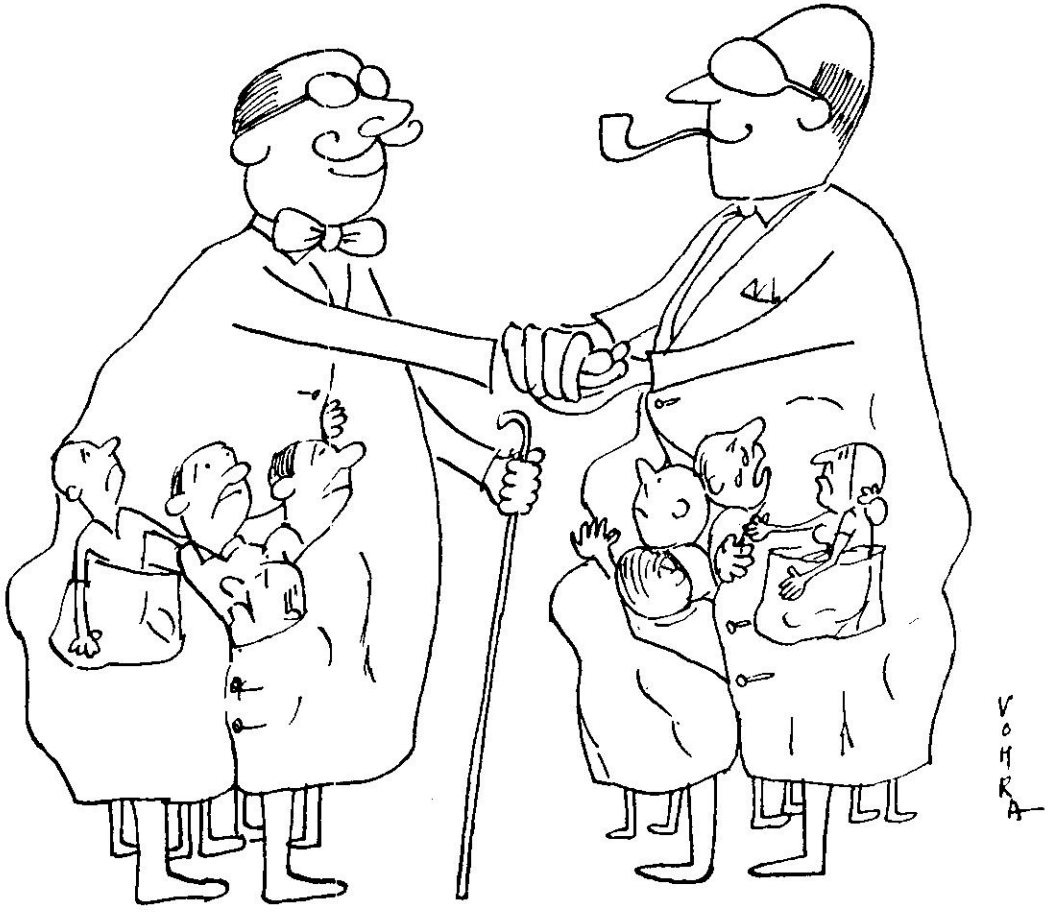
> It is quite true that man lives by bread alone—when there is no bread. But what happens to man's desires when there is plenty of bread, and when his belly is chronically filled? At once other (higher) needs emerge and these, rather than physiological hungers, dominate the organism. And when these in turn are satisfied, new (and still higher) needs emerge, and so on.*[45]

The theory suggests, therefore, that work is most likely to satisfy the lower needs while it is least likely to satisfy the higher needs.

His theory further divides needs into deficit and growth needs. Of the five types of needs only self-actualization is a growth need. Before the growth need can be met the deficit needs have to be satisfied. It is to be mentioned that the meeting of the lower needs does not bring satisfaction. They remove dissatisfaction and pain but they do not bring satisfaction and comfort.

*Lenin said the same thing, a bit more strongly, more nonchalantly, and in fact more significantly : "Remember, Comrades, *after people get bread, they will ask for poetry*"—**Editor**

[45] *Psychology in Industry*, p. 26



Production Volunteer Corps

GN Gandhi*

True to his name, the author, an officer of the Bharat Heavy Electricals at Hardwar, has felt disturbed by the tremendous loss in output due to the poverty of industrial relations in this country; and he has been thinking out a constructive solution: the evolution of a Voluntary Production Society, based on a *Production Volunteer Corps* (PVC) in practically every industrial set up. He discussed this matter with us for quite some time; and we were in the first instance inclined to dismiss it as something entirely Utopian, against the hard background of existing reality.

We, however, find that he is being rightly encouraged by his own Management and by some people in authority in whom the Gandhian element has survived. Against the dark and murky background of present times, we think there is nothing to be lost and probably much to be gained in giving vent to a bit of idealism: in fact, a little bit of Utopian experimentation in every organisation might exert an elevating influence on the whole environment. In that context we think Sri Gandhi's proposal of a Production Volunteer Corps (PVC) is a healthy adventure worth trying out.

We would, however, make it clear that *we are totally opposed to the utilisation of the PVC as a strike-breaking mechanism* **and we have, therefore, taken the liberty of expurgating the relevant portions of Sri Gandhi's original thesis. This, however, in our opinion, does not do any damage to his main contention of revitalising the ancient instinct of man for public good. In fact, we are of the opinion that the essential part of the Gandhian philosophy is exactly that, namely, to put a premium on the goodness of man and to counter its evil potential by activising the goodness inherent in every man. It is true that after Hitler, it is difficult to sustain faith in such a philosophy, but at the same time it is difficult to conceive of an alternative social philosophy that would save the soul of man for what it's worth and, at the same time, maximise social welfare. Sri Gandhi's PVC may not fully succeed everywhere, but even if it works at a few places, it will be worthwhile. Incidentally, the recent Back Britain Campaign in the UK is much like the PVC.**

OF ALL THE COMPLEX PROBLEMS ASSOCIATED with economic growth in a democratic country, the greatest one is how best to safeguard individual freedom guaranteed by the Constitution on the one hand and to ensure optimum un-interrupted production on the other, by means allowed within the framework of the Constitution. In other words while we cannot resort to coercive methods to make people work hard and allow uninterrupted production, we can certainly think of methods within the framework of individual freedom to *domesticate both workers and managers* to so adjust that they work unitedly for optimum production.

*Bharat Heavy Electricals, Ranipur (Hardwar), U.P.

This we can do only when we *bring* workers and managers — the two partners — closer to each other. The present set up, however, does not allow the two to come closer to each other in the absence of any forum where informally both may meet, discuss, understand and appreciate each other's viewpoints. In the situation, as it exists, the two partners do not see eye to eye with each other, considering each other as a distinct class meant to safeguard interests opposed to each other. *Managements consider the Unions as anti-production and anti-management associations,* always fighting to safeguard interests opposed to their's and vice versa. This creates a gulf between the management and workers, and in the absence of strong internal leadership, is the major cause of low productivity. Once this gulf is bridged through some informal system and proper leadership amongst the workers developed, it is possible that we may achieve better relations in our undertakings where unfortunately these are fast deteriorating. *The existing formal arrangements hardly provide opportunities for workers and managers to come closer to each other, for the spirit in the environment is more of 'take and take' rather than 'give and take'.*

Once an informal forum outside the management and unions — open to all workers, supervisors and managers — is set up, we may achieve a change in their hearts, both considering each other not as an opponent but as a partner. It is in this context that a Voluntary Society is proposed (for each of our plants) to be set up with the objective of achieving harmony between the two partners, for ensuring uninterrupted production which the nation needs at the moment.

Voluntary Society

Coercion being out of court in a democracy, we have to prepare people to follow a particular course through persuasive, educative and, if necessary, through training and incentive methods. The idea here is to raise a voluntary society to be sponsored by few dedicated persons carrying the blessings both of the management and the workers, to begin with: consisting of workers, supervisors and managers who will pledge to do their best under all circumstances. The society will raise *a Production Volunteer Corps* to the extent of 20 per cent of the working force, to help it achieve the objective of optimum production. The underlying assumption in securing 20 per cent of the dedicated force is that normally 80 per cent in any community are neutral, 10 per cent are actively good and 10 per cent are aggressively evil. Also, dynamically, the actively good, as also the actively evil are each trying to draw the neutral 80 per cent into its own sphere. As men are by and large naturally good, the 10 per cent actively good fellows should be able to draw an equal number from the passive 80 per cent. It should, therefore, not be difficult for the society to raise a task force to the extent of 20 per cent; and a 20 per cent force strategically deployed is sufficient to ensure optimisation of production, and also to ensure optimisation of the workers' share in the Gains of Productivity.

Membership

Membership of the society will be open to all workers, supervisors and managers, who have the deep-rooted faith in the ideals of the society. Since success in the ultimate analysis will depend upon the sincerity and loyalty of the members of the task force, utmost care has to be taken while enrolling them to ensure that they are joining the society out of sheer conviction and deep faith. The member must, therefore, prepare himself to undergo such of the sacrifices that the society might like to call upon, for example, that he will think more in terms of giving to the organization than taking from it in the same manner as the late President John F Kennedy asked his affluent countrymen in his inaugural address '*Ask not what America can do for you, say what you can do for America*'.

Being a volunteer of the production corps he must sign a pledge that he would do his best under all circumstances, that he would always persuade fellow workers also to do their best; further that he would see that workers do get an optimum share out of an optimum production; and that he would see that neither

management nor workers resort to undemocratic or violent means.

Membership of the PVC would be provisional for a test period of say 6 months during which his loyalty and devotion would be tested. This rigid pruning might result in smaller number of volunteers, but is bound to create a truly sincere and dedicated force which might have to face trying moments in the future.

Organisation of the Society

The organisation of the society would naturally be 'tailored' to suit the requirements of the undertaking, but it is assumed that the Executive body of the proposed Society will comprise of representatives of both management and workers who have deep-rooted faith in the ideals of the society. A draft organizational cum functional system is outlined on page 214.

Functions of the Society

While there indeed can be no limit to the functions, the society, by and large, shall concentrate upon the following :

1. To create conditions through educative and persuasive as well as training measures under which people will voluntarily offer to join the society.
2. Being assured that those offering to join are doing so with a deep-rooted faith in the ideals of the society and with a nobler cause to serve, to enroll them in the task force and train them in the best possible way.
3. To conduct such of the socio-cultural and economic activities for and through members that will develop loyalty, sincerity for and devotion towards the ideals of the society and ultimately for the nation at large.
4. To ensure not only optimum production by all positive means (and, if needed, by additional hours of work) but also creating conditions under which true production activities are always encouraged.
5. To create conditions under which there will be an utmost understanding between the management and workers by streamlining the labour laws and allowing the effective utilization of such of the existing legal machinery — like works committee etc. — that is provided for the redress of grievances and doing such other jobs by which the two partners will come closer to each other.
6. To serve the community and the organization as well as the nation in such of the natural and man-made calamities that from time to time affect the society —such as floods, famines, drought, war and disease.
7. To see that the workers gain out of the production system: a living wage is realised at the earliest, and that the share of the workers in the gains of productivity is adequate for developing an active and healthy citizenship.

These are some of the functions through which the society would try to achieve its overall objectives of ensuring optimum production for the good of all.

Benefits

If the above functions are sincerely and faithfully performed, the benefits to the organisations that promote such societies would be enormous in so far as the society would serve as a bridge between the management and the workers and create conditions for the emotional integration of the two which unfortunately is missing in the present day set up. With the gulf thus bridged through the good offices of the society, most of the differences arising because of the absence of this bridge will not occur and the remaining few will be brought round the table for quick and just settlement. The society, with an impartial position and carrying faith and confidence of both, will thus play a unique role of a mediator between the two partners to ensure on the one hand protection of the just stand (both of workers and management) and un-interrupted optimum production on the other.

PATRON

(Head of the Organization)

CHAIRMAN EXECUTIVE COUNCIL

(To be Nominated by the Patron)

SECRETARY

(To Co-ordinate Activities of Members)

Member : Education Communication

- To organise debates seminars at different levels to discuss and find solutions of various problems.
- Publish brochures & articles to mobilize opinion towards aims of society.
- To raise library containing books of high professional and philosophical nature
- To organise meetings: small at shop level, large at block level and occasionally at plant level, addressed by persons of suitable status to mobilize sympathy and to deepen ideals of society.

Member : Task Force

(Production Volunteer Corps)

Enrolment — Training

To Raise & Develop Loyal P. V. C.

Aims of the Society

1. To raise task force which will ensure optimum production by all possible democratic and nonviolent means.
2. To create feeling of optimism and hope amongst the workers to fight misery, poverty—by resorting to the activities that can create conditions for the good of all.
3. To serve humanity, as a voluntary force whenever there is a calamity: natural in the form of draught, famine, flood etc. or man-made in the form of war etc. by such of the activities as needed.

Member : Socio Cultural Economic Welfare

Economic	Social	Cultural
To raise funds for providing emergency loans to the taskforce and other activities that can achieve economic welfare	Share sorrow events: death sickness Share happy events: mariages births	Outside tours Religious discourses festivals womens and childrens programmes

Benefit

To create a new community of harmonious relationship not only amongst workers but also between workers and Management by bringing the two partners closer to each other since the aims of an organisation and Society will identical.

Conclusion

If we have to retain freedom guaranteed by the Constitution, this is the only way to ensure optimum production; otherwise it would mean that we have not been able to understand and interpret the term freedom and democracy and the responsibilities associated with it. The scheme offers both individual freedom and optimum production, the two objectives we value most. It offers a constructive programme of nation building for young persons, and is a hope for the nation itself. *Its call is to all* and its approach is positive : to generate the will to make India better than what it is by reducing, if not altogether eliminating, the areas of conflict by filling the vacuum created in the present day set up. The future rests upon the present generation; and the will and the determination of our youthful workers constitute the really productive potential of society. This generation owes especially its debt to the coming generations to solve the problem of poverty by removing conflicts and hurdles, for it is this generation that in the last three hundred years has been given an opportunity with lot of freedom and assistance and if we fail to do our job, our coming generations may never get the type of opportunity now being made available to us and hence the urgent need for consideration of the proposal of setting up a Voluntary Production Corps in every organisation. A Work Study Cell is good, but a Voluntary Production Corps is something better. In fact, the two must go together for maximising benefits to the individual worker and to society as a whole.

Population Control in the Reverse Gear

The Case of Rumania

Over the period from 1930 to 1966 the number of live births per thousand population fell steadily from 34.1 to 14.3, giving Rumania the lowest birth rate in Europe, apart from Hungary. For several years past, there have been more procured abortions than live births. According to an East German inquiry, in 1961 one Bucharest hospital reported thirteen abortions for every live birth.

Since October last year abortion has become illegal except for women over 45, for self-supporting women with four childern or for reasons of health, rape or incest. The government also tightened up the divorce laws in order to foster the idea of more domestic stability and remove the stigma of Rumania having the highest divorce rate in Europe A system of not unattractive premiums for families producing two or more children has been introduced Contraceptives, if not actually banned, are neither produced to any extent in Rumania nor imported, although there is some talk of producing the pill, which would then be available only on a doctor's prescription.

Not surprisingly, therefore, the cumulative effect of all these factors was a big jump in the birth rate; in August the number of live births per thousand population rose to 38.9, the highest figure ever recorded. The planners, however, seem to have completely failed to foresee what a sudden increase in the number of babies would involve. There is a shortage of prams, nappies, cots, blankets and specialised baby foods. Maternity beds and trained nursing staff are in very short supply. In some hospitals maternity cases are being treated two to a bed; in others patients have to make do with mattresses placed in the corridors. The current production of prams is fixed at 10,000 a year, which was fine before the new law was introduced but quite inadequate to deal with all the new arrivals.

—*The Economist*, London, Jan. 6, 1968

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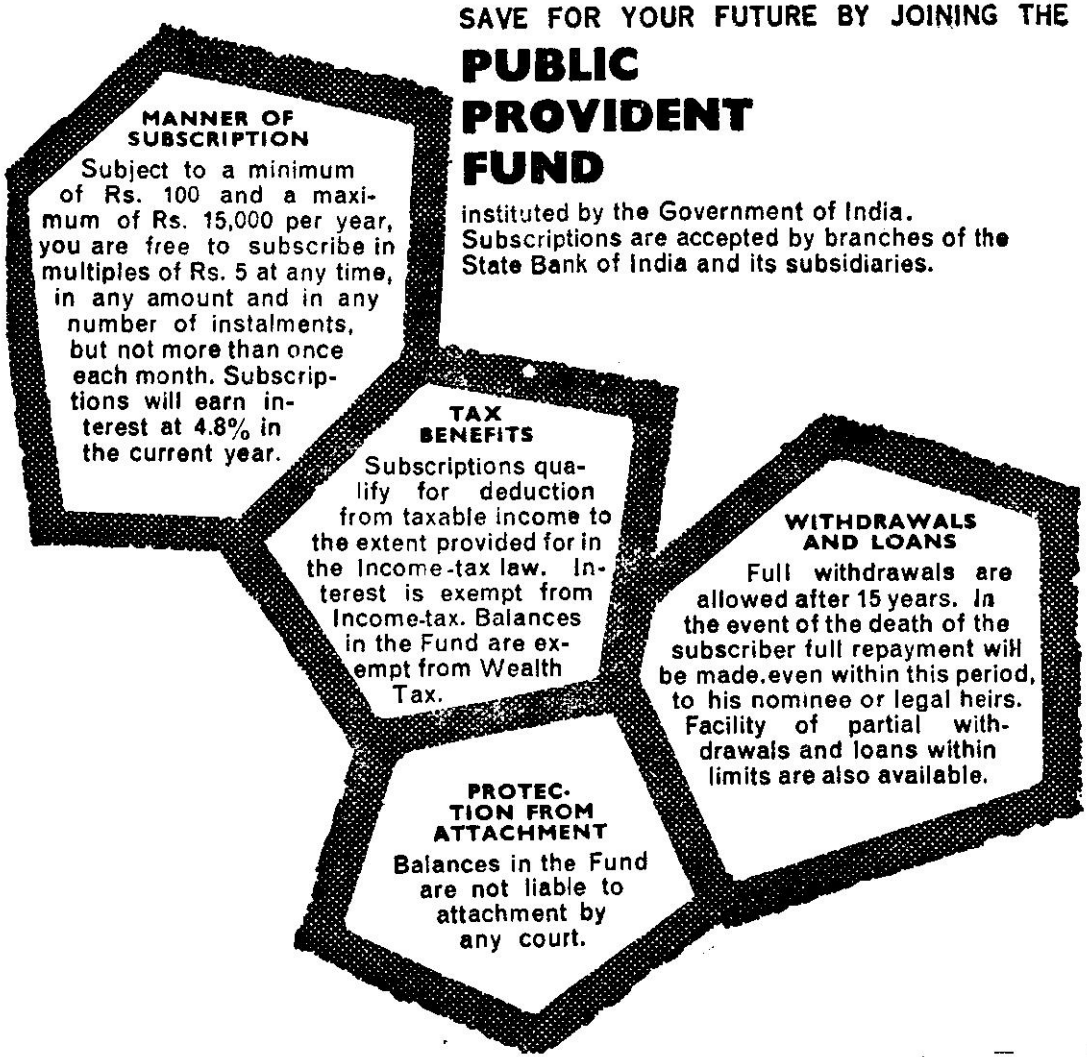

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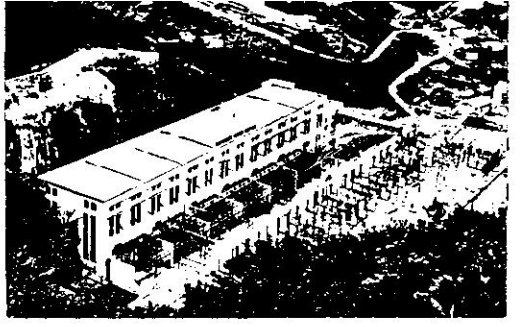

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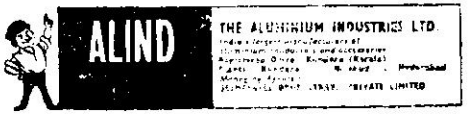

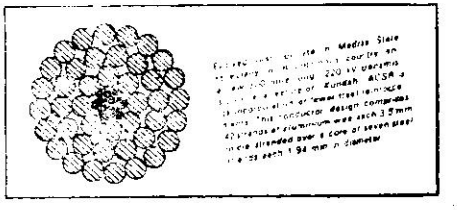

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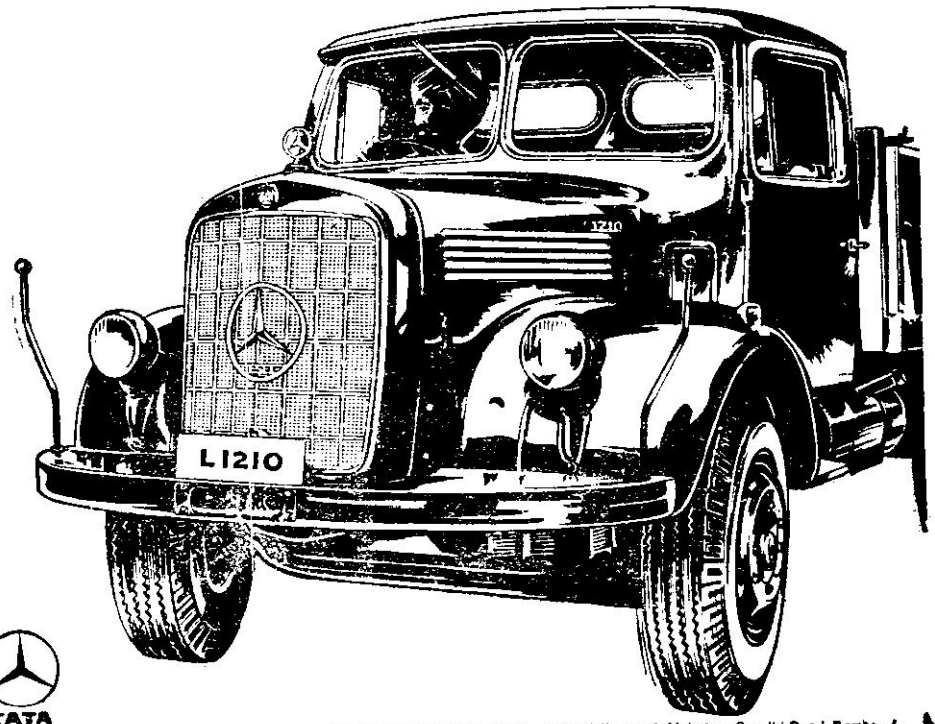

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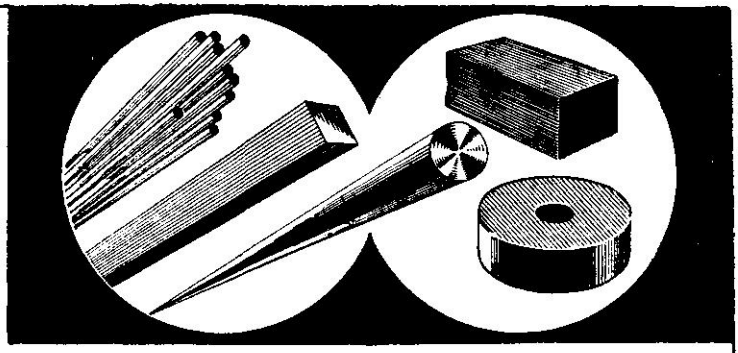

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Productivity Measurement at The Work Centre

Russell W Fenske*

The concept of productivity is of fundamental importance to engineers and managers of industrial enterprise. It provides the basic information necessary to make a choice between alternative resources and/or methods of production so that the decision-maker can choose the alternative that produces the most goods and services from the limited resources available.

For example, the industrial engineer would like to know the optimum combination of machinists (plus helpers) and lathes to maximise the output of a work centre; the departmental foreman would like to know how production will be affected by increasing his crew size or whether substituting a different machine will increase his output. In each case, an understanding of the productivity concept and its measurement would enable the engineer or manager to make a better decision.

The purpose of this article is to clarify the basic concept of productivity, analyse the fundamental relationships in the production process, explain *how these relationships can be used to obtain a meaningful measure of productivity at the work centre (in contrast to the misleading output/manhour traditionally used)* **and illustrate the concept and measurement with simple industrial production examples.**

THE METHOD OF MEASUREMENT TO BE discussed here is based on the fact that it is necessary to determine the actual contributions of the producing men and/or machines in terms of units of product rather than to utilize a macro-measure of output as is the the case with output-per-manhour.

Productivity Terminology

The reader is referred to an earlier article[1] for a detailed evaluation of definitions of productivity. A survey of the literature in that article yielded five basic types of productivity definitions. They are:

1. Productivity is a form of efficiency
2. Productivity is the utilization of resources or effectiveness of utilization of resources
3. Productivity is a ratio (rather than a phenomenon)
4. Productivity is a measure of some kind (rather than a variable requiring measurement)
5. Productivity is a rate of return (primarily in monetary terms)

*Associate Professor of Business Administration, School of Business Administration, University of Wisconsin—Milwaukee (USA).

[1]Fenske, RW : "An Analysis of the Meaning of Productivity"—*Productivity Measurement Review*, August 1965, No. 42, O.E.E.C., Paris, p. 16

Each of these were carefully examined and found to be inappropriate or actually erroneous for a general definition of productivity. The engineer may ask why the first definition is rejected. The answer can be explained in terms of a simple example such as brick laying. The average productivity of a crew of brick layers is "X" bricks laid per man per hour. This measure in iteself provides no indication of efficiency but only an average measure of employee output. Efficiencies *may* be examined by *comparing* this figure to a similar figure for the same crew during some earlier period of time, to a similar figure for another crew for the same point in time, or to some figure that has been established as a standard. However, this comparison is similar to any other measure of efficiency where the component figures in the comparison are not efficiencies themselves but simply quantitative measures.

The rejection of these five concepts of productivity led to the framing of a new definition of the term:

> ".....the magnitude of productiveness; the amount of goods and services produced by a unit of a productive factor in a specific period of time, or the average amount of goods and services produced by a unit of the productive factor in a specific period of time."[2]

Several other terms that will be discussed later require clarification for the reader.

A "productive factor" is one that can produce and is productive because it supplies energy and/or applies the energy to the task (as an "effector") and/or directs the application of the energy to the task (as a "director"). These include labour, equipment, agricultural animals, fruit trees, energy sources and control devices or computers. However, the analysis at the work centre in this article will concentrate on labour and units of equipment.

If only one productive factor (e.g. labour) is required in a process, the productivity is usually called the "simple productivity." If two or more factors are utilized jointly (i.e. men and tools), then the joint magnitude of productiveness for the productive factors is called the "combined productivity." The net productiveness of each factor is termed the "partial productivity of labour," "the partial productivity of equipment," etc. This partial productivity is the parameter that engineers and managers require to make meaningful production decisions.

The term "output" will be utilised to mean the quantity of goods and services produced by a productive factor or factors.

Then, the discrete marginal output produced by a specific unit of a productive factor (i.e. a specific man) will be called the "incremental productivity" of that unit. The "average productivity" will be the mean value of a series of such incremental productivities associated with a number of units of a productive factor (e.g. the average number of bricks laid per hour).

Each of these definitions will become clearer to the reader in the following analysis.

Production Relationships

Measurement of productivity as defined earlier requires determining the amount of goods and services produced by a particular unit of a productive factor (such as the productivity of a specific man or of a specific machine); or, determining the amounts of goods and services produced by all the units of the productive factor, determining the number of units of the factor, and then calculating some type of average (such as the average productivity of the men in a department). In this section, the fundamental relationships in the production process will be examined for the cases under consideration and then these relationships will be utilized to determine how the productivity of the factors should be measured. In the first case this will be a "simple" productivity but in the later cases "partial" productivities and ultimately a "joint" productivity will be required.

[2] Ibid. p. 21.

A. SIMPLE PRODUCTVIITY

1. Outputs of Individual Productive Units Known

The simplest (from the productivity measurement point of view) production relationship exists when a single productive factor (usually labour) is producing a single type of goods or service repetitively. Many examples of this kind of production are available; for instance, a factory worker assembling mechanical parts (no tools or energy source required), an office worker folding and inserting letters in envelopes, or a cannery worker husking ears of corn. In each case, a single worker is involved in producing homogeneous units of goods or services.

The relationship between the quantity of goods and services produced and the productive factor can be shown graphically. Units of labour will be plotted horizontally on the X axis, and the quantity of goods and services produced will be plotted vertically on the Y axis.[3]

Number subscripts will be used to specify particular values of the output variable and will indicate the total output of one, two, or more units of a productive factor.

Y_1=output of one man

Y_4=output of four men

When two productive factors are utilized, double subscripts will be necessary. The first subscript will indicate the number of units of labour and the second the number of units of equipment.

Y_1^2=output of one man working with two pieces of equipment

Y_5^7=output of five men working with seven pieces of equipment

If one man can produce Y_1 units of output, a single point could be plotted where $X=1$ and $Y=Y_1$ (Figure 1). Another point would be at the X−Y origin for zero labour units and zero output ($X=0$, $Y=0$). A straight line connecting these two points will indicate the relationsip between the two parameters when one unit of labour is added to zero units of labour (Figure 2). The reader should note that this slope has no meaning for non-integer values of the productive factor. That is .7 men do not produce .7 units of Y_1. The slope is simply a method of indicating the simple productivity of the unit of the productive factor under consideration for graphical analysis and comparison.

The productivity of the man is Y_1 units of goods and services. Then, men with equal incremental productivities will always have the same slope. However, if the individual outputs differed, the men's productivities would have different slopes as in Figure 3. These simple productivities could be averaged using conventional methods.

We have dealt with the situation where the actual productivity of each unit of a productive factor could be determined. However, it is not always possible to isolate the actual productivity of each unit. Sometimes only the total output of two or more units working together (jointly) is available.

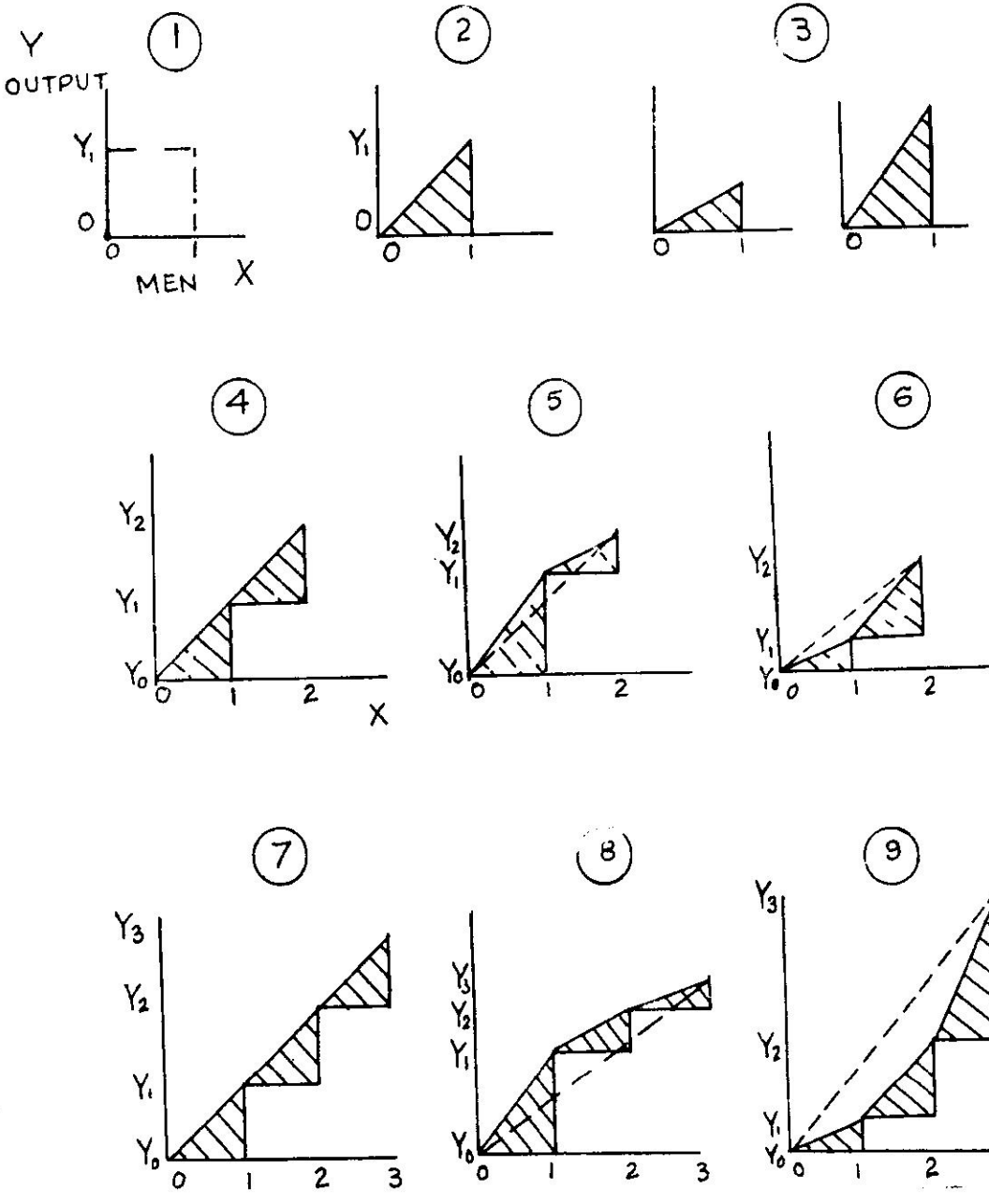
2. Only Aggregate Outputs Known for Two or More Units of a Productive Factor

If only total output is available and a second worker is added to the first, three possible situations may occur (Figures 4, 5, and 6). The productivity of the second man appears to be equal to, less than, and greater than that of the first man, respectively, but these slopes of relationship are incremental or marginal productivities, not actual productivities. If the second man's production exceeds that of the first man (Figure 6), then $\frac{Y_2}{2} > \frac{Y_1 - Y_0}{1}$ which is shown by the steeper slope of the dashed lines (average productivity per man).

If a third man is added to the work centre his productivity could be equal to, less than,

[3] In this entire section, all parameters, for any particular production situation, will be assumed to be measured for the same period of time:—an hour's output of goods and services, an hour's labour of a worker, an hour's services of a piece of equipment, or the same measures for a day, week, month, etc.

FIGURES 1-9
PRODUCTIVITIES OF INDIVIDUAL MEN



or greater than that of the second man and equal to, greater than, or less than that of the first man. This would result in at least nine different charts of the type illustrated in Figures 4-6. The three most significant variations are shown in Figures 7-9. In all cases, the incremental and average productivities are as follows:

Incremental Productivities

$$\left(\frac{Y_1-Y_0}{1}\right)\left(\frac{Y_2-Y_1}{1}\right)\left(\frac{Y_3-Y_2}{1}\right)$$

Average Productivity

$$\left(\frac{Y_3}{3}\right)=\frac{(Y_1-Y_0)+(Y_2-Y_1)+(Y_3-Y_2)}{3}$$

One could generalize by stating that in order to determine the average productivity per unit of a particular productive factor, one must obtain the total quantity of goods and services produced, which can be attributed to that factor (and which is equal to the sum of the incremental productivities), and divide it by the number of units of that factor.

$$\text{Average Productivity}=\frac{\Sigma\,(\text{Incremental Productivities})}{\text{Number of Units of the Productive Factor}}$$

B. PARTIAL PRODUCTIVITY MEASUREMENT

Most production processes require more than one productive factor (labour and equipment, or labour, equipment, and energy). This section will attempt to determine the net or partial productivities of the separate factors for such production operations.

The quantity of goods and services produced will be plotted vertically on the Y axis, the units of labour on the X_1 axis, and the units of tools or equipment on the X_2 axis (Figure 10).

The following special situation will be used to illustrate the principles involved when two resources (men and equipment), either of which can perform the task alone, are utilized. For example, sorting oranges for size can be done by a worker, or by a slightly inclined gravity chute with progressively larger sized holes. The man can produce the quantity Y_{10} working alone (i.e., the man can sort Y_{10} oranges by hand), and the equipment will sort Y_{01} oranges alone (i.e., Y_{01} oranges roll down the chute and fall through holes of graduated sizes (Figures 10 and 11). If the man works with the equipment and the output rises by $Y_{11}-Y_{10}=Y_{01}$, then the relationship between the quantity of goods and services produced and the two productive factors is shown in Figure 11. In this case, output increases by the same amount with the addition of one man either in the absence or presence of the equipment.

$$Y_{10}-Y_{00}=Y_{10}-0=Y_{10},\quad\text{and}\quad Y_{11}-Y_{01}=Y_{10}$$

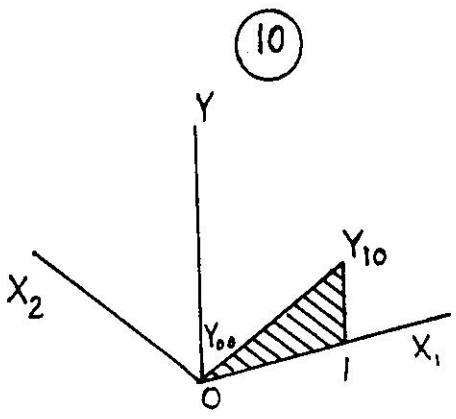
These two figuures Y_{10} and Y_{01} then can be assumed to be the portions of total output (in this case Y_{11}), produced by the respective productive factors. Therefore, the productivity of labour is $\frac{Y_{10}}{1\text{ man}}=Y_{10}$ units of output per unit of labour, and the productivity of equipment is $\frac{Y_{01}}{1\text{ piece of equipment}}=Y_{01}$ units of output per unit of equipment.

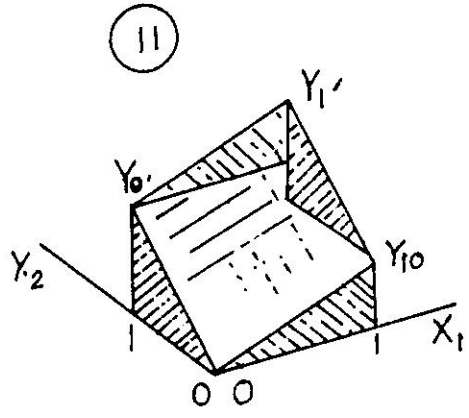
If the addition of a second man increases output by the same amount as that of the first man, the relationship between the quantity of goods and services produced, and the two productive factors is shown in Figure 12. In this case, the average productivity will be equal to the marginal productivity for each factor (Y_{10} per unit of labour, and Y_{01} per unit of equipment).

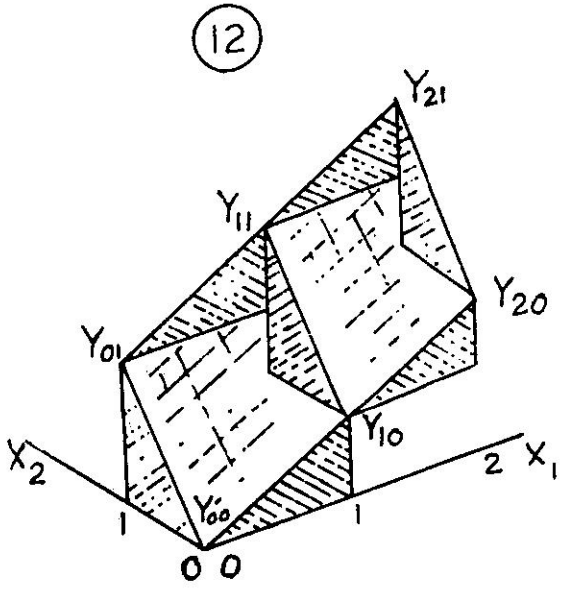
Adding a second piece of equipment instead of the second man yields the same general effect (Figure 13), and addition of both the extra man *and* the extra equipment is shown in Figure 14, with the average and incremental productivities still Y_{10} per unit of labour, and Y_{01} per unit of equipment.

A slightly more complicated situation exists if additional units of one of the productive factors do not produce equal incremental productivities as shown in Figure 15 which is an extension of the simple productivity case

FIGURES 10-12
RELATIONSHIP OF OUTPUT TO TWO PRODUCTIVE FACTORS

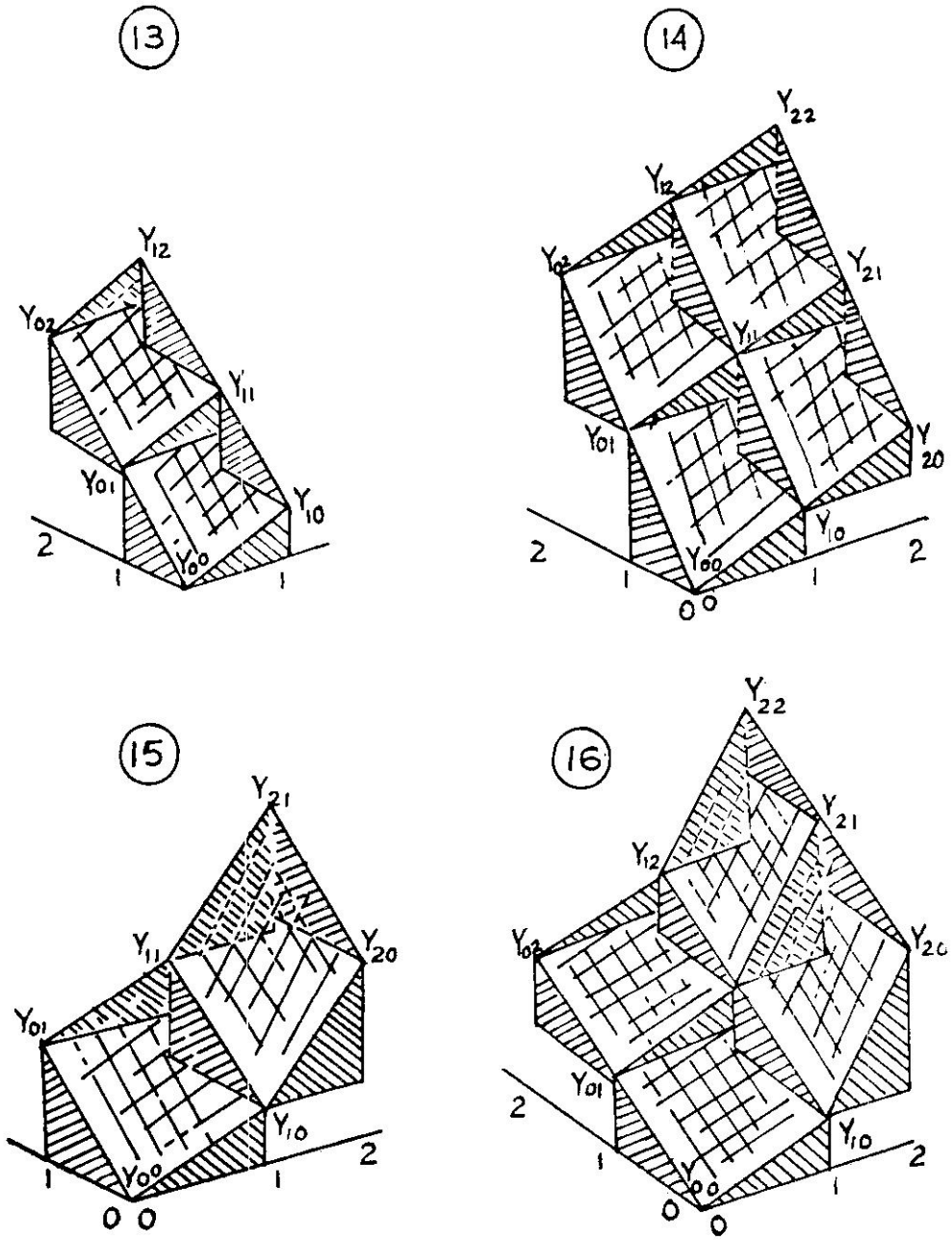






X_1 = LABOR
X_2 = EQUIPMENT
Y = OUTPUT

FIGURE 13-16
RELATIONSHIP OF TWO PRODUCTIVE FACTORS



shown in Figure 16. Additional units of equipment which have equal incremental productivities would have no effect on the productivities as shown in Figure 16.

A similar situation exists if the preceding conditions pertain to equipment rather than to labour, with a constant average productivity for labour and an increasing or decreasing average productivity of equipment as additional units of equipment are added.

If both conditions occur simultaneously as in Figure 17, the productivities of both productive factors differ from any single incremental values, being an average of incremental productivities at the several levels of the other factor : e.g., the incremental productivity of a second man is

$$\frac{(Y_{22}-Y_{12})+(Y_{21}-Y_{11})+(Y_{20}-Y_{10})}{3}.$$

The incremental productivities such as those listed above are equal for all levels of the other factor.

$$\frac{(Y_{22}-Y_{12})}{1} = \frac{(Y_{21}-Y_{11})}{1} = \frac{(Y_{20}-Y_{10})}{1}.$$

Prior to this point, because the relationships (between output and the productive factors) that have been considered have been additive, the productivity of each man was constant no matter how many units of equipment were being used, and similarly the productivity of each piece of equipment was constant, no matter how many men were being utilized. While these conditions do exist in some production processes, as will be illustrated later, in other processes the incremental productivities of a unit of one factor vary with the number of units of the second factor being utilized (Figure 18). The reason for this is that there are usually certain combinations of men and equipment that are more efficient than others.

In this case, $(Y_{22}-Y_{12}) \neq (Y_{21}-Y_{11}) \neq (Y_{20}-Y_{10})$ and $(Y_{22}-Y_{21}) \neq (Y_{12}-Y_{11} \neq (Y_{02}-Y_{01})$. Therefore, *the incremental productivities of a unit of one factor are not the same at all levels of the other factor.* The problem of determining the average productivity of a factor is now complicated, because it is not the simple total of N equal incremental productivities divided by N units of the factor. There are a number of incremental productivities at the different levels of the second factor for each level of the first factor e.g. $(Y_{22}-Y_{12})$, $(Y_{21}-Y_{11})$ and $(Y_{20}-Y_{10})$ for the second man. It might seem logical to use an average of these incremental figures to represent the incremental contribution of this particular unit of the factor.

$$\frac{(Y_{22}-Y_{12})+(Y_{21}-Y_{11})+(Y_{20}-Y_{10})}{3},$$

=the incremental productivity of the second man for the range 0-2 pieces of equipment.

The incremental productivity of the first man in this range would be

$$\frac{(Y_{12}-Y_{02})+(Y_{11}-Y_{01})+(Y_{10}-Y_{00})}{3}$$

and the average productivity of labour would be the arithmetic mean of the calculated incremental productivities of the first and second man.

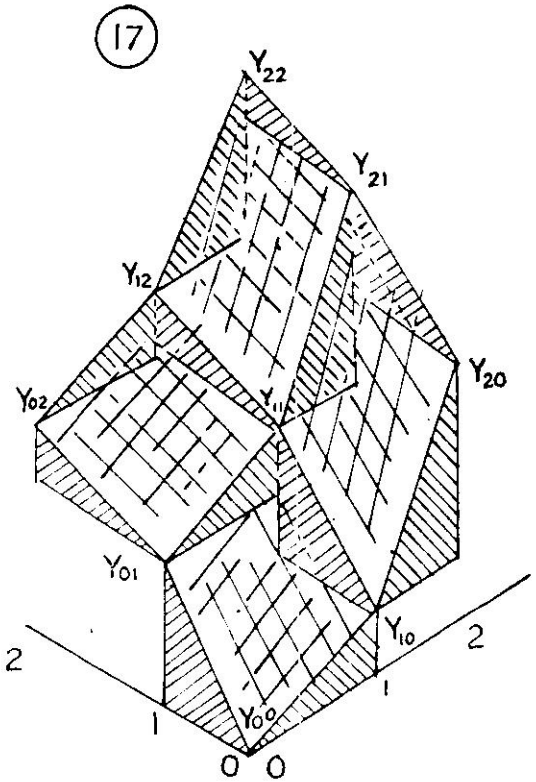
These relationships could be extended by adding additional men and pieces of equipment *ad infinitum* with Figure 18 extended in both the X_1 and X_2 directions and average productivities calculated in the same way. However, *it is not possible in the real world to utilize all combinations of numbers of men and equipment.* There is an "area of rational factor use" defined by economists as the area where the additional output obtained from adding additional units of a factor is *not zero.* A few actual examples will demonstrate this concept.

C. AVERAGE PARTIAL PRODUCTIVITIES IN THE AREA OF RATIONAL FACTOR USE

Figures 19—22 illustrate four production work centres that are more or less typical of actual practice (See Appendix for details).

In Figures 19, 20, and 21 the operation can be performed manually but in Figure 22 the milling operation requires the use of machinery. In Figure 20 almost any combination of men and milking machines is feasible

FIGURES 17-18
NON-LINEAR RELATIONSHIPS



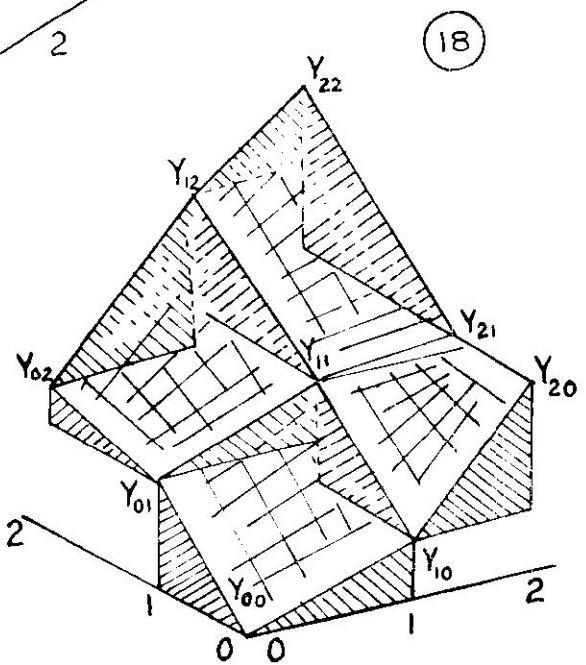


FIGURE 19

RELATIONSHIP OF OUTPUT TO LABOR AND SCREW DRIVERS

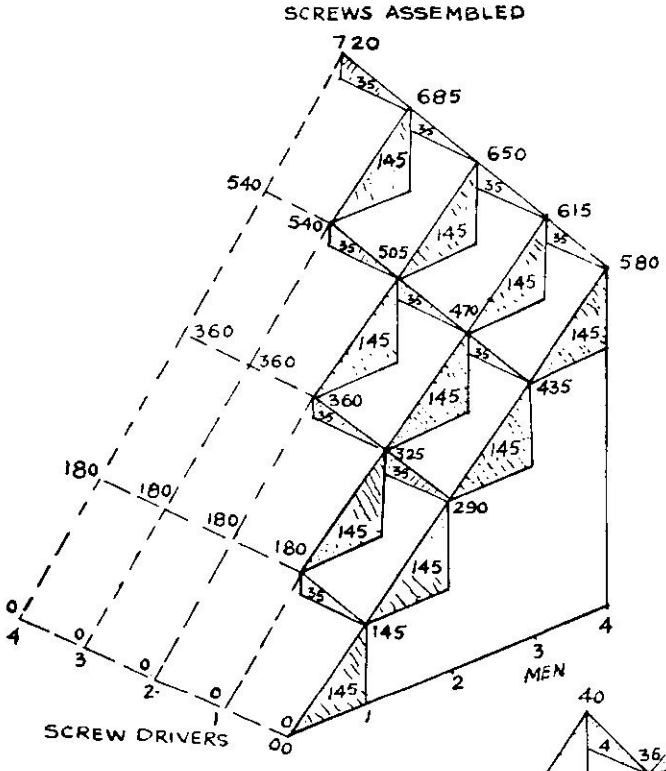
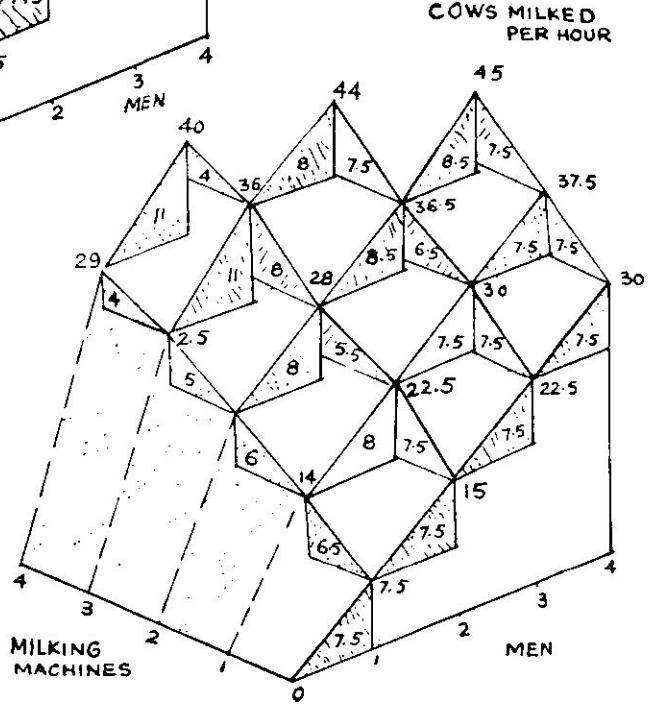


FIGURE 20

RELATIONSHIP OF OUTPUT TO LABOR AND MILKING MACHINES



(except zero men i.e. automatic operation). In figure 19 each man can handle no more than one piece of equipment (a spiral ratchet screw driver) but additional men will increase output with more than one man per piece of equipment.

Figure 21 is similar to Figure 19 except that instead of a perfectly linear relationship a quite different situation prevails due to the characteristics of the process. In Figure 22 only a limited number of combinations yield positive contributions to output.

In all four cases illustrated, the solid lines indicate the "area of rational factor use" and the dashed lines indicate irrational combinations of the productive factors. Obviously, incremental productivities should be averaged only in the former areas.

A few examples will indicate the kinds of information that such charts can provide. For instance, if a dairyman in Figure 20 that has been utilizing three men and one milking machine to milk 30 cows per hour determined his productivity by conventional methods he would calculate:

$$\text{Output/man hour} = \frac{30 \text{ cows milked}}{3 \text{ manhours}}$$

$$= 10 \text{ cows milked/manhour}$$

This figure of 10 cows milked/manhour would not provide him the kind of information he would need to answer the following types of questions:

1. "How many more cows could he milk if he hired one additional man?"—Certainly not 10 !
2. "How many additional cows could he milk if he obtained another milking machine?"—Certainly neither zero nor thirty!
3. "If the herd were increased 50% what additional men and/or milking machines would he require?"—Certainly not $4\frac{1}{2}$ men and two milking machines!

However each of these questions could quickly and easily be answered by examining Figure 20. Furthermore the average partial productivities could be determined for 3 men and one milking machine as follows :

$$\text{Average Productivity of Labour} = \frac{7.5+7.5+7.5+8+7.5}{5}$$

$$= 7.6 \text{ cows milked per hour per man}$$

$$\text{Average Productivity of Equipment} = \frac{6.5+7.5+7.5}{3}$$

$$= 7.17 \text{ cows milked per hour per machine}$$

The types of questions raised in regard to Figure 20 could also be answered in the production situations illustrated in Figures 19, 21, and 22 but the average calculations might be misleading in some cases.

In Figure 22 an average of representative incremental productivities excluding atypical ones would convey a more realistic picture of the actual contributions of labour and equipment. The incremental productivities of the successive machines and men are as follows :

1st machine	..		1st man	
2nd machine	30		2nd man	8, 32*
3rd machine	14*	38	3rd man	8, 7, 18
4th machine	38	37	4th man	9, 8
5th machine	28	39, 38	5th man	8

The asterisk figures are for conditions where the first man was overtaxed by the operation of three machines. Excluding those non-representative figures, the typical productivity of a milking machine is 38 castings per machine in an hour, and the typical productivity of labour is 8 castings milled per man in an hour, or a total of 46 castings milled in an hour by one man and one machine. Conventionally calculated output per manhour for five men and five milling machines is :

$$\frac{230 \text{ castings}}{5 \text{ men} \times 1 \text{ hour}} = 46 \text{ castings per manhour,}$$

a figure which provides the industrial engineer or manager with very little useful information.

D. COMBINED PRODUCTIVITY

The discussion in this article has assumed that there was a region in which substitution of units of one factor for units of another

FIGURE 21

RELATIONSHIP OF OUTPUT TO LABOR AND BOOK COVER MAKING MACHINES

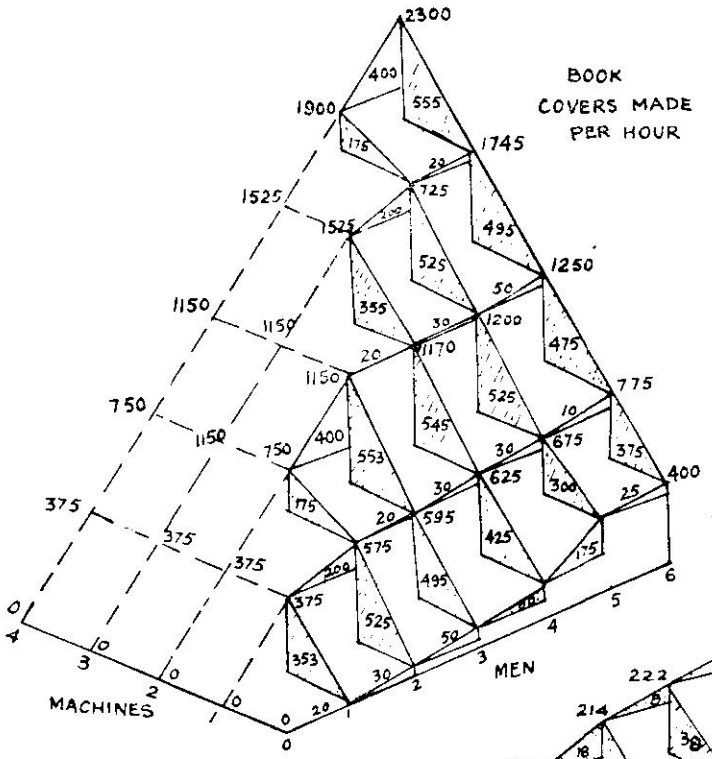


FIGURE 22

RELATIONSHIP OF OUTPUT TO LABOR AND MILLING MACHINES

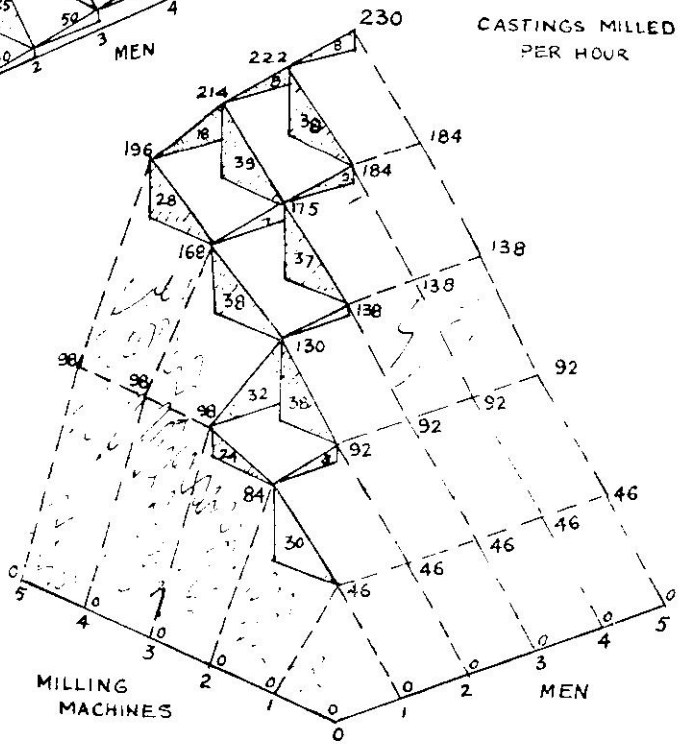


FIGURE: 2 3
PLOWING OPERATION

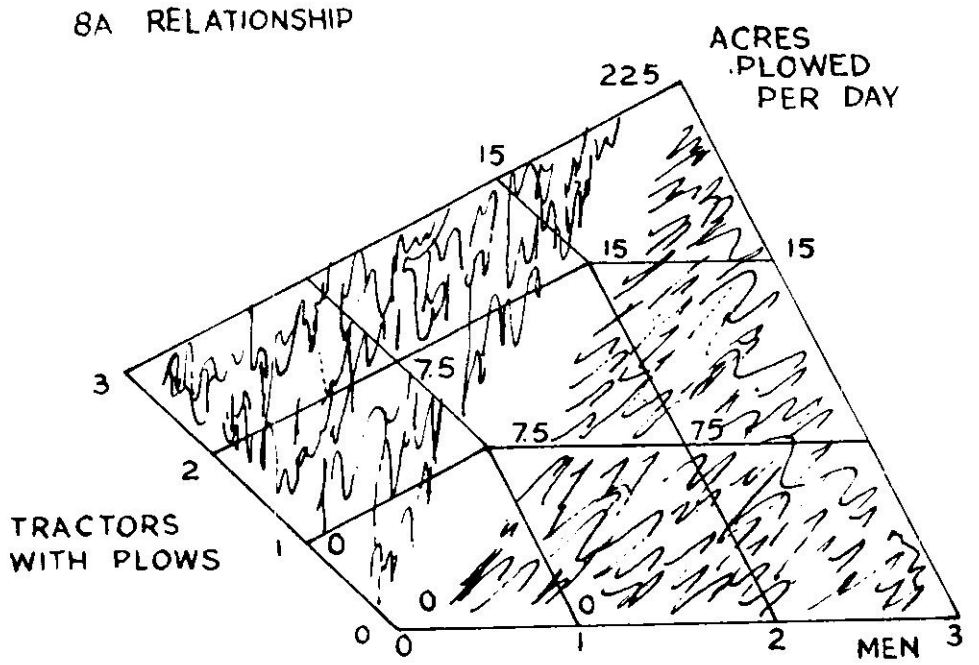


FIGURE: 2 4 INCREMENTAL PRODUCTIVITIES

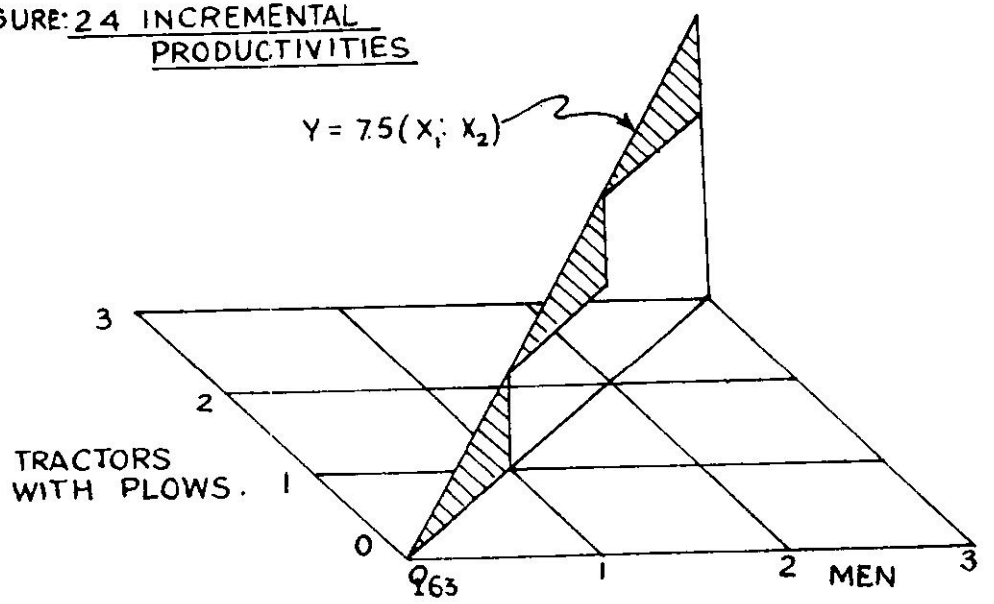
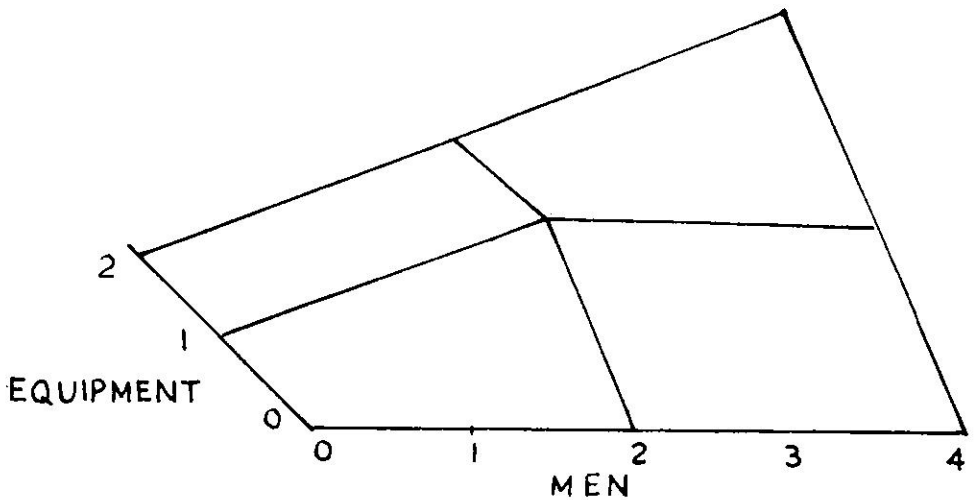
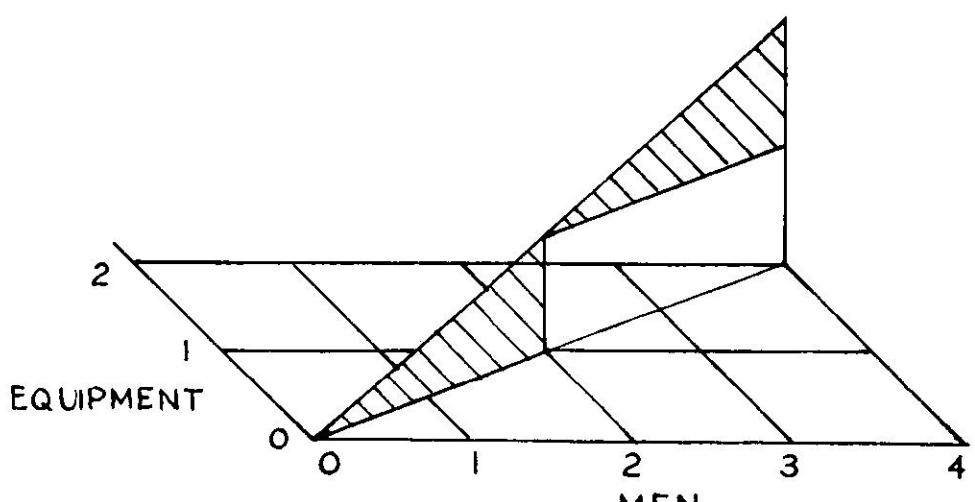


FIGURE 25
COMBINED PRODUCTIVITIES
$X_1 \div X_2$





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factor was both possible and logical (i.e., the incremental productivities of neither factor in this range was zero). This situation is not the universal case, however. Sometimes the two factors are only utilized in a fixed ratio of units of one factor to units of the other factor.

Figure 23 demonstrates a type of production situation for which combinations of men and equipment in only such a fixed ratio can be effectively utilized. The area of rational factor use is limited to a series of points where that ratio exists (in this case, a one to one ratio).

One man and one tractor with a three-bottom plough can plough 7 1/2 acres of rocky soil in East Central Wisconsin in a day. The addition of extra men or extra tractors will not increase that figure, since one man can handle only one tractor at a time, and only one man can be utilized to handle one tractor. Two men and two tractors can plough 15 acres in a day and three men and three tractors 22.5 acres. The relationship of output to one to one combinations of men and equipment is perfectly linear.

On both sides, one of the factors, either labour or equipment, has an incremental productivity of zero. Therefore, both of the planes are irrational regions of operation. The line must be analyzed in two-dimensional space to see its slope, and in particular in a vertical plane extending through all points where the specific ratio of labour to equipment exists (in this case $X_1=X_2$). This is shown in Figure 24. The units along the new horizontal axis are productive units consisting of M men and M machines (in this case one man and one machine).

The relationship of output to this composite productive factor has the slope shown in Figure 24. This slope of 7 1/2 acres per man-plough unit is the productivity of a man and a plough working together, and is the combined man-equipment productivity. Although this is identical to output per man-hour of 7 1/2 acres per manhour, the concept is different — a combined productivity. Partial productivities of either labour or equipment, as has been demonstrated, have no meaning in a case where these factors can be utilized in one and only one fixed ratio.

Industrial engineers often are confronted with this type of situation: one man and one fork-lift truck, one man and one engine lathe, or one man and one mechanical drafting machine.

If the ratio of the units of the two factors is not one to one as in Figure 25, the same general reasoning holds, and either one man and "M" machines, or one machine and "N" men, are considered as a productive unit. Combined productivities of these units can then be determined as in Figure 25.

Conclusions

The purpose of this article has been to attempt to clarify the meaning and quantification of the concept of productivity through the analysis of the relationship of output to the productive factors in contrast to the traditional output-per-manhour figures.

It has been shown that *output-per-man-hour calculations are valid only for situations that involve one productive factor (usually labour) and are misleading for situations involving labour and equipment.* The charts and algebraic approaches demonstrated can provide meaningful answers to the questions concerning productivity that confront industrial engineers and managers continuously.

APPENDIX

Details of Production Work Centres Illustrated

1. *Machine Screw Assembly*

Figure 19 illustrates an example where successive units of labour added have decreasing productivities. Many simple industrial assembly operations are of this general nature.

One man can assemble 145 round head machine bolts (1/4" in diameter and 2" long,

with 20 National Coarse threads per inch) to 1/2" square nuts (20 NC threads per inch) in an hour. The productivity of the second man decreases if specialization is attempted. One man starts the nuts on the threads of the bolt, and holds the bolt while the second man spirals the nut down the length of the bolt by hand. Further specialization with a third man, separates the starting function, so that one man starts the nuts on the bolt threads and sets them down. The second man picks them up and holds them while the third man spirals the nut up the length of the bolt.

The outputs are 145, 233, and 290 assemblies in an hour respectively. The average productivities then are 145, 116, and 96.7 assemblies per man in an hour for one, two, or three men (identical to output per man-hour). When this type of operation is actually performed in industry, it would seem logical to have each man perform the whole task, since specialization is less efficient; hence each additional man increases output by 145 assemblies per hour.

One man using a spiral ratchet screwdriver can produce 180 of the assemblies in an hour. With an assistant to start the nut on the threads manually, 235 assemblies can be produced in an hour. Specialization is also not practical here, since if the second man works alone the output of the two men and one screwdriver is 325 assemblies in an hour.

Similarly, a third man could assist, but he can produce more efficiently working alone to raise output to 470.

With a second screwdriver, the output of one man is unchanged at 180, since he cannot utilize more than one screwdriver at a time. Two men with two screwdrivers can produce 360 assemblies, and a third man will increase this to 505 units.

As can be seen on the chart, output is equal to 145 times the number of men (a linear relationship) plus 35 times the number of screwdrivers up to a 1 to 1 ratio of men to screwdrivers.

II. Cow Milking Operation

This operation (Figure 20) is the milking of dairy cows by hand. The relationship between output and labour is linear or in particular $Y=7\ 1/2$ cows milked (X_1 man) in an hour. The productivity is simply 7 1/2 cows milked per man in an hour, which is identical to output per manhour in this case. In this case, also, additional pieces of equipment can be added up to a 4 to 1 ratio. The incremental productivity of extra machines beyond that ratio is zero.

One man can milk 7 1/2 cows in an hour by hand. This involves washing the udders, milking the cows, and carrying the milk to the milk house. A second man could assist by doing the washing and carrying the milk, but output increases less than proportionately, since the physical requirements of the task do not make it possible to milk more than about 8 or 9 cows per hour. The washing and carrying operations provide a partial rest for the hand muscles. Therefore, additional men are utilized not to specialize the labour, but to perform the complete milking operations.

One man using a milking machine can reduce the actual milking time by about three minutes, milking 12 1/2 cows in an hour. The man will be idle for about three minutes, while the machine is milking, but he can wash the next cow and carry milk to the cooler during this period, increasing output to 14 cows milked in an hour. A second man will be able to milk an additional 7 1/2 cows per hour or a total of 21 1/2 cows, but the first man can wash his cows and carry his milk during the milking machine cycle, raising their combined output to 22 1/2 cows per hour. A third man will raise output to 30 cows an hour. The first two men will be working at capacity, and will not be able to assist him. A fourth man will raise output to 37 1/2 cows per hour, and four men appears to be the maximum utilized on farms in East Central Wisconsin, because herds are usually not larger than forty cows.

One man can handle two milking machines, and milk 20 cows per hour. He will not be

able to assist a second man, since two machines are almost a full-time job. Output for two men and two machines is therefore 27 1/2 cows per hour. It is more efficient if each man uses a machine to milk 14 cows, or a total of 28 cows per hour. A third man can be assisted by one of the first two increasing output to 36⅔ cows, while the fourth man is assisted by the second to milk 45 cows an hour, which is also an upper limit, due to herd size.

One man can milk 25 cows per hour with three machines, but the machines are idle a part of the time, since the man is not as fast as three machines. Two men can handle 36 cows an hour with three machines, and three men can milk a herd of 44 cows in an hour.

One man can milk 29 cows an hour with four machines, but the necessary pace is considered excessive. Two men can easily milk 40 cows with four machines in an hour, which is also an upper limit due to herd size.

III. Bookcover Making

Figure 21 illustrates a more complex example where successive units of labour added have increasing productivities. The data were obtained from a medium sized job shop bookbindery. Bookcovers can be made manually with crew of from one to five girls. For reasons that will become obvious, the larger crews are used whenever possible. The relationsihp between output produced and labour is curvilinear, and in this case, almost logarithmic. $Y=25\ (2^{x-1})$ bookcovers produced in an hour is the approximate relationship in this range.

A comparson of the actual outputs and theoretical outputs using this relationship shows little deviation.

Book Covers Produced in an Hour	*Number of Girls* 1	2	3	4	5
Actual	20	50	100	200	375
$Y=25\ (2^{x-1})$	25	50	100	200	400

The reason for the constant rate of increase in output is due to the peculiarities of the production situation. The production of a bookcover involves glueing the cloth to the cover boards, trimming, glueing of the backing strip to the cover, trimming; and, finally, glueing the cover to the book. Because of the intermittent glueing operations, one person is slowed down by having to clean his hands between operations, and, also by the lack of division of labour. Therefore, additional units of labour increase output more than proportionately in the range up to five girls. A sixth girl has a very low incremental productivity as will be shown later. The crew is never made larger than six girls, because further subdivision of the job is not economical to the bindery.

A bookcover making machine with one man can produce 375 covers in an hour, but machine is idle part of the time, when the man must stop to reload materials. The use of two men increases this output to 575 covers in an hour with the machine running continuously, since the second man can load while the first runs the machine. Additional men cannot be used on the machines; and, therefore, they must produce covers manually.

IV. Milling of Castings

Figure 22 shows an example of an operation which cannot be performed by either labour or equipment alone, and in which labour cannot be utilized in more than a one to one ratio to equipment.

The data were obtained from a firm in the electrical equipment industry. One man with one horizontal milling machine can mill the top flat on 46 castings in an hour. The operation consists of installing the casting in a fixture on the machine, starting the machine which mills the part automatically, returning the table (which holds the fixture) to the initial position, and, finally, removing the finished casting. A second man cannot increase output. Because the operator is idle during the milling cycle, he can perform the required operations on a second machine. The time is not quite sufficient, however, so

that some idle machine time is generated, and output is only 84 castings in an hour. Two men with two machines are most efficient if they each operate a millling machine to produce 92 castings per hour.

One man can operate three milling machines, but since for a considerable portion of the time one machine will be idle, the output is only 98 castings per hour. The addition of a second man increases this to 130 castings, and with a third man, each can operate one machine for a total of 138 castings in an hour.

One man cannot handle a fourth milling machine, but two men can turn out 168 castings in an hour, three men can produce 175, and four men 184 in an hour. The output of four milling machines with 2, 3, 4, and 5 men respectively is 196, 214, 222, and 230 castings milled respectively. The productivities of successive units of labour added or equipment added have a tendency to decrease (Figure 22). ●●●

Galactic Archaeology

A new generation of telescopes is being ordered round the world, costing, according to their design, anything from £2 million to well over £12 million apiece... Sheer economics, if nothing else, have obliged astronomers to make their most recent discoveries with radio telescopes, which are several orders of magnitude cheaper than a really big optical telescope would be. The giant of the optical telescope remains the 200-inch American one at Mount Palomar which was commissioned just after the last war. To build another that size today would cost around £12 million; the 236-inch telescope the Russians are now constructing can hardly cost any less. Smaller optical telescopes come substantially cheaper: 150-inchers can be built for under £5 million; the British and Australian governments are sharing one, the Americans are building two, and there are others. But these do not solve the problem of seeing farther out into space than Mount Palomar.

Radio telescopes, which were first built to hunt for stars that send out radio signals without any detectable light, are the only reasonably cheap answer. Even so, they run to six figures. Sir Bernard Lovell's big dish telescope cost originally nearly £750,000, and he has just been given £400,000 to replace fatigued metals in it and make some improvements. But his next telescope will cost at least £4½ million at current prices and, understandably enough, has not been authorised The man most likely to get the British Government's money is Professor Martin Ryle at Cambridge.

This is partly because his team has an outstanding record—scientifically speaking—for delivering the goods, but also because the Dutch are currently building a very similar telescope which will put the Cambridge team at a disadvantage unless Professor Ryle is allowed to jump ahead of the competition.

Professor Ryle is a key figure, and not only because he is reputedly one of the best engineers in the country, who developed the concept of splitting up his telescope into component parts that he scatters round the countryside to give him a single, vast instrument with a working diameter now planned for three miles...

There is small risk of his not getting the £2 million that he needs from the Government to construct his new, three-mile wide telescope which will give him a nine-fold increase in range over his present one-mile instrument...

All this happens way beyond the reach of the space probes, so far away that millions of years have elapsed between the event and the time its signal reaches earth; it is really a form of galactic archaeology. If the world were coming to an end, we might easily be the last to know it. So £2 million seems quite a cheap investment to find out...

The Measurement of Productivity

Concept & Methodology

AK Ahuja*

Changes in productivity, if properly measured, indicate the comparative performance of an economy over time, the efficiency of utilisation of labour and capital employed, technological developments, involving increasing doses of capital in place of labour etc. While we have to be clear as to the basic concept, the actual mode of measurement has to be tailored to the requirements of a particular study of productivity change.

MANY EXPERTS ARE OF THE OPINION THAT for a study of productivity change, it is necessary to consider jointly a number of productivity indices based on different concepts. Prof. GA Prudensky writes that 'An important methodological question involved in the study of labour productivity is the employment of a system of indexes. Only in this way and not by means of a single universal index, can so complicated a process as the movement of labour productivity be characterized in all its facets.'[1]

Commonly speaking, Productivity Measure is a ratio between output and input, preferably in quantitative terms, both comparably defined and correctly formulated, covering the same field of activity. The ratio can be expressed in terms of selected items of output/inputs or all inputs combined, the accuracy of which depends on the method of combining different types of output/inputs. Most of the difficulties arise because of *the extreme heterogeneity of both inputs and outputs : a property which is not accidental but basic.*

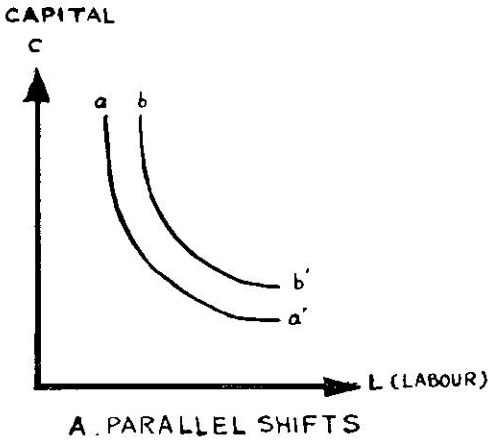
The productivity index measures the shifts in production functions. In the Conference on Income and Wealth, Carl F Christ pointed out that 'The shifts in production functions are what productivity indexes are really about, and that in trying to measure productivity we will be ahead if we remember that production functions are in the theoretical background of what we are doing'. In case of a single factor of production, the production function is represented by a single point on a segment, which in fact is the productivity index with reference to that specific input, say, labour. When productivity with respect to that single input factor changes, the production function also shifts along the segment.

Such productivity index or shifts in production functions can always be measured.

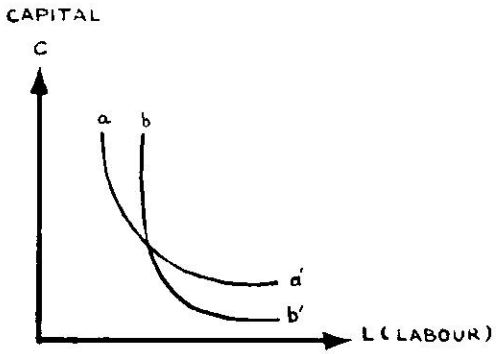
*Research Officer, MMTC, New Delhi

[1] 'Labour Productivity : Concepts, Factors and Growth Reserves' by Prof. GA Prudensky, Academy of Sciences of the USSR (1962)

However, the problem becomes more complicated when there are two factors of production, such as labour and capital. We can, in such cases, give an estimate of productivity



A. PARALLEL SHIFTS



B. NON-PARALLEL SHIFTS

increase, if and only if the production function shifts parallel to itself (Diagram A) which seldom corresponds to reality. The production functions for different regions and at different times may show wide variations in their structure, as shown in the Diagram at B.

The problem becomes more complicated if inputs of raw materials are also included in the factors of production. One of the possibilities in such cases is to work out all the factors of production in terms of any one factor by suitable conversion and reduce the problem into that of a single factor input in order to prepare an index of productivity.

Inputs

An accurate way of arriving at the total input of labour, capital and raw materials, is to find out the total of 'live' labour and 'embodied' labour in capital and raw materials.[2] A complete input-output table may give the total embodied labour involved in the capital and raw materials. Such detailed input-output tables are, however, almost impossible to prepare. Some other solution has, therefore, to be found to work out an approximation to the total input. This is discussed in detail in the following pages.

Types of Productivity Studies

There are three types of useful studies for the measurement of productivity changes.

(*i*) A time series study of productivity when new plants are constructed in successive years in a single industry in order to discover the rate of progress of knowledge about building new plants. The time series study can further be extended over a group of industries in a region or a country.

(*ii*) A cross-sectional study of productivity in newly established plants, in order to discover the dispersion of knowledge about how to build a new plant at any point of time. This study can be extended to two or more industries with their respective age complex of different units or for comparison of productivity in different regions.

(*iii*) A time series study of the productivity of each of several given plants beginning when they were new and extending over their lifetime, to determine the extent of change in productivity over time and the extent to which new discoveries can be used to improve the productivity of existing plants.

---

[2]This is the ghost of Marx come alive, for did he not say that Capital is only embodied (or congealed) labour?—**Editor**

Factors Influencing Productivity Change

An increase in productivity from time to time, from plant to plant, industry to industry or region to region is a result of a large number of factors. Bronslaw Minc, a Polish economist, has classified the factors influencing labour productivity under six heads grouped in two categories :

(a) Labour productive power:

(i) the degree of mechanisation and automation of labour,

(ii) the level of the organisation of work and especially of cooperation and specialisation,

(iii) national resources used in production: the fertility of soil, the richness of deposits and so forth.

(b) Subjective factors relating to labour:

(i) the skill or qualifications of the worker,

(ii) the intensity of his effort in the process of labour or the intensity of work,

(iii) the innate ability of the worker, that is his physical and mental energy.

A third category of factors which affect overall productivity is

(c)) the structural changes:

(i) age complex of different industries

(ii) industrial structure of the economy

It may be pointed out that *an increase in productivity should not be confused with increase in the efficiency of labour achieved by undesirably hard work and sacrificed leisure only, which might represent a worsening of economic welfare.* However, hard work is one of the important factors influencing productivity increases. The increase in productivity, due to various factors other than undesirably hard work, may be termed as technical progress. This may be in the form of greater mechanisation, superior organization, etc., etc.

However, some economists have pointed out that the increase in productivity is not the measure of technical progress and hard work alone, unless we suppose constant returns to scale. Over long periods of time, capital, labour and output grow. Considerable economies of scale would also have a large effect on productivity change because a large-scale economy as a rule should be more efficient than a small-scale economy, even under the same level of technical progress. Actually, as RM Solow has pointed out, the effects of increasing scale and of technical progress are mixed and we run into a familiar kind of identification problem. The data provide no sure and simple way of segregating these increases in output per unit of input which would have occurred through the mere passage of time and increase of knowledge even if inputs were constant and, from those increases which would have been available earlier, if and only if the system had been larger.

In his essay on 'some difficulties in the concept of economic input', Prof. KE Boulding has indicated that the increase in productivity can be bifurcated and effects of returns to scale separated only if the mathematical formulae of the production function at the two points of time are separately available. This, however, is not possible, as such. The most important factors behind technical progress are mechanisation and organisational improvements. In underdeveloped countries, like India, the degree of mechanisation would necessarily be conditioned by the availability of cheap labour and the higher costs of capital goods.

Organisational improvements, in fact, bring in more rapid increases in productivity. "The structure and philosophy of management in an enterprise are", says Charles Myers,* "important determinants, perhaps the determinants of enterprise efficiency and hence of labour productivity. The level of technology is, of course, a critical factor in enterprise efficiency, and I do not mean to ignore it. But technological innovations and implementation in any enterprise are successful only if the people in it are technically competent and co-operate in the implementation process.

Greater efficiency and higher productivity in an industrial society, therefore, require

*'Management and Enterprise Efficiency' by Charles Myers, Massachusets Institute of Technology (1961)

greater attention to the organisational structure, to the development and replacement of managerial resources and to the kinds of managerial philosophy and behaviour which will tap to the fullest the capacities, the energies and the enthusiasms of the human resources in the enterprise. This is the opposite of the engineering concept of productivity, for without the co-operation of people, technical measures to increase productivity will fall short of their objectives."

The productivity increases due to improvements in organisation may be termed as real increases in labour efficiency which should be distinguished from the increase due to improvements in technology, level of mechanisation, etc. The index of labour efficiency cannot, therefore, be worked out individually without specific experimental studies in specific factories as is done in foreign countries. Labour efficiency in a factory can be worked out by a study of productivity changes in a specific factory with a specific mechanical set up and when all the stock of capital is in normal working efficiency without any abnormal breakdowns. Changes in productivity under such conditions are real indicators of changes in labour efficiency. By using different incentives or making some other specific changes, we can work out the influence of such incentives /factors on labour efficiency. Such methods have been used in the USA.*

We need to emphasize that labour efficiency is different from productivity increase, and is only one of its components, the other important factors influencing productivity change being the level of technology and mechanisation. The subjective factors relating to labour and structural changes in industry are also very important factors. Changes in productivity are a result of the combined effect of the influence of changes in all these factors.

*Prof. Lawrence Fenninger, Jr. has given the methods used in Bethlehem Steel Company, in his paper on 'The establishment of norms under incentive systems in the basic steel industry in the United States, (1962)

Productivity Measures

The productivity measures, worked out as the ratio of output to input, fall into three general categories:

(a) Physical productivity in which output used is a fixed composite of goods and services measured by physical quantities of various goods produced. The calculation of such a productivity index is possible only in industries in which the major part of production is a single item of almost uniform quality such as cement, sugar, etc. This, however, is not possible for a group of industries or regions because all the items of the fixed composite of goods and services measured in physical quantities for the whole group of industries or a region, may not and will not change in the same proportion from time to time. A variation in the proportion of increases in output of different items makes it difficult to measure the average increase.

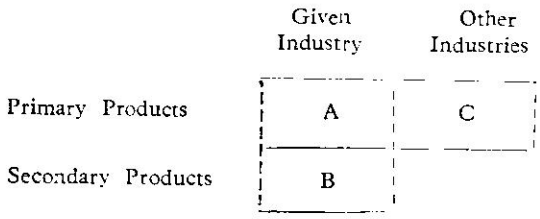
(b) Gross output productivity is generally derived by deflating gross production values by appropriate prize indexes. The latter should be sufficiently detailed to relate to the value of the output in question. The deflated value series are sometimes used as approximations of physical productivity measures.

(c) Net output productivity measures are based on aggregates of value added at constant prices. These measures require the same data as the gross output measures and also information on materials and services consumed with appropriate deflators.

Input and Output Indices

While working out such productivity indices we are required to work out index numbers of output and input. It is very essential that the indices should be based on reliable statistics. As the productivity measurements are essentially shown by a ratio, both factors must be correctly formulated and must cover the same field if the results are to have some significance. The data for indexes used for measuring productivity changes for any economy or sector should have the same

coverage:† that is, they should apply to the same economy or the same sector, and if (as is almost always the case) they are based on a sample of the goods and services in the economy or sector, they should all be based on the same sample. While working out physical productivity in a specific industry, output generally relates to production of products primary to a particular industry, while input data of employment and capital relate to total input for production of both primary and secondary products. Prof. Leon Greenburg has explained* this discrepancy by a diagram.



Physical output data are generally available on the basis of AC, that is, they are the result of employment of input factors A in the given industry and C in other industries. On the other hand input data are used only for the given industry, that is, AB. Such productivity measures are ratios of output to input with different coverage, that is, output of AC and input of AB. Ideally the ratios should relate to the primary and secondary products (AB) of the given industry and inputs of the same industry (AB). The use of net production or value added, however crude it may be, at least has the same coverage for input and output data. However, in case of industries in which B is negligible, such as sugar, cement, jute, etc., and if at the same time C is usually in a constant proportion of A, the index of physical productivity gives broadly satisfactory results.

There are different methods for working out index numbers: none of them is free from limitations. The accuracy of index numbers mostly depends on the adequacy and reliability of the data used. Index numbers do not give accurate results due to defective and inadequate data available for their construction. In addition, the *index numbers fail to take into account the changes in quality of the production which is rapidly changing.* Dr. GC Beri* has given a detailed account of different methods of working out index numbers, along with their limitations.

Output Index Measurement

The index of gross output and net output (or real value added) at base year prices is worked out respectively by the formulae given below :

$$\frac{\Sigma\, Q_1 P_0}{\Sigma\, Q_0 P_0} \qquad \ldots(1)$$

and

$$\frac{\Sigma\, Q_1 P_0 - \Sigma\, Q_i P_0}{\Sigma\, Q_0 P_0} \qquad \ldots(2)$$

where Q and P stand for the quantities and unit values of products (output) and q and p stand for the quantities and unit values of materials, fuels and electricity, etc, consumed in the production process (input).

This aggregate measure of total product in real terms has been worked out in Canada** and the USA for the purposes of productivity analysis. The use of this method for finding the index of output is subject to a large number of drawbacks as has been pointed out by Prof. Leon Greenburg. Some of the major defects are :

(a) A large proportion in the available data is in terms of 'others' mentioned only in value terms. The real price deflator of this sector of 'others' is not available and is usually very defective.

†'On the Design of Consistent Output and Input Indexes for Productivity Measurement' by Irving H Siegel—Conference on Research in Income and Wealth.

*'Data available for measurement of output per manhour' by Prof. Leon Greenburg

*'Measurements of Production and Productivity in Indian Industry' By Dr. G.C. Beri.

**'The estimation of real domestic product by final expenditure categories and by industry origin in Canada' by Prof. V R Berlinguette and F H Leacy.

(b) The price indexes available for production as well as raw materials are far from the real price indexes for specific industry outputs and inputs. This defect can, however, be removed to some extent if the base year prices for specific type and quality of product output/ raw material input are used instead of price index. This requires that data should be acquired on a large number of input and output items separately for specific qualities. There is thus no end to a finer break up of products and input items and we shall have to stop at some place. To the extent that the price index fails to allow for improvements in quality, it results in under-statement of the real output value : when quality deterioration occurs, the opposite tendencies prevail.

In certain cases where such a break up is not possible, a general price series can also be used. Such general price series, however, particularly in this country, are really very crudely compiled, and cannot be validly used for calculating real production in specific industries with a specific product complex. Such indexes are, therefore, not valid for working out indexes for purposes of productivity.

(c) While working out an index of production, only the base year prices are used. However, the use of the base year prices has been questioned by many experts. The preferences and the rate of technological developments vary from item to item. The prices of products show a substantial decline if productivity increases more rapidly than that of other items of production. It naturally results into a higher weight for items for which productivity increases are lower, and *vice versa*. Different base year prices should, therefore, be used to work out the index of real value added.*

(d) For time series study, the coverage is very defective. New areas have been added from time to time and the scope of industries has also changed. Quite frequently, we have a large number of non-reporting factories which materially reduces the comparability of data over time.

*On what basis do we select different base years? **—Editor**

Input Index Measurement

It has been indicated earlier that the input index should relate to the same coverage of the industry or region—in fact the same sample of factories as for the output index—in order to get an accurate estimate of productivity change. In addition to this, however, we face a host of problems in combining the indices of different factors of production. First we have to find out accurate estimates of labour, capital and raw materials*† used for the production process and secondly to find out the most appropriate weighting diagram in order to combine the three indices.

Labour Index

The major categories of labour employed are male, female and child labour. Child labour forms only an insignificant proportion of the total labour employed. These categories of labour cannot be combined on a uniform basis; at the same time to assign any specific weights to male and female labour is rather arbitrary. In case of skilled labour, female

*Normally speaking, raw materials do not constitute a factor of production and productivity of raw materials is meaningless. In case lower raw materials are used by economising and careful handling, its credit should go only to labour and capital, the increased efficiency of which has reduced the use of raw materials. But, however, this component can be excluded from the input factors in the denominator, if it is excluded from the output in the numerator, that is, if output index is taken as Net production. While using gross production also, this factor has not been included in the inputs for the sake of simplicity. In this case, however, it is presupposed that the ratio of raw materials to outputs remains constant. This supposition can be assumed in case of a single industry over a period of time. For industrywise and regionwise comparisons, net production only can be used.

†If raw materials are not a 'factor of production on the ground that economies in raw materials are effected through more efficient labour or better deployment of capital equipment, Labour and Capital can on the same ground be denied the status of a factor of production because superior labour or capital efficiency is really effected by superior organisation. In that sense, organisation would be the only ultimate factor of production.**—Editor**

workers may be even more efficient than male workers in certain lines, whereas in unskilled labour, male workers can be assigned a higher weight. It is, therefore, very difficult to fix any specific weights for the two categories of labour. In order to avoid arbitrariness and also because the proportion of female workers is comparatively small in many lines of industry, and this proportion remains almost constant over a period of time, we may combine male and female labour on an equal basis.

Another problem which the labour index faces is whether it should be worked out on the basis of manhours worked or the total number of workers employed. The use of both these concepts of labour suffer from some defects. The use of manhours worked is more appropriate because it would reflect the situation more accurately, as for example, when larger output is sought to be obtained through working longer hours; or the output increases or remains constant, even though the working time has been reduced. From the Productivity standpoint, these are significant facts, and the use of manhours would, therefore, be appropriate.

On the other hand, it may be pointed out that a reduction in manhours worked may also be due to machinery breakdowns, shortage of raw materials, lack of knowledge and many other reasons, all resulting in labour and capital idleness. This idleness of the factors of production should, in fact, be reflected in the measure of productivity change, which is possible only if we take the number of workers employed. In large-scale manufacturing industries in India, there are 8 working hours per day and a reduction in this in order to improve upon social welfare is hardly considered. The use of manhours may be more appropriate in advanced countries where emphasis is placed on reduction of manhours. It is not so in underdeveloped countries like India where the principal reason for lower rate of manhours worked is breakdowns, strikes, shortages, etc., resulting in idleness of resources. Taking this into account, it is more appropriate to use the total number of workers employed instead of manhours worked.

Combining labour employed in different industries/regions for industrywise and regionwise comparisons, constitutes another problem in Productivity measurement : whether the labour employed should be weighted with the wage index. Labour employed in aircraft industry is highly technical, as compared to that employed in rice milling industry. If appropriate weights are not given to the labour employed in the two industries, the productivity in aircraft industry may work out to be much higher than that in rice milling. Similarly if the labour employed in Bombay is more qualified than that in Bihar, Bombay is likely to show higher productivity due to more qualified labour. The differences in productivity as between Bombay and Bihar based on labour employed weighted with wages may be smaller than the difference when wages are not taken into account. This difference may indicate the effect on productivity due to use of more qualified persons, assuming the same production function for the two states. In order to throw some light on the effects of more educated employment, we may work out productivity indices using weighted as well as unweighted index of labour employed.

Capital Index

The estimation of the quantity of real capital, stock and services is the most important for the measurement of productivity, but at the same time it is the most difficult part of the work. In sectors like agriculture, there are no serious difficulties because it can be measured in a single uniform item such as acres,* but such is not the case in the manufacturing sector. Physical measurement of capital is not possible because different kinds of capital are expressed in different physical units of different quality. The only recourse in these circumstances is to measure capital in some sort of comparable units, *i.e.*, value terms. Professors Richard and Nancy Ruggles have indicated† two methods

*What about Irrigation Works, mechanised equipment, etc., etc.? Are not these the Capital of Agriculture?—**Editor**

†'Concepts of Real Capital Stocks and Services' by Richard and Nancy Ruggles, Yale University Edward Devison has also given these metods in his paper placed before conference on Income and Wealth, held in 1953.

of estimation of capital items (a) value of capital taken as equal to the cost of production of that capital item or (b) measurement of capital on its ability or capacity to produce. Prof. GA Prudensky has indicated@ a third method of finding out the total capital index from the 'total labour required as in the base year to produce all the inputs of machinery and equipment'. Thus all the capital is converted into labour equivalent in the base year. The index of such equivalent labour is the index of stock of capital and services. He has suggested the conversion also of raw materials in terms of labour equivalent.

The estimation of capital by taking capacity to produce loses its usefulness for the study of efficiency because this would mean measuring input by output, and capital productivity as such would always remain unchanged, which does not correspond to facts. Further, as Professor Ruggles* has pointed out : "Technical change in the design of capital equipment should not be incorporated into the measurement of quantity of capital since this again would be attributing all quality change to changes in the quantity of capital, leading to a productivity index in the use of capital always equal to unity."

The use of cost of production of capital goods is also defective because decline in the cost of production of equal quantum of capital due to increase in productivity in the capital manufacturing industry or the use of large-scale production methods would reduce the input of the same quantum of capital, which is absurd. This concept also suffers from another defect as pointed out by Prof. Ruggles. The cost of production of capital produced today cannot be found in the base year because in that year capital of this technology could not be produced since the necessary technical knowledge and equipment were not available in the base year. Theoretically, it is, therefore, meaningless to work out the value of capital at constant base year cost of production.

The use of 'labour required' to produce specific items of capital as a measure of capital is also not appropriate. If the same item of capital is produced at two different points of time, it may require different number of persons to produce it due to different technical knowledge available at the two points of time. Thus two identical plants under this definition will be required to be given two different values.

Thus there does not appear to be any satisfactory general solution to this problem. The basic fact is that capital in general has no physical units and any arbitrary solution will predetermine our results. The only solution, therefore, left is valuation of capital at constant prices by deflating its value by use of some price index. According to Prof. D. Domer of MIT, the 'Stock of capital deflated by price index in which quality changes of capital itself have been accounted for would be a pure input of capital very useful from the productivity point of view.'

While preparing the price index of capital, some specific items of capital of broadly specific quality are selected and market price indices of these specific items are worked out. An average index of such individual machinery price indices with some weights gives an average price index. This assumes that the prices of items, not covered among the specific selected items, have also moved parallel to those of the specific items. Even though this is the best possible method of working out the price index, it is subject to many limitations, as pointed out by Prof. Ruggles :

(a) A machine of slightly different specifications and quality should be regarded as a different machine while working out the price index. It is quite certain that some types of machines produced at two different points of time must be different in specifications and quality at least to some extent. The increase in the price index of the so-called same type of machine may partly be due to the improvement in the quality of the machine, increasing the quantity of capital embodied in that piece.

@'Labour Productivity : Concepts, Factors and Growth Reserves', by Prof. GA Prudensky of Academy of Sciences of the USSR.

*ref. ibid.

The use of its price index as a deflator will give a lower estimate of the real value of capital.

(b) The variations in the price index of specific items of machines specified in the past is far different from those of unspecified items due to different market supply conditions. For example, if an automatic machine has been developed, making the old type of machine obsolete, it is no more in demand in the market. The price index of this old type machine will go down substantially in the market. The real inputs required for the production of this old type machine have not declined to such an extent as the price index. Thus the use of price index based on prices of specified items of machines available in the base year as deflator both for old type and new type machines will give inaccurate estimates of the real capital employed. However, in underdeveloped countries where modern machines are not being produced within the country and the pace of development is slow, the magnitude of difference between the price index of the specific old machinery items and real capital deflator may be small, particularly for short periods of time.

(c) The use of base year weighting is also defective. The newly introduced capital goods tend to be those for which the cost of production has fallen fastest. The price index based on 1900 production structure would, therefore, be relatively too high and the resulting quantity of capital too low. Similarly taking 1968 as base, the capital goods which have disappeared since 1900 tend to be those for which production costs did not fall.

It will be seen that the effects of limitations pointed out at (b) and (c) above are in opposite directions, the combined effect of which may reduce the magnitude of difference between the price index and the real deflator. In this connection Prof. Ruggles has said: "In a normally competitive economy, the cost of capital goods would approximate market value. Despite theoretical objections, the real capital series that are obtained by the usual cost deflation procedures are very important and give an almost accurate series of real capital. The average of differences between indices of cost and market value for all capital may be taken as negligible, because such differences can arise only due to market imperfections, trade practices with respect to discounts, differences in mark ups etc. We may, therefore, use market purchase price of capital or price index as best as we can make it in place of cost of production."

We are thus advised to use the wholesale price index of machinery and equipment for purposes of deflating the total value of capital to work out an index of capital at constant prices.

To work out a deflator is not the only problem. The stock of capital existing at any point of time has been accumulated by purchasing capital at different points of time at different price levels. Creamer has given a method* for estimating capital at constant prices on the basis of life of the capital and investment made in different years. According to him, capital at constant prices is $C=B/D$, where B is the book value of capital and D is a deflator given by

$$D=\frac{\sum_{t=1}^{n} \frac{t}{n} V_t}{\sum_{t=1}^{n} \frac{t}{n} V_t}$$

where n is the total life of capital item, V_t is the investment made t years back at current prices and V is its value at constant prices deflated by the price index.

This method gives a good estimate of capital at constant prices but it requires year to year estimates of investment in the specific sector. For productivity estimates, the investment figures should relate to the very specific set of factories for which output figures are available. Even the figures of total annual investment in industries are not available accurately, let alone the figures for specific sample factories.

*'Capital and Output Trends in Manufacturing Industries' and 'Capital in Manufacturing and Mining' by Creamer

The problem of coverage being more important, another method to arrive at estimates of capital at constant prices using capital data for fixed specific sample factories covered by CMI reports was developed by the author in his article on 'Productivity in Jute Industry' published in Vol. III No. 4 & 5 of the NPC PRODUCTIVITY Journal.

This method can be used only for the years from 1947 to 1958. The coverage of industries after 1958 has been completely changed when the Central Statistical Organization (CSO) started its 'Annual Survey of Industries' in place of the 'Census of Manufacturing Industries'. In the Annual Survey of Industries, the CSO covers a larger number of industries but a smaller number of factories in each industry. The Census of Manufacturing Industries covered only 28 industries but in those industries it covered all factories employing 20 or more workers on any day and using power. The Annual Survey of Industries covers about 200 industries covering all factories employing 50 or more workers with aid of power or 100 or more workers without aid of power. With this change, the total capital in the factories covered increased by nearly 90 per cent, part of which is due to additional investment and a part due to increase in coverage. To keep up the continuity an estimate of capital at constant prices in 1959 may, however, be prepared by deflating its book value in the same ratio as for 1958 except for new investment during the year. The estimate of new investment during 1959 in any specific industry needs to be deflated by the price index. For the years after 1959 the same method as indicated in the article referred to above using recurring formulae will give a complete series of capital at constant prices in different industries/regions.

Gross vis-a-vis Net Capital Index

The above method will give an estimate of net capital at constant prices. Some experts prefer the use of gross instead of net capital. Prof. Ruggles has said that netting of capital should not be made because old capital is less productive due to aging and this fact ought to be reflected in the measurement of productivity. If we have two plants of the same design, one very old and another very new, the productivity measure for the old plant should be much less than that of the new one. If we use the net value of capital, the productivity index in the two plants will be the same or the old plant may even show a higher level of productivity than the new one—which is absurd. Since improved design of capital goods is not more capital, the higher production by such capital equipment should be reflected in a higher index of productivity ; it is equally reasonable to say that old depreciated capital is not less capital but its productivity is less. Year to year deductions from the quantity of capital, to make the productivity of a specific item of capital remain constant over its lifetime, is, according to Prof. Ruggles, not consistent with the desired concept.

Another expert, John Kendrick, holds a different view: the old capital gives a higher value of gross output but only a lower value of net output, because there is an increase in maintenance and repair costs. In fact the changes in productivity measure based on gross output and net output should not differ, which is true only if we use net capital. The idea behind the study of productivity increases is to find the changes in the technical know-how, changes in the processes of production and the efficiency of labour and capital to produce more. It is not, therefore, appropriate to allow reduction in productivity increases due to aging capital in hand. In fact if gross capital is used, the scrapping of old plants in our country would mean a large increase in productivity, which is rather very absurd. Thus the use of gross capital may show a rising productivity index even if the designs are the same and there is no improvement in labour productivity. Such increases due to closing up or scrapping of old plants is only an indication of improvement in the age structure of capital. The changes in the age structure of capital does not affect productivity based on net capital index. In underdeveloped countries, capital is scarce; and to scrap capital before expiry of its life, simply to improve the age structure of capital, would not be conducive to social welfare. It

would be anomalous to interpret it as an increase in productivity. We are more interested in the improvement of technology, efficiency of labour and capital, reduction in idleness, etc., and not in changing the age structure of capital by scrapping old productive units. We should, therefore, use the concept of net capital at constant prices as given by the method indicated earlier.

Substitutes for Capital Index as a Factor of Production

Due to difficulties in the estimation of a capital index, some experts* have used the index of electricity consumed, being an indicator of mechanisation, as a measure of capital. This, however, would not correspond to reality in inter-industry comparisons. Many industries like jute, cotton textiles, etc., are comparatively small consumers of electricity but they do involve large capital investment. George J Stigler has used total fuel input as a measure of capital. This indicator, however, is better than electricity index because fuel (in the form of coal, oil, or electricity), being an energy substitute of labour, is required for running all types of machines. But it is, nevertheless, a very crude index of capital and should not normally be used. Robert M Solow has characterised it as a poor measure of capital services.

On account of all these difficulties, Stigler has suggested the use of labour as the only factor of productivity. He says,** "Labour is quantitatively the largest input and, therefore, large changes in labour productivity over time are likely to reflect at least roughly the movements of a properly-defined measure of productivity." Labour productivity will, therefore, be a better measure of total productivity. However, in general, labour productivity will exceed it, the more capital has grown relative to labour. But even if movements of labour and capital employed are very different, a labour productivity index will provide a tolerable estimate of total productivity if the weight assigned to capital is small. In the USA there has been quite a close correlation between increase in labour and capital. But in India during the last 20 years, capital has increased much more rapidly than labour. Moreover the weight assigned to capital in an underdeveloped country like India is still not so small as to be neglected. It is, therefore, very very necessary to work out the total factor productivity, using both labour and capital index.

Use of Gross/Net Output

Productivity estimates have been made on the basis of gross output and net output, but it has been found that the two give widely different results.

Bronislaw Minc (Polish economist quoted earlier) writes in his essay on 'Problems in the Measuring and Analysis of Labour Productivity' that "The disadvantages of using different types of net production indexes for measuring growth in production and in labour productivity in certain enterprises are related to the fact that the volume of net production may differ considerably from the contribution of these enterprises to National income. For instance, an enterprise may produce goods on which the margin of profit is small, and therefore its net production may be low, but it may contribute substantially to an increase in profits and net production in other enterprises which buy its products (or sell their products to it). The net production of particular enterprises, therefore, does not always reflect the actual growth of production of these enterprises."

To avoid this he has used a new index of production which he calls the **stabilized material absorption index,** given by

$$Y = \frac{Pc_1 + (Pg_1 - M_0)}{Pg_0}$$

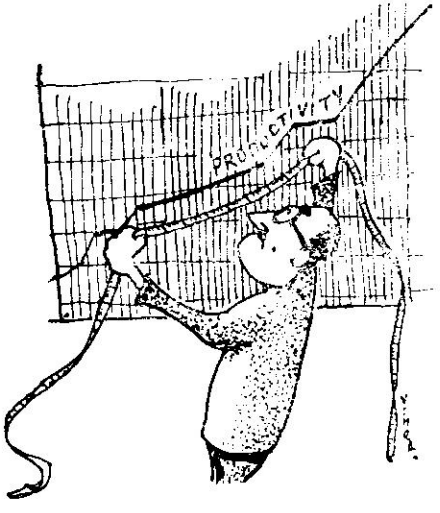
where Pc_1 = net production during the given period, Pg_1 and Pg_0 = total production during the given period and the base period : M_0 = the share of raw materials in total production during the base period.

*For example Dr. GC Beri has used it—'Measurement of Production and Productivity'

**'Economic Problems in Measuring Changes in Productivity', by George J Stigler

The index, however, simply modifies the input of raw materials in order to maintain it in the constant ratio as in the base year. But if we are measuring productivity on the basis of total inputs of labour and capital (excluding raw materials), this modification cannot be made in our production index. Minc also does not give any suggestion for improvements on price fluctuations.

The US Department of Labour has estimated, for nearly 300 industries in the United States, the net value added by manufacture at constant prices in order to work out accurate changes in productivity. The trend estimates have been derived, using the double deflation method. The dollar value of output and dollar value of materials and fuel input are deflated separately for different industries and industry groups. The resultant constant dollar values of inputs are subtracted from the constant dollar value of output yielding a measure of constant dollar value added.



The use of value added by manufacture, even though corrected by double deflator method in an overall study, is defective, particularly due to the existence of others both in output and raw materials consumed. The price index does not relate to output and raw materials required in the selected industries alone. Factories maintain stocks of raw materials purchased at different price levels. They are evaluated at the purchase price which is different from the price at the time of consumption in the manufacturing process.

Since raw materials form quite a significant proportion of gross value of output (nearly 65 per cent.), a small error in the estimate of raw material makes a big difference in the net production and, therefore, gives a widely erroneous estimate of productivity.

This method has been found very cumbersome and difficult, particularly when the various itemwise inputs and outputs, along with price index data for each are not available for Indian industries. However, it has been used on an experimental basis in cotton textiles which is an important industry in our country.

The upshot of the whole discussion in the context of the Indian Economy in its developmental phase is that we do actually need a number of well-tailored productivity indices, which would throw distinct light on progressive changes over time in the efficient utilisation of labour, of capital, and of raw materials. While theoretical discussions are useful and tools of analysis should be continuously checked and refined, econometricians should begin experimenting in the construction of a wide variety of indices, and their practical utility would be the determining factor in their continuance, refinement, ideas regarding new indices needed to appraise new situations, new policies, new technologies, and above all, the rate and direction of change. ●●●

Reflections on Two Productivity Concepts

V Lakshman Rao†

Of the 'family of concepts' of productivity, at least two appear to have attracted much attention and formed the basis for many empirical studies of which one (Labour Productivity) had dominated the field till recently and even now to a large extent, and the second Total or Multifactor* Productivity, of relatively recent origin and development, though by no means an entirely new one. The latter is also christened as 'capital-and-labour' productivity. The aim of the paper is to discuss in some detail these two concepts and what they imply.

IT HAS BEEN SAID[1] THAT INCREASES IN productive efficiency are at the root of 'economic progress, defined and measured in any way. It is a truism that growth in output is determined by the rate at which resource use is increased and the efficiency with which the inputs are combined. In other words increase in output is made up of two elements: one is the increase in output due to increase in inputs or resources expended and the other is the rise in productive efficiency.

Further, changes in productivity affects other economic variables like costs, prices, profits, output, employment, and so enters into many economic problems**

That we cannot think of a single definite general purpose productivity measure is obvious from the definition of productivity. *We can think of as many productivity concepts*

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*In his comment on Kendrick's work 'Productivity Trends in the United States' Stanley H. Ruttenberg objects to the use of the term total factor productivity by putting a question 'Should a productivity measure be called total factor productivity, when it excludes measurement of many in tangible factors other than labour and capital?' (p. 244)

[1]*Note* : Numbered Footnotes listed under References

**"Indeed in one way or another, productivity enters virtually every broad economic problem whatever current form or new name the problem takes—industrialization, or research and development, or automation, or tax reform, or cost-price squeeze or improvement factor, or wage inflation, or foreign dollar shortage" — Solmon Fabricant : Basic Facts on Productivity Change, introduction to Kendrick's book cited above.

After discussing in detail the significance of productivity indices, M.M. Mehta gives the following conclusion:

> "They could serve as powerful tools of economic analysis, as valuable yardstick for measuring the magnitude of economic changes, as a useful 'barometer' for forecasting economic conditions and prospects; and as a 'bench mark' for evaluating the economic progress of the country"—Measurement of Industrial Productivity.

and corresponding measures as the number of factor inputs we care to distinguish. The choice of measure would depend upon the purpose on hand. Perhaps the plurality of the concept is one reason for the subject of productivity to be 'surrounded by considerable confusion'. The second is the lack of proper appreciation of the fact that there are two sets of problems connected with productivity studies—(i) those related to the definition and measurement and (ii) those concerning the correct interpretation of the productivity data.[2] Obviously the latter set of problems impinges on the former. Then there are difficulties inherent in the statistical measurement of both output and input—the two parts of the productivity ratio.

If we relate output (choosing a measure of output) to any single factor input (say, labour) we get 'single factor productivity' or 'partial productivity ratio' (labour productivity). Instead of relating output to any single factor input if we relate output to the entire input complex (or labour and capital taking appropriate output mesasure) what we get is multi-factor (or total) productivity. It can be readily seen that these are average ratios and not marginal ratios.

Of the many objectives of productivity studies the following three may be noted.

The first is to measure the changing efficiency with which resources are being converted into real goods and services at any level of economic activity—a firm or an industry or the entire economy.

The second is to know the economies achieved in the use of particular resources. The particular resource chosen for study would mostly depend upon the relative scarcity (or cost) of different factor inputs.

The third is to relate productivity change to changes in other economic variables such as prices, costs, profits, output, employment etc. and to disclose, analyse and explain the relationships that subsist between productivity and other related economic variables.

Keeping in view both the objectives of productivity studies and the possibilities for confusion as to the significance of different productivity concepts, we discuss in what follows the two concepts, labour productivity and total productivity.

Labour Productivity

Labour productivity is the ratio of output to labour input. It is nothing but 'output adjusted on prorata basis for changing employment'. "The greatest interest has always centered in the relationship between production and labour, the universal resource, and the term ratio productivity is used without qualification to refer to this ratio"[3]. The reasons for giving so much importance to this measure are not difficult to understand.

First, as has been pointed out above, labour is a 'universal resource' and primary factor of production. Strictly speaking, every other factor input can be converted into its labour equivalent because it is in the nature of 'produced means of production.'* Of course, the statistical problems of measurement involved in this are by no means easily surmountable. Further, output per head is an important determinant of general levels of living. So, it is not surprising that, by and large, labour productivity measure holds the ground even now and much interest is shown in the performance of labour.

Second, the problem of unemployment (and underemployment) of labour has got both social and economic implications; and full employment of labour is not only an economic but also a social objective of any civilised society. Further, closely allied to this is the problem of adaptation to the changing economic environment. Labour displaced due to technical change must be re-employed somehow. To achieve these goals, suitable policies were to be framed on the basis of labour productivity studies which indicate the changing labour

*Attempts were made to express the total input in terms of labour time both embodied and actual: embodied labour time is that which is represented in the materials, fuels, machines and other non-labour elements used.

requirements. Relative to other factor inputs, labour input can be measured easily either in terms of number of workers or manhours spent.

Third, in many industrialised economies which pioneered productivity studies (notably the U.S. and the U.K.) labour is a scarce factor. Their preoccupation has been to make the best use of the scarce factor; and the productivity studies made in these countries to a large extent were based on labour productivity measures.

To quote T Barna :

> "If.....the view is taken that labour employs capital (and not the other way round) to increase its standard of life by capitalistic methods of production, 'dear' labour becomes the objective of policy and not one of its determining factors."[4]

John W. Kendrick[5] criticised labour productivity (or any partial productivity index) on the ground that besides productivity efficiency it also reflects inter-factor substitutions. Output per manhour, for example, may go up as a result of the substitution of capital for labour (increased capital per manhour) as well as because of the increased efficiency of production generally.*[6] This shows how difficult it is to find any simple relationship between wages and labour productivity.

However, as long as movements in labour and other resources are proportional (or nearly proportional), changes in labour productivity index may reflect correctly changes in total productivity (output per unit of combined input of labour and capital) and hence may "rank correctly the commodity producing industries with respect to true productivity change."[7] But when non-labour input is growing at a faster rate than labour input, labour productivity measure overstates increase (or understates) in productive deficiency. (See the Appendix.) While during the seventy-year period since 1889, output per unit of labour input went up in the US private economy at an average annual rate of 2.4 per cent, output per combined labour and capital input (each weighted by the market value of its services) increased only at 1.7 per cent.

To what extent can labour productivity measures be relied upon in case of underdeveloped economies?

In case of capital-scarce, labour-rich underdeveloped countries, labour productivity measures may be misleading unless used and interpreted with great caution. In this connection it is worth noting the comment made by an ILO Productivity Mission which visited India.[8]

"To many in India who tended to think of productivity exclusively in terms of labour productivity the only way of increasing productivity seemed to be the installation of new labour-displacing equipment. It was thought that retrenchment would be certain and new capital investment necessary. A consequence was that many employers and all trade unionists were wary of the consequences of raising productivity. There was little unstinted support for the Mission until it defined precisely what it meant by increasing productivity, how increases were to be achieved and what benefits to be looked for by all concerned."

Further, the major problem in underdeveloped economies is not so much of economising the use of labour† as that of making

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*Making certain assumptions (i. Factors are paid their marginal products (ii) neutral technological change (iii) production function is homogeneous, (of degee one). Solow arrives at the result $\frac{Q}{q} = \frac{A}{a} + W_k \frac{K}{k}$

where Q is output per unit of labour input, K is capital-labour ratio and A is the index of technical change (or pure productivity change). Dots denote the time derivatives. W_k is the share of capital in the total product.

(7) Changes in labour productivity correctly measures those in capital and labour productivity, only when $\frac{K}{k}$ is zero: i.e. labour and capital grow at the same rate.

†This is not to deny the fact that in India, as in a number of underdeveloped economies, though unskilled labour is abundant, skilled and technically trained labour is scarce and dear. Here we are not referring to the supply of labour of some specified skills but in general.

the best use of scarce resources such as capital (including foreign exchange) and managerial skills.

Primarily this is true with respect to the entire economy, and the feasible and appropriate technological choices it can make. At the micro-level, however, the entrepreneur would not be guided by the global consideration of relative factor scarcities. His objective is not so much the maximisation of productivity of one factor or the other as to maximise profits. Still, the relative scarcities of factor inputs would be reflected in relative factor costs and thus even decisions at micro-level will be influenced by this fact. But labour productivity, "Although convenient for various reasons tends to concentrate attention on the productivity of the worker and to obscure the often greater importance of the productivity of capital equipment."[9]

Labour productivity measures may make them to concentrate primarily on labour-saving techniques which is not in consonance with the factor endowment of many of these countries and which may aggravate the problem of unemployment and labour unrest. Further labour compensation would be tied to productivity, and trade unions may clamour for higher wages on the basis of increasing labour productivity; for an increase in labour productivity overstates the increase in productive efficiency and so wage increases based on labour productivity would not bear true relationship to increases in productive efficiency as such. There is the danger of wages increasing at a faster rate than true productivity rise which has many deleterious consequences of which the most damaging is an inflationary rise in prices (so-called wage-price spiral). Some expert in fact diagnosed this as the important cause for the present steep rise in prices in India and suggested proper wages-income policy to contain inflation.[10]

During a period when development has got underway and new investment is taking place at a faster rate (as in the case of India under planned effort) labour productivity is bound to rise whatever may be the economies (or diseconomies) reaped in the use of other resources. (See the Appendix Table 2.) So, if exclusive reliance is placed on labour productivity measures and increases in them, economising the use of other inputs may be lost sight of, or neglected.

Total Factor Productivity

The inadequacy of the partial productivity measures like labour productivity led to the measurement of total productivity which is the ratio of output to the combined input of labour and capital. Jacob Schomookler[11], Abromovitz[12], Hiram S Davis[13], Kendrick[14], Siegel[15], Solomon Fabricant[16] and others developed and used this concept of total productivity in their studies. It is named differently by different writers: multifactor or total productivity, index of efficiency, technologic change, measure of ignorance, and residual. It was termed as 'residual' by Domar in his survey paper 'Measurement of technological change.' Later, he gave up the use of this term because it absorbs like a sponge all increases in output not accounted for by the growth of explicitly recognised inputs[17]. Moses Abromovitz, in his study of resource and output trends in the USA since 1890, remarks that productivity increase played an important part in American economic development; but he speaks of productivity as '*Some sort of measure of our ignorance because very little is known about the causes of productivity increase*'.— (Italics ours)

In many of the growth models hitherto presented, technological progress (the main factor behind productivity increase) as a factor promoting and accelerating economic growth was not given much importance while capital accumulation took the central place in all discussion of economic development.

A number of productivity studies have pointed to the role played by technological-organisational progress leading to enormous increase in productive efficiency. The study of the US economy by Kendrick has shown that during the seventy-year period since 1889 each year's increases in productivity accounted, on the average, for almost half of the year's increase in product while the other half reflected

an increase in resources—labour and tangible capital.* This fact opens up a new path, tracing economic change mainly engineered by technological-organizational progress. Perhaps, capital accumulation plays a relatively smaller role in accelerating economic growth compared to technological progress. This is not to say that even if capital accumulation ceases to take place, economic growth can still be had through technical progress alone. Because *technical progress is not a costless affair* it requires investment in many directions. Moreover, much of the technological progress may be of the 'embodied' type. *As a matter of fact it is not meaningful to speak of capital accumulation and technological change as two distinct and separate entities.* To quote Domar "...complete isolation of capital formation from technological progress is empirically impossible, and to the extent that our deflation methods of capital formation do not fully account for quality changes $\overline{K}$ (rate of capital accumulation) may be understood and $\overline{A}$ (rate of technical change) overstated."[18]

If we want to measure changes in productive efficiency as such we require a total productivity measure. The movements in this ratio reflect the changing relationship between benefits received and benefits attainable with base period techniques. These movements consequently measure a basic economic phenomenon, the changing efficiency of the transformation of economic means into economic ends.[19]

The changes in total productivity reflect the combined influence of four factors.† It includes the effect of changes in relative prices of factor inputs, increases in the competitive nature of the economy (or the decreases in its monopolistic nature), economies of scale due to increasing scale of operations, and increases in technical efficiency.[20] The distribution of the increase in productivity among these four components is a problem involving many conceptual and statistical difficulties awaiting solution.

So in the final analysis even output per unit of combined capital and labour input does not measure changes in productive efficiency alone, except under some special conditions, but also reflects the influence of some other elements.

In the conclusion it must be said that different productivity ratios (including labour and total productivity ratios) are not in the nature of substitutes but each throws light on some aspects of the general rise in output during the process of economic growth, and the most thorny problem facing the economic statistician is the allocation of productivity increases among its different components.

APPENDIX

The following two tables would give some statistical evidence in support of a few points referred to in the text.

TABLE I

Productivity Growth in Selected Countries in recent years

Economy	Labour productivity	Residual /or Total Productivity	Ratio between Annual Rates of Growth and Residual output %
U.S.A.	2.5	1.4	47
Canada	2.8	1.2	30
U.K.	1.4	.6	25
Germany	5.5	3.6	50
Japan	5.8	3.7	44

Col 1: Annual percentage rates of growth of labour productivity : gross value added per man-hour.

*It is interesting to note that DW Jorgenson and Z Grisches in their recent paper have shown that if real product and real factor input are accurately accounted for, the observed growth in total factor productivity is negligible—The Explanation of Productivity Change —the Review of Economic Studies, July '67 Vol XXXIV.

†If a production function has constant returns to scale and if all marginal rates of substitution are equal to the corresponding price ratios, a change in total factor productivity may be identified with a shift in production function. Under these conditions movements in total factor productivity would only reflect the effect of technological change — See Solow op. cit. and DW Jorgenson and Z Girsches.

Col 2 : Annual percentage rates of growth of value added, arithmetic residual—the residual as computed here is simply the ratio of the index of value added (in constant prices and gross of depreciation) to the index of labour and capital inputs, each input weighted by its share in the corresponding value added of output in the base year.

Col 3: This column would throw light on the importance of the growth of the residual as compared with the growth of output.

Sources: Domar and Others : Economic Growth and Productivity in the United States, Canada, United Kingdom, Germany, and Japan in the Post-War period. The Review of Economics and Statistics, February 1964. No. 1, Vol. XLVI.

TABLE II

Labour Productivity in Manufacturing Industries in India, Base (1951=100)

Year	Index of Manufacturing	Index of Employment	Index of Productivity
1951	100.0	100.0	100.0
1952	103.0	98.5	104.6
1953	105.8	98.2	107.7
1954	113.2	98.0	115.5
1955	125.6	101.5	123.7
1956	137.2	106.5	128.8
1957	141.7	110.0	127.7
1958	145.0	111.6	129.9
1959	157.1	113.1	138.9
1960	175.0	117.1	149.4
1961	185.5	121.9	152.2
1962	199.6	127.9	156.1
1963	217.3	130.4	166.6

Source : *Eastern Economist* Annual, 1966

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1. Hiram S. Davis : The Industrial Study of Economic Progress, University of Pennsylvania Press, Philadelphia, 1947.

2. W.E.G. Salter in his book "Productivity and Technical Change" (Cambridge, 1960) refers to this issue. "One of the reasons why interpretative analysis of productivity has been slow to develop has been the interminable controversy over what is productivity and what do we really wish to measure .... most of this discussion has proved fruitless and only served to confuse issues of measurement with the issues of interpretation". (p. 2)

3. I.L.O. : Methods of Labour Productivity Statistics, Geneva, 1951.

4. T. Barna : 'The Productivity of Labour: Its Concept and Measurement' in the Bulletin of the Oxford University. Institute of Statistics, Vol 8 No. 7, July 1946 p. 205 quoted in I.L.O. op. cit.

5. Op. cit. p. 17 :

6. Robert M. Solow : 'Technical Change and aggregative production function'. Review of Economics and Statistics August, 1957.

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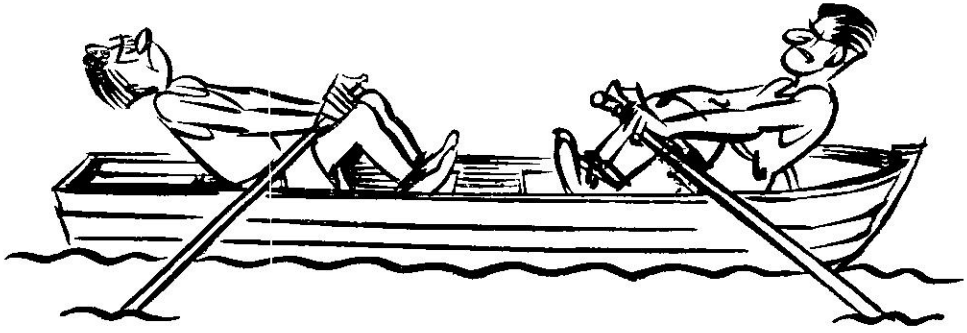
17. Evsey D. Domar : Measurement of Tehnological Change, Economic Journal, Dec. 1961.

18. Ibid.

19. Jacob Schomooker : Op. Cit.

20. For an excellent theoretical discussion of these components see Stigler op. cit.



How Far Size Affects Productivity of The Industrial Unit

GP Mukherji & Pranbandhu Dass*

The aim of this study is to analyse and examine (on the basis of available statistical data) the relationship that exists between 'Size' and the 'Productivity Indices' of an industrial unit. This analysis of the productivity indices of the different sized units is designed to ascertain a size of the unit as would be consistent with the maximum of efficiency. The existing literature on the subject reveals a definite conflict of several fundamental view points. As pointed out by Dr. MM Mehta[1], the Federal Trade Commission, which undertook an elaborate study[2] of the 'Relative Efficiency of Large, Medium-sized and Small-sized Business', came to the conclusion that large plants and companies are generally less efficient in terms of 'unit costs' and 'rates of return' than medium-sized or even, in some cases, small-sized units. JM Blair[3], working almost on the same set of statistical data, came to diametrically opposite conclusions. On the other hand, Dr. L Rostas[4] holds that 'there does not appear to be any definite interrelationship between the relative size of plant and relative output per worker'. This shows the pressing need for more intensive and thorough studies into the size-productivity relationship.

TO SIMPLIFY THE ENQUIRY, ONLY NINE major industries are selected for the present, *viz.*, jute, cotton, sugar, iron and steel, general engineering and electrical engineering, chemicals, cement, vegetable oils (excluding edible hydrogenated oils) and rice milling. The criterion for selection has been the gross ex-factory value of output and the value added by manufacture as reported in the Census of Indian Manufactures. The contribution of these selected industries is evident from the Tables printed on the following pages.

The selected industries taken together accounts for more than 82 per cent of the total industrial activities of India as brought out by the Census.

Meaning and Measure of Size

The word 'size' in Economic terminology is defined as 'scale'—meaning thereby the scale of production, of output, or of operation. The size

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[1]Dr. MM Mehta—Measurement of Industrial Productivity, Ch. III, p. 45.

[2]. Temporary National Economic Committee (USA)—Monograph No. 13, pp. 95-97.

[3]. 'Relation between size and Efficiency of Business'—Review of Economic Statistics, August 1942, pp. 125-135.

[4]"Comparative Productivity of British and American Industries"—National Institute of Economic Research, Cambridge, p. 60.

TABLE I

Coverage of the nine selected industries as compared to the total of the 29 industries—for certain important items

Sl. No.	Items	Unit	Nine selected industries	All 29 industries	Per cent. covered
(1)	(2)	(3)	(4)	(5)	(6)
1.	No. of registered factories in existence	No.	5790.00	7067.00	81.93
2.	No. of factories from which returns were received	No.	5458.00	6637.00	82.24
3.	Total volume of employment	(lakhs)	15.18	17.15	88.51
4.	Total productive capital	(Rs. in crores)	660.42	787.76	83.84
5.	Total salaries, wages and other benefits or privileges	,,	194.77	218.56	89.12
6.	Gross ex-factory value of output	,,	1080.87	1287.55	83.95
7.	Value of total input consumption	,,	756 09	914.63	82.67
8.	Value added by manufacture	,,	32.48	37.29	87.10

of an industrial unit is usually measured by any one of the following criteria :

(*i*) technical equipment

(*ii*) volume of employment

(*iii*) capital structure

(*iv*) value or volume of production.

Each one of these measures has its own advantages as well as limitations. It is a baffling question as to which one of these alternative methods is the appropriate one. The only solution that suggests itself under the situation is that, suitability of a certain method is to be ascertained in the light of the exact nature of the requirement and the existing circumstances, if not the extent of availability of data.

Limitations of the Study

Coverage and Scope : Since the present study is an analysis of the Census data, we should be clear about its coverage and scope. The Census is confined to the first 29 industry groups only, out of 63 major groups into which the organised Manufacturing Industries of India have been divided following the United Nations Industrial classification. These 29 groups are supposed to include the 28 major industrial activities of India. However, some important industries like tea, coal, tobacco, etc. fall outside the scope of the Census and make it incomplete to that extent. Further, the division itself is not very satisfactory, as it classifies the factory according to its principal product (value being the basis of selection). Secondly, the Census of Indian Manufactures contains the statistics of the Factories within the purview of the Indian Factories Act and that too its scope is confined to Zone I factories only, i.e., those power using factories only which employ 20 or more workers on any day. Thus the non-power using sector or Zone II, the less important industries and the smaller industries remain unaccounted for. The third important point worth mentioning in this connection is about the geographical coverage. The geographical coverage varies from year to year (though the

variation is sometimes very small). The area covered by the Census conducted under the Industrial Statistics Act 1942 for the year 1954 is as follows :

West Bengal, Bombay, Madras, Uttar Pradesh, Andhra, Bihar, Mysore, Madhya Pradesh, Punjab, Delhi, Orissa, Rajasthan, Patiala and East Punjab States Union, Saurashtra, Assam, Travancore-Cochin, Ajmer, Himachal Pradesh, Vindhya Pradesh and Kutch.

Hence the excluded areas are : Andaman and Nicobar Islands, Bhopal, Bilaspur, Cooch Bihar, Coorg, Hyderabad, Jammu and Kashmir, Madhya Bharat, Manipur and Tripura. It is also stated that "except for Hyderabad the number of factories in the states not covered by the census is negligible".

Further, it is stated that the factories under the control of the Defence Ministry irrespective of the industry to which they belong, are excluded from the census, and the period covered by the census relates to the calendar year except in the case of the 'Sugar Industry' for which the year ending 30th June is adopted. Yet another point worth mentioning in this connection (sugar industry) is that figures for gur industry though shown separately from that of sugar for the previous years (i.e. 1952 and 1953) have however been excluded from the report for the year 1954 as the returns received were found to be defective. As regards the vegetable oil industry--only oil seed crushing and extraction and processing of vegetable oils excluding manufacture of edible hydrogenated oils have been taken into account.

Scant data about size: As CMI furnishes no data allowng the use of any of the remaining criteria as a measure of size we are left only with the choice of accepting the volume of employment for our study. Furthermore, we are to follow the census size grouping, which is shown below:

Group	I :	employing less than 20 persons per working day.			
Group	II :	employing not less than 20 and not more than 49 persons per working day.			
Group	III :	—do—	50	—do—	99
Group	IV :	—do—	100	—do—	249
Group	V :	—do—	250	—do—	499
Group	VI :	—do—	500	—do—	999
Group	VII :	—do—	1000	—do—	1999
Group	VIII :	—do—	2000	—do—	4999
Group	IX :	employing 5,000 or more persons per working day			

The above grouping, though not very satisfactory for certain industries like jute etc. is the only information available in the latest census report (1954) regarding "Size" and thus has to be followed. A further limitation of our study is that it is an analysis of only one year's data (1954) and hence the conclusions are but tentative.

Concentration of factories by size-class : The distribution of the number of factories together with their percentages by size group (as measured by the total number of persons employed) is shown in Table II.

Table II shows the percentage concentration of number of factories in the smaller size-classes for the rice milling industry. For vegetable oils, chemicals, iron & steel and general engineering industries concentration is found to be in the medium groups. The table further shows that these four industries may again be classified into two groups as follows:

Group I Industries (where the concentration of the number of factories though present in the medium groups) showing a definite bias towards smaller size classes.

Group II industries where no such bias is present.

The vegetable oil and general engineering industries belong to the first group—with a bias towards "smaller" size. Chemicals and iron & steel industries belong to the second group—with no bias towards either side. The industries sugar, jute and cement show the concentration in the larger groups. Amongst these three the percentage concentration of number of factories is much more and for larger group for jute than that of the other two. The case of cotton industry is slightly peculiar. Here the distribution presents a bi-modal curve having a high con-

TABLE II

Percentage distribution of number of factories by the "Size group" of number of persons employed

Sl No.	Size	Food Stuffs			Textiles		Heavy Industries				All 29 industries
		Rice milling	Sugar	Vegetable oils	Cotton	Jute	Cement	Chemicals	Iron & steel	Gen. engg.	
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
1.	below 20	30.2	9.7	25.3	5.5	..	..	7.9	10.5	27.8	21.7
2.	20 to 49	41.6	6.5	45.6	13.7	..	..	36.0	39.5	41.3	36.3
3.	50 to 99	24.5	0.6	22.2	5.3	..	..	26.1	21.8	15.5	18.5
4.	100 to 249	3.6	1.3	6.3	7.2	1.0	..	18.8	15.3	9.2	9.2
5.	250 to 499	0.1	7.2	0.6	8.0	1.0	23.8	5.0	2.4	3.5	3.9
6.	500 to 999	..	42.9	..	11.5	3.8	47.6	4.6	2.4	1.7	3.6
7.	1000 to 1999	..	29.9	..	21.5	31.4	23.8	1.3	2.4	0.8	3.4
8.	2000 to 4999	..	1.9	..	22.6	58.0	4.8	..	2.4	0.2	2.9
9.	5000 & above	..	..	..	4.7	4.8	..	0.3	3.3	..	0.5
10.	Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
11.	Effective number of factories (factories from which information was received)	1462	154	947	488	105	21	303	124	1854	6637
12.	Number of registered factories in existence	1514	160	1019	521	108	21	319	126	2002	7067

centration in the larger groups while the concentration in the smaller groups is also not altogether negligible.

Meaning and Scope of Productivity

Before discussing how far "size" (as denoted by labour force) affects "productivity" of the industrial unit, let us be clear about its meaning and scope. Productivity, in the widest sense is the "measurement of the economic soundness of the means". The concept of productivity is sometimes considered as synonymous with efficiency, but there is a distinction between the two. As pointed out*, the word efficiency does embrace the idea of productivity, but goes beyond it in that it expresses an aptitude or capacity—in short, a quality of the unit, the productivity of which is under consideration, while the concept of productivity introduces the idea of relationship between product and input factors. True productive efficiency should be measured by "the output of goods

*Productivity Measurement, Vol, I, 1955, p.26—Organisation for European Economic Council.

and services relative to the corresponding total input of resources used in their production". Due to the heterogeneity of the different input factors it is difficult to find any suitable procedure for combining these factors into one single form. Because of this, and "because in many cases the chief input variable is the manpower employed, productivity is sometimes measured in terms of the value of output relative to the manhours involved." However, the relationship between output and any one of the input factors neither expresses the efficiency nor the true productivity, since production trends depend on other factors as well. It may be mentioned that labour, apart from being the chief input variable, has yet another advantage, because of the fact that "worker" holds a central place in the whole economic system. The worker is a 'producer' on the one hand and a 'consumer' on the other. And, above all, persons as units of enumeration are easier to conceive of than that of values.

Analysis of Productivity Indices

Our present study is an analysis of the following productivity indices :

(A) "Labour Productivity" as measured by (i) "value added by manufacture per person employed" $\frac{V}{E}$ and (ii) "Gross ex-factory value of output per employed person" $\frac{O}{E}$

(B) "Capital Productivity" or "Capital Efficiency Ratio" as measured by "Value added as percentage of total productive capital" $\frac{V}{PC} \times 100$

(C) "Total Productivity" or Operative Efficiency" defined* as "the obverse of an estimate of total cost expressed as percentage of value of products, and hence can be taken as a rough measure of the surplus of value of products over material and labour costs."

$$\text{Total productivity or Operative Efficiency} = \frac{CP}{O} \times 100$$

As CMI gives no information regarding management, it is not possible to measure productivity from the viewpoint of management. It may be mentioned that ratios like V/I, or I/O, or $(I/CP) \times 100$, $\frac{PC}{E}$, $\frac{L}{E}$ etc. and the degree of mechanization and rationalization as measured by value of plant and machinery per worker or operator, or ratio of administrative and supervisory staff to the primary staff, etc. are not taken into account here, since they affect only the productivity indices and are not productivity indicators.

The detailed tables (not shown here) for the relevant productivity indices present a picture which is not very homogeneous. The important characteristics as depicted by the detailed tables are summarised in Table III.

Table III delineates the nature of the graphs for the labour productivity ratios $\left(\frac{V}{E} \text{ \& } \frac{O}{E}\right)$, capital productivity ratio $\left(\frac{V}{PC} \times 100\right)$ and the operative efficiency ratio $\left(\frac{CP}{O} \times 100\right)$, for the selected industries. For plotting the graphs, ratios were taken on the ordinate and size-groups on the abscissa. The table further shows that, in general, the nature of the graphs for the labour productivity ratio $\frac{V}{E}$ and the operative efficiency ratio $\left(\frac{CP}{O} \times 100\right)$ are more or less reciprocal of each other with a few exceptions, the notable exceptions being cement and chemical industries. The cement industry presents a rather peculiar picture — with only 21 factories distributed over four size classes. For the

*Journal of Royal Statistical Society—Vol. 119, 1956. "Some Aspects of the Structure of Indian Industry"—by Vera Anstey and Russi J Taraporevala.

TABLE III

Sl. No.	Name of Industry	Labour Productivity		Capital Productivity	Operative Efficiency
		$\frac{V}{E}$	$\frac{O}{E}$	$\frac{V}{PC} \times 100$	$\frac{CP}{O} \times 100$
(1)	(2)	(3)	(4)	(5)	(6)
	I. Foodstuffs				
1.	rice milling	$I_{(3)}$	Irregular	$I_{(5)}$	$D_{(3,5)}$
2.	sugar	$I_{(3,7)}$	J skewed	$I_{(3,6)}$	$D_{(3,6)}$
3.	vegetable oils (excluding edible hydrogenated oil)	$I_{(6,8)}$	$I_{(4)}$	I	$D_{(4)}$
	II. Heavy industries				
4.	cement	Bell shaped	Bell shaped	$I_{(7)}$	$D_{(7)}$
5.	chemicals	J skewed	$I_{(4,7)}$	Bell shaped	$U_{(4,5,6)}$
6.	iron & steel	I	$I_{(5,8)}$	$I_{(4,6)}$	$D_{(6,8)}$
7.	general engineering & electrical engineering	$I_{(6)}$	$I_{(3,6)}$	$I_{(3,6,8)}$	$D_{(6)}$
	III. Textiles				
8.	jute	J twisted	J twisted	$D_{(3)}$	J twisted
9.	cotton	I	J twisted	$I_{(4)}$	J skewed
10.	All 29 industries	$I_{(7,8)}$	Bellshaped	$I_{(9)}$	$D_{(8)}$

Note: 1. I stands for increasing trend with practically no exception groups.

2. $I_{(m,n)}$ stands for increasing trend with exceptions in the (m)th and (n)th groups (m & n—none of these being greater than 9.)

3. $D_{(m,n)}$ stands for decreasing trend with exceptions in the (m)th & (n)th groups (none of these m and n's being greater than 9).

4. $U_{(m,n,p)}$ reveals U shaped curve (meaning of suffixes being the same).

labour productivity ratios $\frac{V}{E}$ and $\frac{O}{E}$ this industry gives a "Bell" shaped curve, showing that the medium size groups are more efficient than either extreme ones. The second interesting feature brought out by the above table is about the chemical industry. This industry gives a U shaped curve for the operative efficiency ratio $\left(\frac{CP}{O} \times 100\right)$, groups 4, 5 and 6 being the exceptions and a bell-shaped curve is obtained for the capital productivity ratio $\left(\frac{V}{PC} \times 100\right)$. Both these

ratios taken together show that the medium-sized groups are more efficient than the remaining ones. J skewed and J twisted curves are obtained for the industries sugar, chemicals and textile industries (jute and cotton). Frequency of J twisted is slightly greater than that of J skewed, the ratio of their occurrence being of the order of 4 : 3. J twisted curves are obtained for only the textile group, for the ratio $\frac{O}{E}$ for both the textile industries and for ratios $\frac{V}{E}$ and $\left(\frac{CP}{O} \times 100\right)$ for jute textile industry. However, it is rather a delicate task to draw a clear line of demarcation between the two (i.e. between J twisted and J skewed). Increasing trend is visible elsewhere (in most of the cases with a few exception groups).

Efficient groups : Table IV shows that for the selected industries 24 (total of col. 5) size groups out of 62 (total of col. 4) stand above the efficiency level. Out of these 24, frequency of higher (i.e. 5th-9th) size groups (i.e. with not less than 250 workers) to that of lower (i.e. 1st — 4th) is of the order of 19 : 5. Thus the predominance of large-sized units above the efficiency level is well brought out: (79 per cent. of the factories above efficiency level are large sized units. The table also shows that the contribution of these so to say "efficient groups" to the industry total is high for rice-milling, textile industries (jute and cotton), cement, and low for the industries sugar, iron & steel and general engineering & electrical engineering. The vegetable oil industry stands in between. However, if the percentage contribution of smaller size groups above the efficiency level be left out of account we find that the contribution of larger size units to the industry total is always low except cotton (jute and cement are not taken into account as size of the units are very large and no factories occur in the smaller groups). Thus it follows that practically for all industries (except jute, cotton and cement) a few very large size units orient the result considerably. This result is obtained by using gross ex-factory value of output per employed person as the base for fixing the efficiency level.

TABLE IV

Industry-wise percentage of factories covered by the size groups above efficiency level

Sl. No.	Name of industry	Effective No. of factories	Total No. of size groups	Size groups above efficiency level		
				Number	Count	Percent of factories covered
(1)	(2)	(3)	(4)	(5)	(6)	(7)
	I. Foodstuffs					
1.	rice milling	1462	5	2	2,5	41.7
2.	sugar	154	8	3	4,5,8	10.4
3.	vegetable oils (excluding edible hydrogenated oil)	947	5	2	3,5	22.8
	II. Heavy industries					
4.	cement	21	4	1	6	47.6
5.	chemicals	303	8	4	3, 5, 6, 9	36.0
6.	Iron & Steel	124	9	2	7, 9	5.7
7.	General Engg. & Electrical engg.	1854	8	3	5, 7, 8	4.5
	III. Textiles					
8.	Jute	105	6	4	4, 6, 7, 9	41.0
9.	cotton	488	9	3	5, 6, 8	42.1
10.	all 29 industries	6637	9	6	1 to 6	93.2

NOTE : By efficiency level is meant the average value for all groups taken together, base being the gross value of output per employed.

Comparative Analysis

A comparative picture of the Indian, British and New Zealand industries regarding the nature of the size-productivity indicator graphs for the selected nine industries is brought out by Table V :

TABLE V

Comparative position of industries in India, Great Britain and New Zealand as regards the nature of the graphs (size and productivity ratios)

Country	Reference year	Productivity	Classification of industries by nature of graphs for productivity indicators				
			Increasing trend (I)	Decreasing trend (D)	U-shaped trend (U)	J-shaped trend (J)	Bell-shaped trend (B)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
India	1954	O/E	1. vegetable oils (excluding edible hydrogenated oils) 2. chemicals 3. iron and steel 4. general engineering & electrical engg.			1. sugar 2. jute 3. cotton	1. cement
		V/E	1. rice-milling 2. sugar 3. vegetable oils (excluding edible hydrogenated oils) 4. iron & steel 5. general engg. & electrical engg. 6. cotton			1. chemicals 2. jute	1. cement
Great Britain*	1930	O/E	1. grain-milling 2. iron & steel tubes 3. seed crushing 4. iron foundries	1. cotton weaving 2. iron smelting 3. jute 4. textile finishing	1. sugar 2. cotton spinning 3. iron & steel blast furnaces		1. non-metalliferous-mines
New Zealand†	1936	V/E	1. vegetable & animal oils and fats 2. textiles 3. concrete products 4. basic metal industries 5. metal products 6. machinery 7. electrical machinery				1. chemical products

*Colin Clark — The Conditions of Economic Progress (1957), Ch. VI, pp. 347-48.

†European Productivity Agency—Productivity Measurement Review, p. 38, No. 13, May 1958—M.M. Mehta, Structure of Indian Industries

It is found that in general food groups show increasing trend (production increases as size increases), while cement and non-metalliferous mines give Bell-shaped curves, i.e., maximum value lying somewhere in the intermediate groups. But New Zealand presents a different picture insofar as this industry shows increasing trend. In textiles, non-increasing trend is visible for India and Britain, while New Zealand reports increasing trend. Jute industry's is a rather peculiar case—British industry (Colin-Clark) reports negative correlation between size of the firm as measured by total value of employment, and output per employed person. M. M. Mehta reports high positive correlation between size of looms installed and cost while we find J-shaped curves — which is indeed surprising. The discrepancy may be due to different methods of measure and arbitrary grouping of size, differences in scope and coverage, concepts and definitions of the terms etc.

Conclusion

In conclusion, it appears that in general there is an increasing trend — productivity increases as size increases. But exceptions are also present and for some industries like 'cement', Bell-shaped curve is also obtained. It may be interesting to note that New Zealand industries report 40 per cent increasing trend, 30 per cent constant or no definite trend and the rest other miscellaneous trends. (source already quoted). Thus it may not be wrong to infer that size (as measured by the number of workers) and productivity indicators are slightly positively correlated.

Abbreviations

1. PC = total Productive Capital
2. E = average number of persons employed or volume of employment including both workers and persons other than workers.
3. L = total labour charges including salaries and wages and other benefits and privileges to workers & persons other than workers.
4. I = input includes value of fuels, materials consumed and work done for the factory by other concerns.
5. O = output or gross ex-factory value of products—represents the value of products, by-products and work done for customers.
6. V = 'Value added by Manufacture' : This represents that part of the value of the product which is created in the factory, and is computed by deducting from the gross ex-factory value of the product, the value of fuels and materials used, work done for the factory by other concerns, and depreciation of fixed assets.
7. CP = total cost of production, and includes value of input items (I) and total labour charges (L). CP = I + L. ●●●

Meaning and Honesty at All Costs

A high-level debate is going on in the USA regarding the rebellious spirit that now pervades the Student World. Dr. Kavanaugh, an ex-clergyman of the Roman Catholic faith, is on the side of the young for their determination to stand against popes, take on presidents, and disappoint parents. It will organise marches, refuse to fight wars, reject impersonal education, scorn dead marriages, ignore formalised religion, abandon traditional superstitions, and search for meaning and honesty at any cost.

Wages and Productivity in Cotton Textile Industry

THE INSTITUTE OF ECONOMIC GROWTH'S research publication on Wages and Productivity in the Cotton Textile Industry in India is almost a breakthrough in the field. For almost the first time in Indian economic history, the job of measurement of productivity, for the time being limited to the field of cotton textiles, has been attempted scientifically and in considerable depth. The authors, Dr. JN Sinha and Sri PK Sawhney, as can be easily seen from the work, have an unusual mastery of the science and art of measurement. They possess the necessary theoretical background essential for competent analysis, and for avoiding howlers that non-professionals are liable to commit. The approach is throughout diagnostic and the authors, while they know where they are going, do not get bogged down by impracticalities or the quixotic demand for conceptual purity. With considerable dexterity and finesse they are able to find their way through making the necessary adjustments and compromises essential for arriving at reasonably valid computations of highly complex and sometimes rather intractable material. The presentation throughout is lucid.

However, the work suffers from the usual curse of the academician in India, namely, a number of unacademic references to competing works in the line. In the printed copy, the authors would be well advised to take out those references and also those value judgments not substantiated by statistical analysis. In fact this research piece is so substantial that it can stand by itself; and it is not necessary to draw conclusions either with regard to capital formation in the cotton textile industry or the return to the investing class on the basis of the statistics compiled and analysed by the authors. These really require other data and many other facts to validate some of the generalisations in which the authors have indulged. The actual worth of this publication lies in the results implicit in it which are of great significance from the point of view of the understanding of economic trends.

The present study forms part of a wider project on wages and productivity in selected Indian industries. This part so far made public relates only to the cotton textile industry; and the main objective, as the authors put it, "is primarily to determine the sharing of productivity gains".

In a knowledgeable way, the authors have made good use of Kendrick's monumental work on Productivity Trends in the United States. But they have modified—and have done it competently—Kendrick's concepts and tools to suit the needs of the specific problems of the Indian Cotton Textile Industry, and the limitations of available data.

In the Preface, the authors have made critical references to the Labour Bureau study of the trends in the utilisation of labour and other inputs in selected industries. In their opinion, the Labour Bureau study suffers from some methodological limitations: it does not furnish an over-all measure of productivity, covered by the concept of total factor productivity; and it does not cover the problem of sharing of productivity gains, which in the authors' opinion is basic to capital-labour relations and the growth of the industry, and therefore there is no justification for an additional work on the subject.

While we would not like to offer any comments on the Labour Bureau indices without a detailed examination, we think in this virgin field there is room for all manner of experimentation, and it is the duty of the academician to realise the intellectual limitations, under which research work is done in different types of organisation. In fact the record would show that we have made quite a bit of contribution to the subject, for the NPC Productivity Journal has, during the last decade, carried a number of research pieces on the concept and techniques of measurement of productivity, with application to various fields of industry; and we have, besides, brought out a whole Special Issue on Measurement of Productivity with world-wide contributions on the theory and practice of measurement, international comparisons, industry studies, etc., and we think that there is scope for everybody—for the NPC to recognise competent work wherever it is done; for the Institute of Economic Growth and Universities, to keep abreast of theory, and make contributions to further theoretical development, to guide research in specific lines, for government departments like the Labour Bureau to keep the fire burning and the Ministry of Labour to make studies wherever they can, for their physical and financial resources are enormous; also for stray iconoclastic intellectuals to have their bite, big or small, on this rather enormous and uncovered field.

In this context and in this spirit we welcome this publication of the Institute of Economic Growth.

The authors have put the case squarely in the very opening line of the Introduction. "In a developing economy wage policy is faced with a real conflict between the needs of workers for larger consumption and the demands of the economy for a higher rate of capital formation." While this is basically true in the sense that at any point of time, the economy can stand a certain volume of aggregate expenditure without generating inflationary pressure, it is possible, however, that under certain circumstances, such as conditions of recession, a large mass consumption may by itself be the cause of a higher rate of capital formation : and the two instead of being in conflict may in fact be essentially complementary. Restraints on consumption of all classes of people including workers are essential for the containment of inflationary pressures, for they distort the whole functioning of the economic system and damage capital formation; otherwise there need be no conflict between the legitimate claims of the workers and the social need for higher capital formation, provided inflationary pressures are contained by adequate monetary and fiscal policies. This is the correct theory.

The authors have quoted the Planning Commission "that the rate of progress has to be determined not only by the needs of the workers but also by the limitations of the country's resources". All this is really not essential to the authors' main task of the measurement of productivity ; and it would raise all manner of fundamental issues regarding resources. It is true that financial resources constitute a limitation but the workers are the real resources of the community and the fulfilment of their needs would enrich the resources upon which the community depends for development. The authors have directly or indirectly conceded the point; but why bring in factors which disturb an understanding of the main analysis?

Again it is true that the employment at the existing level of wages should be maintained and if possible increased. This implies that the workers themselves are by their demands for higher wages reducing the volume of employ-

ment or adversely affecting the employment potential. We thought that the economists are by now agreed that Keynes had successfully demolished this theory. In any case it would be worthwhile to go into the factors enunciated by Keynes which determine the aggregate volume of employment. We agree with the authors that "productivity analysis should occupy a central place in the study of wage problems and policies", but at the same time we would like to emphasise that the analysis should be associated with a very firm grasp of fundamentals.

It is historically true that both in Capitalist as also in Communist countries, real wages have been very low, over time ; and high rates of capital formation have been built on a substantial exploitation of labour ; but would any economist suggest that there was no other way out? This would in fact mean a yielding to Marxian determinism ; and that is one thing that rational men cannot accept, with all the regard that we have for the high academic achievements of Karl Marx and for his historical contribution to the history of economic thought. Naturally, if there is determinism there is no rational thinking, and we better shut up the shop of economic studies.

The authors concede that the historical experience of industrialised economies is an unsatisfactory guide to our wage policies. "The historical experience of industrialised economies is an unsatisfactory guide to our wage policy since absolute levels of their wages and living were never so low as prevail in India today. At our wage levels the workers are unable to procure the basic supply of goods and services needed to maintain them in a reasonable state of health and efficiency." While this is true, this is not the point. It is of course not even true to say that the level of wages in Britain in the early part of the Industrial Revolution was sufficient to maintain the British workers in a reasonable state of health and efficiency. The point really is that the unconscionable sufferings inflicted on British workers during the Industrial Revolution and on Russian workers during the Stalin regime were not at all necesasary for high capital formation; in fact they exhibit an ignorance of the true state of the economic process. Sociologically, it is true that taking all the circumstances—political, economic and social—high capital formation in Britain in the 18th and 19th centuries and in Russia after the Revolution, can only be regarded as an integral part of a total social process of which the harsh treatment of the workers was but one part. Keynes's exposition of capital formation was superior in the sense that under conditions of less than full employment, a country can eat the cake and have it also : in fact the two can only go together, till a state of full employment is reached; or inflationary pressures are held in check by adequate economic policies supported by rigid physical controls.

We agree with the authors that "the desired effect of introducing minimum efficiency wage may fail to be realised so long as other aspects of the industry are not set in order;" also with the statement: "if wages are linked to productivity, rising productivity trends should ultimately produce the desired wage levels;" and we are of the opinion that the study made by the authors would contribute to the desired end.

In Chapter II on Concepts and Definitions, the authors start with the proposition that "linking wages with productivity provides a generally agreed basis for wages adjustments." To the best of our knowledge, there is no general consensus on the linking of wages with productivity. While labour appears to be opposed to it, employers are for it, but under circumstances and conditions to which the workers are unlikely to agree. We think it right that wages should be linked to productivity but this should be part of a comprehensive industry-wise agreement, covering all the gains of the investor class, including remuneration of all kinds : salaries, commissions on sale and purchase, etc. etc., and fiscal policies are modified so as to encourage investment of retained profits, modernisation, upgrading of the skills of the workers, investment in their health and housing, etc. etc. It seems to be forgotten that apart from their bonafide share in the gains

of productivity, the investing class in control of industry are in a strategic position to channel to themselves the fortuitious gains of the market place.

Apart from these *obiter dicta*, we are of the opinion that the methodology as worked out in Chapter II of this thesis, is an extremely competent piece of work and we would like to commend it to young students of economics. In fact in making statistical calculations, the authors have been ultra careful and they have taken pains to arrive at valid conclusions, as for example in the determination of capital stock under Indian circumstances : "... the depreciated real value of stock would be a meaningful category only if the rate of depreciation allowed for corresponds to the decline in the real product yielding capacity of various items in the stock. In the Indian context this is far from the truth. Depreciation is calculated at the rates allowed by the income tax authorities for assessing taxable income. It is based on certain arbitrary accounting procedures and need not reflect the decline in the capacity of the real stock to contribute to product and revenue. In fact, George Rosen observes that, 'in underdeveloped countries, a machine is probably more often used at approximately constant levels of output for a period far beyond the accountancy life of the machine measured by normal depreciation, until it is eventually discarded or sold for scrap'. Under these circumstances gross rather than depreciated value of the stock would be more closely related to the capital services consumed by the industry."

There is, however, one doubt we have which relates to the following formulation of the authors. "Since our interest lies in measuring the net amount actually available for distribution between labour and capital, we measure by deducting the value of materials and fuel and power (at current prices) from the value of output (at current prices) and deflating the amount thus obtained by the index of output prices"' Our first reaction is : Why deflate? Why deflate at all? We think it is perfectly legitimate, and this appears to be the current thinking on the subject, that current prices have their own validity, which deflated prices do not have, in spite of their comparability as a historical series. In fact we are of the opinion that the authors have made a good breakthrough on a commonsense basis to deduct from the volume of output at current prices, the value of materials and fuel and power also at current prices, since the objective is to arrive at a net amount actually available for distribution. As such, while all the judgment will be necessary for an understanding and interpretation of data, deflation while establishing historical comparability would drain the statistics of all validity. However, this is only a suggestion for the authors' consideration.

Chapter III deals with Data and Techniques of Measurement; and here too we are in agreement with the various adjustments which the authorrs have done in the course of their work, but we would again like to enter a caveat that it is not at all necessary to refer to the deficiencies of the Labour Bureau indices of productivity, whether they have done this or that etc. etc. The authors are experienced persons, and know how research is done in government institutions, and at the universities. Both types of research have their uses and problems and aspects of intellectual and ethical interest, and it is not at all necessary to go at one another. Similarly, we consider the references to Dr. Beri's work on page 26 as rather unfortunate because while the point made by the authors may be correct, Beri's work (which won him the Bowley prize at the LSE) and its contribution to the measurement of productivity—in our opinion, it is a substantial one—should be judged as a whole.

Then we come to the best part of the authors' work: Analysis of Productivity Trends. It is worthwhile reprinting here the best part of the authors' work on which, very obviously, they have taken substantial pains. In fact it must be said that while the authors have been somewhat immodest in their references to competing works, they have been rather modest in not exhibiting or drawing attention to the enormous volume of background material which they must have processed, to arrive at such neat tables as are printed here.

TABLE I

LABOUR PRODUCTIVITY

Year	Ratio of Gross Output to Labour Input		Ratio of Net Distributable Output to Labour Input
	Total	Workers	
1950	100.0	100.0	100.0
1951	112.3	109.4	109.9
1952	120.7	116.5	105.8
1953	122.8	117.7	124.1
1954	120.1	120.2	122.9
1955	123.3	124.8	136.3
1956	120.1	121.9	130.1
1957	124.0	126.6	119.6
1958	123.3	126.9	124.1
1959	120.2	124.3	128.5
1960	127.8	127.8	145.1
1961	133.9	131.1	153.6
1962	133.2	130.6	145.1
1963	146.6	144.6	155.9
Annual Trend Rate	+1.9*	+2.0*	+2.9*

*Significant at 1 per cent level

TABLE II

CAPITAL PRODUCTIVITY

Year	Ratio of Gross Output to Capital Input	Ratio of Net Distributable Output to Capital Input
1950	100.0	100.0
1951	109.8	105.1
1952	110.7	104.9
1953	113.6	116.7
1954	112.6	115.3
1955	117.8	130.2
1956	116.1	125.9
1957	118.2	114.1
1958	103.1	103.7
1959	107.7	114.3
1960	108.6	123.3
1961	117.0	134.1
1962	110.1	120.0
1963	113.8	120.9
Annual Trend Rate	@	+1.3**

**Significant at 5 per cent level
@Insignificant

TABLE III

RAW MATERIAL PRODUCTIVITY

Year	Ratio of Gross Output to Materials	Ratio of Gross Output to Fuels and Power
1950	100.0	100.0
1951	107.3	106.9
1952	111.3	111.8
1953	111.6	113.7
1954	111.5	113.4
1955	112.4	115.6
1956	111.1	108.8
1957	111.6	111.3
1958	109.4	105.3
1959	108.1	102.4
1960	109.1	101.0
1961	106.2	106.1
1962	103.4	98.2
1963	108.5	105.3

TABLE IV

TOTAL FACTOR PRODUCTIVITY

Year	Based on the Concept of Gross Output	Based on the Concept of Net Distributable Output
1950	100.0	100.0
1951	108.7	109.2
1952	114.2	105.6
1953	114.0	121.9
1954	113.7	120.6
1955	115.5	134.5
1956	113.5	128.9
1957	115.0	118.0
1958	111.7	118.0
1959	110.7	124.3
1960	112.8	138.1
1961	112.9	147.4
1962	109.8	136.9
1963	116.3	144.0
Annual Trend Rates	+0.5***	+2.4*

*Significant at 1 per cent level
***Significant at 10 per cent level

These tables speak for themselves and the periods marked by changes in economic circumstances are clearly indicated in the presentation of the tables. While there has been a substantial increase in labour productivity, measured by any criterion, the increase in capital productivity is much less; and the authors have good reasons for saying that "*capital has increased faster than labour* and there has been *some measure of capital-labour substitution.*" It is very significant that the increase in raw material productivity has been negligible over the period. This is really a significant part of the analysis, being a pointer to the direction in which work should be done in the industry. In fact we are of the opinion that these conclusions have far greater significance than those relating to the sharing of the gains of productivity, though that part of the work is also characterised by a high degree of excellence, as purely statistical research.

Reverting to the statistical tables, we find that it is low raw material productivity that has depressed the Total Factor Productivity, based on the concept of gross output. When that part is excluded, the substantial increase in labour productivity and the less substantial increase in capital productivity, which must be taken together, do exhibit themselves in the trends of Total Factor Productivity.

In fact, the authors have attempted a further refinement of the statistical analysis which goes into the very heart of productivity: by working out capital-labour ratios, scale of operation and utilisation of capacity, as given in Table V.

TABLE V

CAPITAL-LABOUR RATIO, SCALE OF OPERATION AND UTILISATION OF CAPACITY

Year	Capital Ratio		Average Scale of Operation	Utilisation of Capacity
	Capital per Unit of Labour	Capital Utilised per Unit of Labour		
(1)	(2)	(3)	(4)	(5)
1950	100.0	100.0	100.0	100.0
1951	102.2	105.2	135.7	104.5
1952	100.8	106.0	158.7	105.7
1953	106.4	113.7	167.0	105.5
1954	106.6	116.3	168.8	105.5
1955	104.7	116.5	173.7	106.7
1956	103.4	115.7	172.6	115.2
1957	104.8	120.3	186.3	113.7
1958	119.6	141.3	167.3	106.8
1959	112.0	135.2	179.7	109.2
1960	117.7	143.6	186.6	116.1
1961	114.5	140.4	205.3	122.2
1962	121.0	149.9	192.6	124.4
1963	128.9	162.4	206.2	125.9
Annual Trend Rates	+1.7*	+3.5*	+3.7*	+1.6*

Source : Cols. 2, 3 and 4 are based on Appendix Tables 1, 2 and 3

Col. 4 computed from *Indian Textile Bulletin* 1957 and June 1963, published by the Office of the Textile Commissioner, Government of India, Bombay

*Significant at 1 per cent level

Significant at 5 per cent level

From this data the authors feel firm that capital has contributed substantially to labour productivity : "*In fact, capital-labour ratio alone explains about* 63 *per cent of variations in labour productivity* and R^2 improves further to .82 when economies of scale are added to it. . . . Respective values of simple R^2 indicate that both scale of operation and capacity utilisation factor significantly influence the capital productivity."

Chapter V on 'Sharing of Productivity Gains and Factor Compensation' exhibits the same excellence in statistical analysis as the preceding chapters, and, the authors have worked out here the idea of constant product prices, which has its own significance in the context. In the beginning, however, we would like to say something that in our opinion is highly important. The Table on page 61 gives what is called the trend in real wages ; and it is shown that between 1950 and 1963, the real wages in the textile industry increased slowly and painfully by about 13 per cent over the whole period which works out at an annual trend rate of 0.3 per cent. On the other hand labour productivity as measured by the ratio of gross output to labour input increased by 45 per cent and as measured by net distributable output, by 56 per cent. We seriously suggest that these changes in real wages and productivity be compared and thought over. *If labour productivity has increased by* 45 *per cent, measured by one criterion and* 56 *per cent, measured by another criterion, then an increase of* 13 *per cent. in real wages would show that the workers have had an extremely raw deal. However, if capital has contributed to labour productivity, then there would be no point in differentiating between capital productivity and labour productivity, and carrying over the differentiation to the sharing of the gains, for it would lead to all manner of confusion.*

However, the conclusion of the authors regarding the factor shares in the productivity gains are worth looking at. The authors remark what is obvious: "Table VI reveals that labour gained over the entire period 1950-63, 60 per cent of productivity increment while the share of capital was 40 per cent."

TABLE VI

FACTOR SHARES IN PRODUCTIVITY GAINS

(In Millions of Rupees)

Period	Total Productivity Gains	Labour Gains	Capital Gains
1950-63	724.0	434.4 (60 0)	289 6 (40.0)
1950-55	477 6	179 6 (37 6)	298.0 (62.4)
1955-59	—110 4	107.0	—217 4
1959-63	356.8	147.8 (41.4)	209.0 (58.6)

NOTE: (1) Figures in brackets are percentage shares of respective factors in the corresponding total gains.

(2) These gains are measured by fitting equations 1, 2, and 3, on page 47 to the data given in Table 8.

Now this raises an important social issue. While we say that labour got 60 per cent of productivity increment and the share of capital was only 40 per cent during the period under reference, it is obvious what labour means, but it is not so obvious what capital means. It is important to elaborate this because later on the authors go on to consider the motivation with regard to capital formation etc. etc. Who are the class of people who represent this capital? What is their contribution to industry? Where from do they get the money to invest in the industry? What are their sources of total gain? for men are in industry for the totality of their gains, not merely for their return that their investment gets. We think, therefore, that the statistical analysis as presented here, while valid and excellent in itself, does not validate the conclusions in respect of capital formation; and that these are not firmly based on socio-economic facts. It is true that even in a period of stagnant and declining productivity (1955-59) the organised strength of workers enabled them

to secure positive gains for themselves in spite of adverse conditions faced by the industry. It is reasonable to infer that while the return to capital as correctly measured by the authors was negative, the aggregate returns to the capitalists through all their operations were positive, and sufficient to attract them to continue to be in the market place, and that it was not an act of charity that workers were able to improve their economic position despite declining productivity. In the market place as in life it is a question of balance of advantages and what you lose on the swings you make up on the roundabouts.

In further refinement, the authors have worked out factor shares in incremental output, as given in Table VII.

TABLE VII

FACTOR-SHARES IN INCREMENTAL INPUT

(In percentage)

Period	Labour Share	Capital Share
1950-63	55.5	44.5
1950-55	67.2	32.8
1955-59	53.6	46.4
1959-63	31.3	68.7

These statistics are perfectly all right, but we do not think that the following conclusion is justified : "Considering that the capital share in productivity gains lags considerably behind its rapidly rising share in the incremental input, the industry is likely to suffer a setback in the process of capital accumulation through the ploughback of internal non-wage incomes." It is true that in a narrow sense the process of capital formation through the ploughback of internal non-wage incomes may be adversely affected under the circumstances, but it may not be, for it is the total amounts that accrue to the class of capitalists, on all accounts that determine the ploughback, their capacity to invest, their attitude to invest etc. etc.

What is more fundamental is that the process of capital formation (industry-wise) is governed by entirely different factors and circumstances. As it is, capital formation in the cotton textile industry in India would depend upon : (a) The demand for cloth which in itself would be a function of the changes in the national income, and incomes of the various classes of persons, (b) the availability of raw material that would satisfy this demand, (c) the amount of investment that government itself is likely to make directly and indirectly in the modernisation of cotton textile industry. If these factors are favourable, the capitalists would invest, for they would like to cash in on what may really be called the productive policy of government ; yet *the authors have laid apart no share for government in the gains of productivity.*

About the consumers' share in the gains of productivity, the authors have said little, but the following may have bearing. "..... the labour prices have moved up by 65 per cent and capital prices, by 79 per cent over the entire period, while the product prices moved up only by about 18 per cent." Can it be said that a rise of only 18 per cent in product prices shows that in one way or the other the consumer has also his share in the gains of productivity? This, however, requires detailed analysis and the authors might have not worked in that direction. In fact we are of the opinion that the conclusions of the authors regarding the relative gains of labour and capital, and their possible implications need be worked out on the basis of very detailed economic study of the operation of the cotton textile industry. There are many imponderables and many intangibles which need to be worked into the analysis, in order to understand why people work hard or why they do not, why they invest and wherefrom they invest, whether they would run away or pack up and go abroad to new industries, or just go into a spree: these are sociological questions, but they nevertheless need an answer in the social interest.

Nevertheless we commend again the excellence of the authors' statistical calculations and analysis and it is worthwhile giving the readers the benefit of their exhaustive analysis as given in the comprehensive Tables VIII and IX.

TABLE VIII

NET DISTRIBUTABLE OUTPUT, FACTOR INPUT, PRODUCT PRICES AND FACTOR PRICES

Year	Net Distributable Output					Labour			Capital		
	At Current Prices	At Constant (1950) Prices of Product	Total Factor Input at Constant (1950) Input Prices	Average Product Price[1]	Total Factor Price[2] (P_f)	Income at Current Prices	Input at 1950 Rate of Compensation	Price[3] (P_l) (Index 1950=100)	Income art Current Prices	Input 1950 Rate of Compensation	Prce[4] (P_k) Inexd (1950=100)
	(In Millions of Rs)			(Index:1950=100)		(In Millions of Rs)			(In Millions of Rs.)		
1	2	3	4	5	6	7	8	9	10	11	12
1950	1083	1083	1083	100.0	100.0	744	774	100.0	309	309	100.0
1951	1480	1247	1142	118.7	129.6	865	812	106.5	615	331	185.8
1952	1236	1244	1178	99.3	104.9	937	840	111.6	298	338	88.2
1953	1382	1506	1236	91.8	111.8	986	868	113.6	396	368	107.6
1954	1502	1611	1335	93.2	112.5	1019	937	108.8	482	398	121.1
1955	1685	1862	1384	90.5	121.7	1047	977	107.2	639	408	156.6
1956	1794	1855	1439	96.8	124.7	1171	1019	114.9	624	420	148.6
1957	1619	1755	1487	92.2	108.9	1232	1049	117.4	387	438	88.4
1958	1555	1636	1392	95.1	111.7	1131	943	119.9	425	450	94.4
1959	1836	1878	1511	97.8	121.5	1301	1044	124.6	535	466	114.8
1960	2308	2063	1494	111.8	154.5	1416	1017	139.2	892	477	187.0
1961	2726	2378	1613	114.7	169.0	1592	1107	143.8	1134	506	224.1
1962	2704	2235	1632	121.0	165.7	1750	1101	158.9	954	531	179.7
1963	2791	2369	1645	117.9	169.7	1792	1086	165.0	999	558	179.0

Source : Figures are computed from reports of the *Census of Indian Manufactures* from 1950 to 1958 and the *Annual Survey of Industries* from 1959 to 1963.

[1] Col. 2 ÷ 3
[2] Col. 2 ÷ 8
[3] Col. 7 ÷ 8
[4] Col. 10 ÷ 11

TABLE IX

FACTOR SHARES IN TOTAL INPUT, RELATIVE FACTOR PRICES AND FACTOR-SHARE IN NET DISTRIBUTABLE OUTPUT

Year	Percentage Share in Total Factor Input		Relative Factor Prices (Index 1950=100)		Percentage Share in Net Distributable Output	
	Labour[1] (L/I)	Capital[2] (K/I)	Labour[3] (P_l/P_f)	Capital[4] (P_k/P_f)	Labour[5] (W/Y)	Capital[6] (R/Y)
1	2	3	4	5	6	7
1950	71.5	28.5	100.0	100.0	71.5	28.5
1951	71.0	29.0	82.4	143.1	58.5	41.5
1952	71.3	28.7	106.5	84.0	75.9	24.1
1953	70.2	29.8	101.6	96.3	71.3	28.7
1954	70.2	29.8	96.7	107.7	67.9	32.1
1955	70.5	29.5	88.1	128.5	62.1	37.9
1956	70.8	29.2	92.2	119.2	65.3	34.8
1957	70.5	29.5	107.9	81.0	76.1	23.9
1958	67.7	32.3	107.4	84.5	72.7	27.3
1959	69.1	30.9	102.7	93.9	71.0	29.0
1960	68.1	31.9	90.2	121.0	61.4	38.6
1961	68.6	31.4	85.1	132.5	58.4	41.6
1962	67.4	32.6	96.0	108.3	64.7	35.3
1963	66.0	34.0	97.1	105.6	64.1	35.9

[1] Col. (8) of Table 5 ÷ Col. (4) of Table5
[2] Col. (11) of Table 5 ÷ Col. (4) of Table 5
[3] Col. (9) of Table 5 ÷ Col. (6) of Table 5
[4] Col. (12) of Table 5 ÷ Col. (6) of Table 5
[5] Col. (2) of times Col. 4
[6] Col. (3) times Col. 5

The authors have drawn a number of inferences from these tables. Analytically one of the conclusions is significant for reproduction here: ". . . when there are fluctuations in productivity, capital tends to gain more in years when the factor inputs have been utilised more efficiently. This is an expected result since in the short period wages are comparatively sticky and as a residual claimant, capital tends to get a larger share in years of rapid rise in productivity. . ." This is the real crux of the problem. When productivity increases, the management in the first instance gets all the gains ; and its sharing naturally depends on the relative power equation. One of the reasons why workers hold back their productivity, as we might say, is that they are not sure whether the gains of additional productivity would be passed on to them.

In fact we would like to seriously suggest to the authors that the problem of sharing the gains of productivity, on which they have done such excellent work in this thesis, concerns really not the sharing of the existing gross or net product, but the sharing of the potential productivity. It is said that roughly in any industry, workers are putting in only about 30 to 40 per cent. of what is their normal capacity; and that they are holding back as much as 60 to 70 per cent of what they can really do because they are not sure of their share in the gains of additional productivity. The problem of sharing the gains of productivity, therefore, does not concern so much the cake that is produced, but the very much larger cake that can be produced, if the concerned people were to put in their very best. It is this dynamic aspect of productivity that the economists ought to be concerned with in the live problem of Sharing the Gains.

There are some small points which may be mentioned here. The Table on page 58 shows that money wages at current prices increased by 51 per cent in the period under review, while labour productivity increased by 45 per cent on the gross output basis and 56 per cent on net distributable output basis. Thus while money earnings have increased in proportion to productivity, real earnings, as we have pointed out earlier, increased nominally.

It is also likely to create a misunderstanding that the authors have compared the actual rise in wages to the rise that they would have obtained on the basis of the recommendations of the Wage Board. The facts are all right but in the context of the analysis liable to lead to an unnecessary misunderstanding, because the authors are quite clear on the point that "the welfare of workers is indicated not by money earnings but by real earnings (i.e. money earnings deflated by the cost of living index)."

Also, a comparison of the real work increase of workers in the cotton textile industry, with changes in the *per capita* income in the country, is liable to serious misunderstanding ; even on a factual basis we think that there is some misprint somewhere. If the *per capita* income increased by 19 per cent, this is larger than the 13 per cent increase in the real earnings of cotton textile workers. We, therefore, do not understand how an increase of 19 per cent in *per capita* income "falls short of the observed increase in real earnings of the textile workers." We think that this must be a printing error because there is no comparable flaw in the authors' statistics or analysis, elsewhere.

Also a more detailed statistical and economic analysis is required for determining whether "the movement of wages during 1955-59 in a period of declining productivity involved an intolerable wage burden on the industry."

The authors have also worked out a rate of return on capital (See Table XIII printed on page 281). This is worth a close examination.

The authors have drawn their own conclusions from this table. We would only like to question the assumption that "non-wage incomes are primarily meant for reinvestment" ; this does not appear to have a justification in fact. We do not agree with the authors' conclusion that the return on capital has been insufficient or that the net rate of return is not much above the prevailing rate of interest. This may be, but it is not valid to compare the prevailing rate of interest with the deflated rate of return. If the rate of return is to be compared, it must be to the rate of return on current prices and

TABLE XIII

RATE OF RETURN ON CAPITAL

(In percentage)

Year	At Current Prices	At Constant Machinery Prices
1	2	3
1950	8.6	8.6
1951	15.9	13.9
1952	7.6	5.9
1953	9.2	7.3
1954	10.4	8.2
1955	13.4	10.3
1956	12.7	9.6
1957	7.6	5.5
1958	8.1	5.8
1959	9.8	6.9
1960	16.0	10.8
1961	19.2	12.5
1962	15.4	9.7
1963	15.3	9.1

we find that on this basis the rate was above 10 per cent in 8 out of 13 years. It was as high as 19 per cent in 1961 and the lowest level of 7.6 per cent was reached only in 2 years.

We agree with the authors that "steps must be taken to secure a sustained rise in productivity which alone can make it a promising field for the additional investment consistent with the legitimate aspirations of workers for rising levels of living," but this generalisation is trite, compared to the depth of the authors' statistical analysis. In fact, as an essay on Measurement of Productivity, it is *par excellence* and the academic competence and integrity of the authors are unusual, considering the deterioration of standards at the universities. ●●●

Productivity in the British Railways

When a Paddington-bound train failed to make a scheduled stop recently, and left a lot of passengers stranded, a Western Region spokesman said : "It was just one of those little human failings." Indeed ! The same thing happened to me (in reverse) recently. Returning home, with two very tired small sons, I was astonished to see the train whiz straight through our station. We got off, together with other cross commuters, at the next station along the line. The guard was sorry but there was nothing he could do. The driver was sorry but he hadn't been given a list of stations to stop at. No taxis. No buses. No station-master. The solitary porter shrugged his shoulders: he was there to collect tickets. When someone suggested phoning Paddington, the solitary porter looked as though he felt we might just as well try Kosygin or LBJ. However, a determined and businesslike gentleman in our party did phone Paddington, did get through to someone important and, lo and behold, an express was stopped and took us back in style, so the honour of British Railways was redeemed. But such episodes leave one apprehensive. If a train can miss a scheduled stop, might it not also miss a signal, or, whatever ? One's customary confidence in the safety (as opposed to efficiency) of rail travel is undermined. What is worse, by not thinking and acting fast enough, I have missed perhaps the only opportunity I shall ever have of pulling the communication cord without being fined !

—Paul Johnson in the *New Statesman*

Wage-Productivity Differentials in Indian Industry

Ahluwalia & Kumar[1]

Productivity is the key-note to economic development. Various factors affecting labour productivity can be grouped under three main heads : general, organisational and human factors. Fiscal and credit system, industrial research etc. are embraced by the first category. The size of the plant, its utilisation, output level, mechanical equipment per worker, number of working hours and shifts, degree of specialisation and the extent of standardisation form part of the second category, whereas the main constituents of the third category would be wage incentives, trade union behaviour etc.

Productivity does not merely measure the effort and contribution of labour alone but is the combined effect of a variety of factors. The physical ability of the worker puts some check on the intensity of labour which he can put in. Measures, such as a need-based wage, are designed to meet the physical demands of work and living, which highlights the importance of studying wages in relation to productivity levels.

THE MAIN OBJECTIVE OF THIS PAPER IS TO study wage-productivity differentials in different regions of India. It covers manufacturing units employing fifty or more workers and using power, or hundred or more without power.[2] The study reveals that the value added per worker is the highest in petroleum refineries, both for All-India and States average. Correspondingly the lowest was observed in the case of manufacture of ice.[3]

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[1]SS Ahluwalia and Sharwan Kumar are research officers, working in the Perspective Planning Division of the Planning Commission, New Delhi. The authors desire to emphasise their personal responsibility for the research piece published here and to thank Sri Mohinder Singh for the computational assistance given to them in this connection.

[2]The study is based on the Annual Survey of Industries (ASI), 1963. All the 203 manufacturing industries for which data were available, have been covered. The data were collected in respect of 'Productive Capital (PC) employed', 'Value Added (VA) by manufacture', 'Wages and Benefits (WB) accruing to the workers', 'Number of Workers (NW) employed', and 'the total Man-Hours (MH) put in by the workers'. This information was collected for all the 203 manufacturing industries for different states and All-India. Appendix A gives the detailed Statistical Analysis on which the conclusions are based. Appendix B indicates the methodology employed in statistical calculations and adjustments. Appended Tables 1 and 2 give All-India and States average ratios per worker and per man-hour to value added, productive capital employed and wages and benefits for all the manufacturing industries.

[3]The conclusions in paragraphs 1 and 2 are in accordance with common sense, for value added would be in direct proportion to capital intensity, which is the highest in automated plants like petroleum refineries, and the lowest in ice and snuff manufacture—**Editor**

In case of value added per manhour the two highest ratios were for insecticides etc., and petroleum refineries, and the lowest for snuff manufacture.

In case of capital employed per worker and per manhour, petroleum refineries again were the highest in all the cases except in one where it occupied the second highest position—the first in this case (All-India per manhour) being insecticides manufacture. The lowest ratios per worker and per manhour at All-India and States level were for explosives and snuff manufactures respectively.

Wages and benefits per worker and per-man-hour were found to be the highest in case of manufacture of paper and paper products and insecticides etc. respectively, for the States. At All-India level, the wage per worker was highest in the manufacture of aircraft and that per manhour in insecticides etc. Snuff manufacture has the lowest wages per manhour at All-India and States levels. As against this, wages per worker were found to be lowest in case of furinture etc., (All India) and manufacture of explosives etc. (State level).

It would be interesting to observe that *all the ratios were found to be the highest in case of Maharashtra and the lowest in case of Tripura,* except productive capital employed per worker and per manhour which figured highest in case of Orissa.

APPENDIX A

Statistical Analysis

Section 'A' deals with the analysis of variance, section 'B' gives the results of analysis of covariance and section 'C' studies the rank correlation between different sets of variables.

Section A

The total variation has been broken into two components, namely, variation due to states and variation due to industries. The mean sum of squares for states as well as that for industries has been tested against the 'Error Variance' and the 'F' ratios have been worked out. Table I gives the analysis of variance.

TABLE I

Analysis of Variance — Value Added per Worker

Due to	Sum of squares	Degrees of freedom	Mean squares	'F' ratio
States	699.267	20	34.963	16.413
Industries	22588.393	202	111.823	52.496
Error	8605.657	4040	2.130	
Total	31893.317	4262		

It will be seen that 'F' ratios both for states and for industries are quite high : as such the variation in the value added per worker between states and between industries is highly significant statistically, at 1% level.

In order to minimise the variation due to number of working days, number of shifts etc., the ratio of value added to manhours (instead of number of workers) was considered. Here again, the 'F' ratios are quite high and statistically significant at 1% level but it is interesting to observe that these ratios are lower as compared to the corresponding ratios for value added per worker. Table II gives the analysis of variance.

TABLE II

Analysis of Variance — Value Added per Manhour

Due to	Sum of squares	Degrees of freedom	Mean squares	'F' ratio
States	139.845	20	6.992	12.503
Industries	4080.677	202	20.201	36.129
Error	2258.896	4040	0.559	
Total	6479.419	4262		

TABLE III

Analysis of Variance—Productive Capital Employed per Worker

Due to	Sum of squares	Degrees of freedom	Mean squares	'F' ratio
1	2	3	4	5
States	8919 550	20	445·977	10.625
Industries	474266 170	202	2347·852	55·939
Error	169564 730	4040	41·971	
Total	652750 450	4262		

TABLE IV

Analysis of Variance—Productive Capital Employed per Manhour

Due to	Sum of squares	Degrees of freedom	Mean squares	'F' ratio
1	2	3	4	5
States	1894·199	20	94·709	7·249
Industries	85177·590	202	421.671	32·277
Error	52778·581	4040	13.064	
Total	139850·370	4262		

TABLE V

Analysis of Variance—Wages and Benefits per Worker

Due to	Sum of squares	Degrees of freedom	Mean squares	'F' ratio
1	2	3	4	5
States	46.000	20	2.300	33·275
Industries	635·483	202	3·145	45·514
Error	279·242	4040	0.069	
Total	960.725	4262		

TABLE VI

Analysis of Variance—Wages and Benefits per Manhour

Due to	Sum of squares	Degrees of freedom	Mean squares	'F' ratio
1	2	3	4	5
States	10.214	20	0.510	18.804
Industries	122·953	202	0.608	22.411
Error	109·722	4040	0.027	
Total	242.890	4262		

The variation in total productive capital employed per person and per manhour are presented in Table III and Table IV.

It will be observed that the variation between states and between industries is statistically highly significant (at 1% level) for both the cases. In this case the variation between industries is more prominent than that between states in both cases.

In the case of wages and benefits per worker and per manhour, the variation between states, as between industries is again, statistically, highly significant —at 1% level. The main point of interest here is that the variation as between states and industries is more closely marked in the two cases as compared to earlier cases.

Section 'B'

The results of analysis of covariance between value added and wages and benefits (both measured per worker) are indicated in Table VII. The test of significance for regression line revealed that variation due to regression was, statistically, highly significant at 1% level. The difference between 'Industries mean' and 'States-mean' was also found to be highly significant statistically. The results for the 'Tests of significance' are given in Tables VIIA, VIIB, and VIIC.

Analysis of covariance between value added and wages and benefits per manhour is presented in Table VIII. Tables VIIIA, VIIIB, VIIIC give the corresponding tests of significance for the regression line, industries mean and states-mean respectively. In all the cases the tests of significance reveal highly significant variations.

TABLE VII

Analysis of Covariance—Value Added and Wages and Benefits per Worker

Due to	De rees of freedom	Y^2	YZ	Z^2	β	β YZ	Residual sum of squares
States	20	699.267	139.969	46.000	0.20016	28.016	17.983
Industry	202	22588.393	2338.721	635.483	0.10353	242.142	393.340
Error	4040	8605.657	573.648	279.242	0.06665	38.239	241.003
State+Error	4060	9304.924	713.617	325.242	0.07669	54.729	270.513
Industry+Error	4242	31194.050	2912.369	914.725	0.09336	271.907	642.818

TABLE VII A

Test of Significance of Regression Line

Due to	Sum of squares	Degrees of freedom	Mean squares	'F' ratio
1	2	3	4	5
Regression	38.239	1	38.239	640.852
Error	241.003	4039	0.059	

TABLE VII B

Test of Significance of Industries-Mean Effects

Due to	Sum of squares	Degrees of freedom	Mean squares	'F' ratio
1	2	3	4	5
Industry+ Error	642.818	4241		
Error	241.003	4039		
			0.059	
Difference	401.814	202	1.989	33.336

TABLE VII C

Test of Significance of State-Mean Effects

Due to	Sum of squares	Degrees of freedom	Mean squares	'F' ratio
1	2	3	4	5
State+ Error	270.513	4059		
Error	241.003	4039	0 059	
Difference	29.510	20	1.475	24.728

TABLE VIII

Analysis of Covariance—Value Added and Wages and Benefit per Manhour

Due to	Degrees of freedom	Y^2	YZ	Z^2	β	βYZ	Residual sum of squares
1	2	3	4	5	6	7	8
States	20	139.845	30.636	10.214	0.21907	6.711	3.502
Industry	202	4080.677	440.234	122.953	0.10788	47.493	75.459
Error	4040	2258.896	306.637	109.722	0.13574	41.625	68.097
State+Error	4060	2398.742	337.273	119.937	0.14060	47.422	72.514
Industry+Error	4242	6339.573	746.872	232.676	0.11781	87.989	144.686

TABLE VIII A

Test of Significance of Regression Line

Due to	Sum of squares	Degrees of freedom	Mean squares	'F' ratio
1	2	3	4	5
Regression	41.625	1	41.625	2468.847
Error	68.097	4039	0.016	

TABLE VIII B

Test of Significance of Industries-Mean Effects

Due to	Sum of squares	Degrees of freedom	Mean squares	'F' ratio
1	2	3	4	5
Industry+Error	144.686	4241		
Error	68.097	4039	0.016	
Difference	76.588	202	0.379	22.488

TABLE VIII C

Test of Significance of States-Mean Effects

Due to	Sum of squares	Degrees of freedom	Mean squares	'F' ratio
1	2	3	4	5
State+Error	72.514	4059		
Error	68.097	4039	0.016	
Difference	4.416	20	0.220	13.098

Analysis of covariance results between value added and productive capital employed per person and per manhour are given in Tables IX and X respectively. The relevant tests of significance are shown in tables IXA, IXB, IXC and XA, XB and XC respectively. The variation has been found to be significant in these cases as well.

Tables XI and XII give the results of analysis of covariance between productive capital employed and wages and benefits per worker and per manhour respectively. In this case also, the tests of significance revealed statistically highly significant variation. These results are presented in tables XIA, XIB, XIC and XIIA, XIIB, XIIC.

TABLE IX

Analysisof Covariance—Productive Capital Employed and Value Added per Worker

Due to	Degrees of freedom	Y^2	YZ	Z^2	β	βYZ	Residual sum of squares
1	2	3	4	5	6	7	8
States	20	8919.550	1134.550	699.267	0.12719	144.312	554 954
Industries	202	474266.170	7897.340	22588.393	0.1494-	10598 337	11990.056
Error	4040	169564.730	10346 320	8605.657	0.06101	631 300	7974 356
State+Error	4060	178484.280	11480.870	9304.924	0.06432	738.498	8566.425
Industry+Error	4242	643830.900	81243.660	31194.050	0.12618	10251.965	20942.085

TABLE IX A

Test of Significance of Regression Line

Due to	Sum of squares	Degrees of freedom	Mean squares	'F' ratio
1	2	3	4	5
Regression	631.300	1	631.300	319.752
Error	7974 356	4039	1.974	

TABLE IX B

Test of Significance of Industries - : Mean Effects

Due to	Sum of squares	Degrees of freedom	Mean squares	'F' ratio
1	2	3	4	5
Industry+ Error	20942.085	4241		
Error	7974.356	4039	1.974	
Difference	12967.729	202	64 196	32 515

TABLE IX C

Test of Significance of States-Mean Effects

Due to	Sum of squares	Degrees of freedom	Mean squares	'F' ratio
1	2	3	4	5
State+ Error	8566.425	4059		
Error	7974.356	4039	1.974	
Difference	592 069	20	29 603	14 994

TABLE X

Analysis of Covariance—Productive Capital Employed and Value Added

Due to	Degrees of freedom	Y^2	YZ	Z^2	β	β YZ	Residual sum of squares
1	2	3	4	5	6	7	8
States	20	1894.199	266.495	139.845	0.14069	37.493	102.351
Industry	202	85177.590	12873.566	4080.677	0.15119	1247.195	2133.481
Error	4040	52778.581	5780.012	2258.896	0.10951	632.994	1625.902
State+Error	4060	54672.780	6046.507	2398.742	0.11059	668.710	1730.031
Industy+Error	4242	137956.170	18658.578	6339.573	0.13525	2523.573	3816.000

TABLE X A

Test of Significance of Regression Line

Due to	Sum of squares	Degrees of freedom	Mean square	'F' ratio
1	2	3	4	5
Regression	632.994	1	632.994	1572.458
Error	1625.902	4039	0.402	

TABLE X B

Test of Significance of Industries—Mean Effects

Due to	Sum of squares	Degrees of freedom	Mean square	'F' ratio
1	2	3	4	5
Industry+ Error	3816.000	4241		
Error	1625.902	4039	0.402	
Difference	2190.097	202	10.842	26.933

TABLE X C

Test of Significance of State—Mean Effects

Due to	Sum of squares	Degrees of freedom	Mean square	'F" ratio
1	2	3	4	5
State + Error	1730.031	4059		
Error	1625.902	4039	0.402	
Difference	104.129	20	5.206	12.933

TABLE XI

Analysis of Covariance—Productive Capital Employed and Wages and Benefits per Worker

Due to	Degrees of freedom	Y^2	YZ	Z^2	β	β YZ	Residual sum of squares
1	2	3	4	5	6	7	8
States	20	8919.550	251.926	46.000	0.02824	7.115	38.884
Industries	202	474266.170	7526.129	635.483	0.01586	119.432	516.051
Error	4040	169564.730	958.699	279.242	0.00565	5.420	273.821
State+Error	4060	178484.280	1210.625	325.242	0.00678	8.211	317.031
Industry+Error	4242	643830.900	8484.828	914.725	0.01317	111.818	802.906

TABLE XI A

Test of Significance of Regression Line

Due to	Sum of squares	Degrees of freedom	Mean square	'F' rato
1	2	3	4	5
Regression	5.420	1	5.420	79.953
Error	273.821	4039	0.067	

TABLE XI B

Test of Significance of Industries—Mean Effects

Due to	Sum of squares	Degrees of freedom	Mean square	'F' ratio
1	2	3	4	5
Industry+ Error	802.906	4241		
Error	273.821	4039	0.067	
Difference	529.084	202	2.619	38.634

TABLE XI C

Test of Significance of States—Mean Effects

Due to	Sum of squares	Degrees of freedom	Mean square	'F' ratio
1	2	3	4	5
State + Error	317.031	4059		
Error	273.821	4039	0.067	
Difference	43.209	20	2.160	31.867

TABLE XII

Analysis of Covariance—Productive Capital Employed and Wages and Benefits per Manhour

Due to	Degrees of freedom	Y^2	YZ	Z^2	β	βYZ	Residual sum of squares
1	2	3	4	5	6	7	8
States	20	1894.199	67.094	10.214	0.03542	2.376	7.837
Industries	202	85177.590	1471.979	122.953	0.01728	25.437	97.515
Error	4040	52778.581	1325.498	109.722	0.02511	33.289	76.433
State+Error	4060	54672.780	1392.593	119.937	0.02547	35.471	84.465
Industry+Error	4242	137956.170	2797.478	232.676	0.02027	56.727	175.948

TABLE XII A

Test of Significance of Regression Line

Due to	Sum of squares	Degrees of freedom	Mean square	'F' ratio
1	2	3	4	5
Regression	33.289	1	33.289	1759.092
Error	76.433	4039	0.018	

TABLE XII B

Test of Significance of Industries—Mean Effects

Due to	Sum of squares	Degrees of freedom	Mean square	'F' ratio
1	2	3	4	5
Industry+Error	175.948	4241		
Error	76 433	4039	0 018	
Difference	99.514	202	0.492	26.033

TABLE XII C

Test of Significance of States—Mean Effects

Dueto	Sum of quaress	Degrees of freedom	Mean square	'F' ratio
1	2	3	4	5
State + Error	84.465	4059		
Error	76.433	4039	0.018	
Difference	8.031	20	0.401	21.221

SECTION 'C'

In this section coefficients of rank correlation as between different sets of ratios have been studied for All-India and for states. The values of correlation coefficients are given in the Table XIII.

TABLE XIII

Rank Correlation Coefficients

Variables	All-India	States
1. Value added per worker and capital employed per worker	0.774	0.734
2. Value added per manhour and capital employed per manhour	0.760	0.722
3. Value added per worker and wages and benefits per worker	0.686	0.764
4. Value added per manhour and wages and benefits per manhour	0.648	0.674
5. Productive capital per worker and wages and benefits per worker	0.564	0.547
6. Productive capital per manhour and wages and benefits per manhour	0.507	0.492

From the above Table it may be observed that the rank correlation coefficients between different characteristics are statistically highly significant at 1 per cent level. The values of coefficients are highest in the case of value added and capital employed, implying thereby that the industries which have higher value added (per worker and per manhour) also rank high in respect of capital employed. Wages and benefits, in relation to value added (per worker and per manhour) also indicate high values of the rank correlation coefficients, but these are numerically lower than those for capital employed and value added. Rank correlation coefficients between productive capital employed and wages and benefits (per worker and per manhour) are the lowest in comparison to other combinations, but nevertheless they are statistically significant. Values of the rank correlation co-efficients at All-India level are observed to be invariably higher than the corresponding values based on the average ratios for the states.

As expected, the rank correlation coefficient of each of the variables viz. value added, productive capital employed and wages and benefits as measured between per worker and per manhour are observed to be very high—the values being higher than 0.9 in each case as shown in Table XIV.

TABLE XIV

Rank Correlation Coefficients (between per worker & per manhour)

Variable 1	All-India 2	States 3
1. Value added	0.909	0.917
2. Productive capital	0.924	0.922
3. Wages and benefits	0.911	0 903

The rank correlation coefficients between various characteristics (for all industries) at state level are given in Table XV.

TABLE XV

Rank Correlation Coefficients Between Different Characteristics at State Level

Variables 1	per Manhour 2	per Worker 3
1. Value added and productive capital employed	0.597	0.589
2. Value added and wages & benefits	0.701	0.602
3. Productive capital employed and wages & benefits	0.525	0.675

The values of the coefficients are observed to be statistically significant.

The results of the present paper are tentative in nature and need more detailed examination. The results of further analysis would be presented in subsequent studies.

APPENDIX TABLE I

Value Added, Productive Capital, Wages & Benefits per Worker and per Manhour for Different Industries 1963 — States Averages

Sl. No.	Industry	VA* / MH		VA* / NW		PC* / MH		PC* / NW		WB* / MH		WB* / NW	
		Value	Rank	Value	Rank	Value	Rank	Value	Rank	Value	Rank	Value	Rank
1	2	3	4	5	6	7	8	9	10	11	12	13	14
1	slaughtering, preparation & preserving of meat and other miscellaneous food preparation	2.4	62	5.3	65	3.7	99	8.5	99	0.4	163	1.0	156
2	milk food and malted foods	2.7	52	7.0	44	13.1	21	23.9	16	0.6	87	1.5	73
3	canning & preserving of fruits & vegetables	1.2	136	2.8	126	1.9	161	4.6	157	0.2	199	0.7	185
4	canning & preserving of fish & other sea foods	1.4	114	4.2	84	1.7	170	5.0	148	0.2	198	0.8	176
5	flour mills	2.2	67	5.4	62	6.0	62	13.9	61	0.5	130	1.2	114
6	rice mills	0.8	176	1.4	192	2.0	157	3.6	171	0.2	197	0.5	193
7	dal mills	1.0	157	2.5	148	1.3	183	3.2	178	0 2	196	0.6	191
8	bakery products	2.3	64	5.7	58	2.7	132	6.5	124	0.4	162	1.1	140
9	sugar	2.0	73	5.0	70	9.4	33	23.3	30	0.5	129	1.3	103
10	gur	0.8	175	1.5	187	5.2	74	5.2	143	0.4	161	0.4	197
11	manufacture of cocoa, chocolate & sugar confectionery	2.2	66	5.0	69	3.6	102	8.3	100	0.3	185	0.8	175
12	manufacture of edible oils (other than hydrogenated oils)	1.2	135	2.6	139	2.9	125	6.7	121	0.3	184	0.7	184
13	hydrogenated oil(vanaspati)	3.5	33	8.8	27	9.2	35	23.0	32	0.6	86	1.5	72
14	tea manufacturing	3.5	32	8.3	34	6.0	61	14.1	59	0.5	128	1.1	139
15	coffee curing works	0.5	195	0.8	199	1.7	169	3.0	181	0.2	195	0.4	196
16	cashewnut processing	0.3	200	0.8	198	0.3	200	0.7	200	0.1	201	0.3	201
17	starch	2.6	58	7.1	43	5.7	67	15.6	50	0.5	127	1.4	83
18	cold storage	0.3	199	0.8	197	6.2	59	14.9	56	0.2	194	0.7	183
19	salt	0.9	168	1.7	181	1.2	185	2.5	189	0.3	183	0.6	190
20	distilling, rectifying & blending of spirits (alcohol)	2.0	72	4.5	78	5.3	72	11.6	75	0.4	160	1.0	155
21	wine industries	0.7	187	2.1	168	6.3	58	17.1	47	0.4	159	1.0	154
22	breweries and manufacturing of malt	7.4	4	15.7	5	8.3	40	17.6	43	0.3	182	0.7	182

23	soft drinks & carbonated water industries	4.9	14	11.6	13	7.5	44	17.7	42	0.6	85	1.4	8 2
24	biri	0.4	197	1.0	194	0 8	196	1.9	195	0.3	181	0.8	174
25	cigar	0.6	193	1.4	191	0 7	198	1.7	197	0.3	180	0.8	173
26	cigarettes	6.7	5	16.1	4	6 3	57	17.1	46	0.7	55	2.8	8
27	snuff	0.1	203	6.2	54	0.1	203	12.0	70	0.1	203	0.8	172
28	zerda	1.3	124	2.7	134	2.5	138	4.6	156	0.2	193	0.5	192
29	other tobacco manufactures	1.1	150	1.9	175	1.6	175	2.4	190	0.3	179	0.3	200
30	cotton textiles	1.1	149	2.6	138	2.2	150	5.2	142	0.6	84	1.5	71
31	jute textiles	0.7	186	1.9	174	1.0	191	2.6	187	0.4	158	1.1	138
32	woollen textiles	0.9	167	2.2	162	3.0	122	7.2	115	0.3	178	0.9	161
33	silk	0.4	196	0.9	195	3.8	96	8.7	98	0.2	192	0.6	189
34	art silk	1.8	83	4.7	74	4.3	85	10.7	82	0.6	83	1.6	56
35	webbing narrow fabrics, embroidery and lace manufacture	1.3	123	3.1	119	2.0	156	4.9	151	0.5	126	1.2	113
36	textiles dyeing, bleaching, finishing and processing including mercerizing, finishing, calendering, glazing, proffing etc.	0.9	166	2.1	167	3.1	115	7.3	114	0.4	157	1.1	137
37	thread and thread ball making	2.6	57	6.1	55	6.7	51	15.6	49	0.6	82	1.5	70
38	carpet weaving	0.6	192	1.4	190	0.9	195	2.1	192	0.3	177	0.7	181
39	knitting mills,(hosiery, & other knitted goods	1.5	98	3.5	100	2.4	143	5.7	136	0.4	156	1.0	153
40	cordage, rope & twine industries, manufacture of textiles n.e.c.	0.8	174	2.9	122	1.4	179	3.1	180	0.3	176	0.9	160
41	cotton ginning, cleaning & processing	0.6	191	0.8	196	1.9	160	2.5	188	0.2	191	0.3	199
42	jute pressing	4.7	17	2.7	133	10.1	29	5.9	129	1.4	6	0.8	171
43	wool balling and pressing	1.4	113	2.4	151	1.0	190	1.8	196	0.2	190	0.3	198
44	coir manufacture	1.0	156	2.3	156	1.7	168	3.8	166	0.4	155	0.9	159
45	artificial leather & oil cloth & linoleum and similar products.	1.9	80	4.6	76	4.6	81	11.2	80	0.4	154	1.1	136
46	gas mantles and manufacture of textile n.e.c.—others	1.9	79	4.6	75	2.6	134	6.3	126	6.3	153	1.0	152
47	tarpaulins, tents, sails and others made up canvas goods	1.3	122	3.3	110	0.6	199	1.5	199	0.5	125	1.3	102
48	foot wear	1.7	86	3.7	90	1.7	167	3.7	168	0.5	124	1.2	112
49	clothing and tailoring and others	0.7	185	1.7	180	1.3	182	3.1	179	0.3	189	0.6	188
50	umbrella manufacture	0.7	184	1.6	186	2.3	146	5.3	140	0.4	152	1.0	151
51	saw milling	0.9	165	2.2	161	2.5	137	5.7	135	0.3	175	0.7	180
52	plywood	1.1	148	2.7	132	3.0	121	7.4	110	0.4	151	1.0	150
53	wooden & cane containers & cane smallware	1.1	147	2.6	137	1.3	181	3.3	175	0.5	123	1.2	111

APPENDIX (*Contd.*) TABLE I

1	2	3	4	5	6	7	8	9	10	11	12	13	14
54	joinery and general wood-working	1.1	146	2.5	147	2.2	149	4.9	150	0.3	174	0.8	170
55	cork & wood products n.e.c. others	1.2	134	2.5	146	3.7	98	7.5	109	0.3	173	0.7	179
56	manufacture of furniture & fixtures—wooden	0.7	183	1.6	185	1.7	166	3.8	165	0.5	122	1.1	135
57	manufacture of furniture & fixtures —metal & others	1.0	155	2.4	150	2.0	155	4.6	155	0.4	150	1.0	149
58	pulp-wood pulp, mechanical, chemical including dissolving pulp ; paper-writing, printing and wrapping; and newsprint	3.0	45	5.6	59	19.7	10	31.3	20	0.9	21	1.7	48
59	paper board and straw board	1.7	85	4.4	80	4.5	82	11.9	71	0.5	121	1.3	101
60	paper packaging (corrugated paper, kraft paper, paper bags, paper containers, etc.)	1.7	84	4.1	85	4.1	89	9.8	87	0.5	120	1.1	134
61	hard board including fibre board & chipboard	3.4	35	8.6	30	12.0	22	29.7	22	0.5	119	1.3	100
62	manufacture of paper & paper products —others	3.5	31	8.3	33	6.3	56	14.9	55	2.1	2	5.0	1
63	letterpress & lithographic printing & book binding	1.6	93	3.6	95	2.8	128	6.2	127	0.7	54	1.5	69
64	other printingi ncluding photography	1.6	92	3.6	94	2.7	131	6.1	128	0.7	53	1.7	47
65	tanneries & leather finishing plants	1.3	121	1.9	173	4.1	88	4.1	160	0.7	52	0.8	169
66	manufacture of leather products except footwear and other wearing apparel	1.4	112	3.6	93	4.6	80	11.2	79	0.6	81	1.5	68
67	tyres and tubes	7.8	3	19.2	2	22.5	7	54.7	8	1.3	7	3.2	4
68	surgical & medicinal products including prophylactics; and manufacture of rubber products—others	1.6	91	3.8	87	2.8	127	6.6	122	0.4	149	1.1	133
69	rubber footwear	2.6	56	6.3	53	1.9	159	4.6	154	0.9	20	2.2	19
70	mixed—fertilizers	3.5	30	5.9	57	8.1	41	13.6	62	0.6	80	1.0	148
71	inorganic fertilizers	4.2	22	11.1	15	8.0	42	20.2	36	1.0	13	2.6	11
72	inorganic heavy chemicals	3.5	29	9.5	23	11.9	23	31.6	18	0.6	79	1.8	34
73	synthetic resins & plastics & synthetic rubber	4.3	21	11.3	14	53.2	2	137.7	2	0.8	30	2.1	22
74	organic heavy chemicals	6.3	7	14.5	7	31.7	6	72.3	5	0.5	118	1.9	99
75	man-made fibres including regenerated cellulose rayon, nylon, etc.	5.6	11	14.7	6	19.2	11	50.8	9	0.5	117	1.5	67
76	explosives including gun-powder & fuses	2.6	55	0.3	202	15.6	77	0.2	203	0.5	116	0.1	203

77	dye stuffs	5.4	13	13.3	11	15.9	13	39.2	11	0.6	78	1.6	55
78	turpentine and rosin — products of fermentation industries other than alcohol & other basic industrial chemicals	4.7	16	12.5	12	8.9	37	23.6	29	1.0	12	2.7	9
79	vegetable oils, including solvent extracted oils	1.2	133	2.8	125	7.1	48	15.9	48	0.4	148	1.1	132
80	paints, varnishes and lacquers	4.5	19	10.2	19	6.8	50	15.3	52	0.7	51	1.6	54
81	glue and gelatine and waxes and polishes etc. (for leather, wood, metal, glass etc.)	2.9	48	6.5	50	5.7	66	12.8	66	0.5	115	1.1	131
82	fine chemical including photographic chemicals	13.6	2	8.2	36	51.5	3	31.3	19	2.8	1	1.7	46
83	insecticides, fungicides ; weedicides	3.4	34	8.8	26	14.0	19	36.2	13	0.8	29	2.1	21
84	textile auxiliaries & sizing materials	4.6	18	10.3	17	15.8	14	35.0	15	1.2	8	2.6	10
85	manufacture of miscellaneous chemical products etc.	2.8	50	6.4	52	8.3	39	18.9	38	0.5	114	1.2	110
86	drugs and pharmaceuticals	3.9	24	8.8	25	8.6	38	19.2	37	0.6	77	1.5	66
87	soaps and glycerine	5.5	12	13.4	10	9.5	32	23.2	31	0.9	19	2.2	18
88	perfumes, cosmetics & other toilet preparations	4.7	15	10.2	18	5.6	69	12.3	69	0.6	76	1.3	98
89	matches	2.2	65	5.3	64	2.4	142	5.7	134	0.9	18	2.2	17
90	lac, including shellac	1.3	120	0.5	201	2.6	133	0.3	202	0.4	147	0.2	202
91	petroleum refineries	14.6	1	35.6	1	85.8	1	207.8	1	1.5	4	3.8	3
92	manufacture of miscellaneous products of petroleum and coal	3.7	28	9.5	22	21.4	9	56.6	7	0.6	75	1.7	45
93	fire bricks	0.7	182	1.9	172	3.0	120	9.4	90	0.3	172	0.8	168
94	refractories & furnace lining bricks—acidic, basic and natural	1.3	119	3.5	99	3.3	113	8.9	96	0.4	146	1.2	109
95	tiles	0.9	164	2.0	169	1.8	162	4.2	159	0.3	171	0.8	167
96	glass hollow-ware	0.5	194	1.3	193	1.0	189	2.6	186	0.3	170	0.8	166
97	sheet and plate glass	1.2	132	3.4	106	6.5	55	18.0	41	0.5	113	1.5	65
98	glass wool & miscellaneous glassware	0.7	181	1.9	171	1.6	174	4.0	163	0.4	145	1.1	130
99	laboratory glassware	0.8	173	2.1	166	2.3	145	5.7	133	0.4	144	1.1	129
100	chinaware and pottery	0.7	180	1.7	179	2.4	141	5.7	132	0.3	169	0.8	165
101	sanitary ware and whiteware	1.0	154	2.5	145	3.3	112	7.9	103	0.3	168	0.8	164
102	insulators	0.9	163	2.2	160	5.5	71	13.3	64	0.4	143	1.1	128
103	manufacture of cement (hydraulic)	3.0	44	8.2	35	10.8	26	29.1	24	0.7	50	1.9	27
104	asbestos cement	2.9	47	8.3	32	3.9	94	11.1	81	0.7	49	2.0	25
105	hume pipes and other cement & concrete products (including reinforced products)	1.1	145	2.5	144	3.3	111	7.5	108	0.4	142	1.0	147

APPENDIX (*Contd.*) TABLE I

1	2	3	4	5	6	7	8	9	10	11	12	13	1
106	stone dressing and crushing	0.8	172	1.8	178	.20	154	4.6	153	0.2	188	0.6	187
107	grinding wheels and abrasives	3.8	26	10.0	21	10.1	28	27.0	25	0.6	74	1.6	53
108	mica factories	0.6	190	1.4	189	1.6	173	3.7	167	0.3	167	0.7	178
109	manufacture of non-metallic mineral products n.e.c.—others	0.2	202	7.2	41	0.2	202	10.4	84	0.1	202	1.1	127
110	iron and steel (metal)	1.9	78	4.8	73	13.9	20	36.1	14	0.7	48	1.8	33
111	ferro-alloys	3.2	40	8.7	29	14.3	16	38.7	12	0.4	141	1.1	126
112	iron & steel castings & forgings	0.9	162	2.3	155	3.6	101	9.2	94	0.4	140	1.1	125
113	iron & steel structurals	1.4	111	3.4	105	10.1	27	23.7	28	0.5	112	1.3	97
114	iron & steel pipes	3.2	39	8.0	37	9.7	31	23.8	27	0.7	47	1.7	44
115	non-ferrous basic metal industries	6.4	6	17.0	3	22.2	8	58.4	6	0.8	28	2.1	20
116	metal containers & steel trunks	1.9	77	4.3	82	4.0	92	9.4	89	0.6	73	1.6	52
117	cutlery, locus, etc	0.7	179	1.8	177	1.2	184	2.8	182	0.3	166	0.9	158
118	bolts, nuts, nails, screws, springs, chains etc.	1.4	110	3.4	104	4.8	78	11.4	76	0.4	139	1.1	124
119	enamelling, japaning & lacquering, galvanising, plating and polishing metal products.	0.8	171	1.8	176	1.4	178	3.2	177	0.4	138	1.1	123
120	type founding	1.6	90	3.6	92	1.9	158	4.3	158	0.5	111	1.2	108
121	welding	1.4	109	3.3	99	3.3	110	7.9	102	0.3	165	0.8	163
122	safes and vaults	0.6	189	1.6	184	0.9	194	2.2	191	0.4	137	1.0	146
123	razor blades	5.6	10	5.2	66	4.3	84	4.0	162	0.7	46	0.7	177
124	hurricane lanterns	0.8	170	2.2	159	1.0	188	2.7	184	0.5	110	1.3	96
125	hand tools and small tools	2.9	46	6.8	47	6.5	54	15.3	51	0.7	45	1.7	43
126	metal fittings for shoes and leather articles and wearing apparel	1.3	118	3.2	115	2.7	130	6.5	123	0.4	136	1.0	145
127	sanitary & plumbing fixtures & fittings of metals	1.2	131	2.9	121	1.5	176	3.4	172	0.6	72	1.4	81
128	weights & manufacture of metal products except machinery & transport equipment—others	1.4	108	3.3	108	3.0	119	7.0	116	0.5	109	1.1	122
129	boilers and steam generating plants	1.2	130	2.7	131	38.6	4	86.6	3	0.6	71	1.3	95
130	internal combustion engines	1.8	82	4.2	83	2.9	124	6.9	120	0.7	44	1.6	51
131	textile machinery (such as spinning frames, carding machines, power looms etc. including textile)	1.3	117	3.1	118	3.7	97	8.7	97	0.5	108	1.3	94
132	jute machinery	3.7	27	8.7	28	3.5	105	8.2	101	0.5	107	1.2	107

133	sugar machinery	1.4	107	3.1	117	5.6	68	12.6	68	0.5	106	1.3	93
134	tea machinery	1.5	97	3.9	86	3.9	93	9.9	86	0.6	70	1.7	42
135	mining machinery	1.1	144	2.7	130	32.5	5	78.2	4	0.5	105	1.1	121
136	metallurgical machinery & cement machinery	1.6	89	3.5	91	4.1	87	9.3	92	0.9	17	2.0	24
137	chemical machinery	1.4	106	3.4	103	4.0	91	9.4	88	0.5	104	1.2	106
138	pharmaceutical machinery	1.0	153	2.3	154	2.5	136	5.8	130	0.6	69	1.4	80
139	paper machinery	3.0	43	7.2	40	7.1	47	17.2	45	0.7	43	1.7	41
140	construction machinery	1.5	96	3.5	98	4.0	90	9.3	91	0.7	42	1.6	50
141	oil mill machinery	1.4	105	3.4	102	2.1	152	5.1	145	0.5	103	1.4	79
142	rice, dal and flour mill machinery	1.1	143	2.3	153	1.6	172	3.3	174	0.6	68	1.3	92
143	size reduction equipment-crushers, ball mill etc.	1.1	142	2.5	143	9.1	36	20.2	35	0.4	135	1.0	144
144	conveying equipment-bucket elevators skiphoists, cranes, derricks, etc	2.5	59	5.9	56	7.7	43	18.1	40	0.5	102	1.1	120
145	mixers & reactors—kneading mills, turbo mixers, etc. and centrifugal machines	2.0	71	4.5	77	5.1	76	11.3	77	0.7	41	1.5	64
146	power driven pumps—reciprocating, centrifugal etc.	1.4	104	3.3	107	2.9	123	6.9	119	0.5	101	1.3	91
147	air & gas compressors & vacuum pumps (excluding electrical furnaces)	3.3	37	8.3	31	5.9	64	14.7	57	0.6	67	1.7	40
148	refrigeration plants for industrial use	2.1	69	4.8	72	2.2	148	5.0	147	0.9	16	2.2	16
149	fire-fighting equipment & appliances including fire engines	1.4	103	3.2	114	2.2	147	5.0	146	0.8	27	1.8	32
150	ball roller & tapered bearing & speed redution units	2.6	54	6.8	46	9.2	34	22.9	33	0.5	100	1.5	63
151	machine tools	1.5	95	3.5	97	6.5	53	15.0	54	0.7	40	1.7	39
152	tractors, harvestors, etc.	0.9	161	2.2	158	5.0	77	11.6	74	0.6	66	1.5	62
153	agricultural implements	1.8	81	4.3	81	3.0	118	6.9	118	0.7	39	1.7	38
154	earth moving machinery & fork lift trucks etc.	1.6	88	3.7	89	3.1	114	7.5	107	0.5	99	1.3	90
155	typewriters and duplicators	4.3	20	10.8	16	6.0	60	15.1	53	1.1	10	2.8	7
156	calculating machines & other commercial, office and household equipment	1.9	76	3.4	101	6.9	49	11.7	73	0.8	26	1.4	78
157	air-conditioners and refrigerators	1.4	102	3.2	113	2.4	140	5.7	131	0.6	65	1.4	77
158	sewing and knitting machines	2.4	61	5.3	63	3.3	109	7.3	113	1.4	5	3.1	6
159	weighing machines	3.2	38	7.2	39	3.3	108	7.3	112	0.8	25	1.8	31
160	machinery except electrical machinery—others	1.2	129	2.8	124	1.7	165	4.0	161	0.5	98	1.3	89

APPENDIX (*Contd.*) TABLE I

1	2	3	4	5	6	7	8	9	10	11	12	13	14
161	equipment for generation, transmission & distribution of electricity including transformers	0.9	160	2.2	157	14.2	18	30.9	21	0.7	38	1.5	61
162	electrical motors	5.9	9	14.0	8	5.9	63	13.9	60	0.7	37	1.7	37
163	electrical fans	1.2	128	2.7	129	3.0	117	6.9	117	0.6	64	1.5	60
164	electrical lamps	2.0	70	4.8	71	5.2	73	12.6	67	0.6	63	1.5	59
165	manufacture of electrical furnaces, xray equipment, electrical machinery, apparatus, appliances & supplies—others	1.4	101	3.1	116	4.6	79	10.0	85	0.6	62	1.4	76
166	electrical cables and wires	5.9	8	13.8	9	11.2	24	26.3	26	0.9	15	2.2	15
167	household appliances such as electric irons, heaters etc.	1.1	141	2.6	136	2.4	139	5.6	138	0.4	134	1.0	143
168	storage batteries	3.9	23	10.0	20	7.2	46	18.4	39	0.9	14	2.4	12
169	dry cells	2.7	51	6.9	45	3.6	100	9.1	95	0.8	24	2.2	14
170	telephones	2.4	60	5.4	61	14.2	17	31.6	17	1.0	11	2.2	13
171	telegraph equipment and teleprinters	1.4	100	3.5	96	3.0	116	7.3	111	0.7	36	1.8	30
172	wireless communication apparatus & radio receivers including amplifying and public address equipments	1.9	75	4.4	79	5.1	75	11.8	72	0.6	61	1.5	58
173	ship and other vessels drawn by power	1.2	127	2.6	135	2.3	144	5.2	141	0.7	35	1.7	36
174	boat building	0.7	178	1.6	183	1.4	177	3.2	176	0.5	97	1.1	119
175	railway locomotives	1.2	126	2.7	128	4.1	86	9.2	93	0.8	23	1.9	26
176	railway rolling stock	1.3	116	2.9	120	1.7	164	1.6	170	0.7	34	1.7	35
177	tramway works	1.1	140	2.8	123	1.3	180	3.3	173	0.8	22	2.0	23
178	manufacture of motor vehicles	3.0	42	7.1	42	5.7	65	13.5	63	0.7	33	1.8	29
179	repair of motor vehicles	0.9	159	2.1	165	2.1	151	4.9	149	0.6	60	1.4	75
180	manufacture of motor cycles and bicycles and manufacture of transport equipment, n.e.c.	1.6	87	3.7	88	5.5	70	12.8	65	0.6	96	1.3	88
181	manufacture of aircraft	3.3	36	7.8	38	16.7	12	40.7	10	2.0	3	4.8	2
182	surgical instruments	1.1	139	2.5	142	1.7	163	3.8	164	0.6	59	1.3	87
183	water meters, steam meters & electricity meters.	3.0	41	6.5	49	6.5	52	14.2	58	0.5	95	1.2	105
184	industrial instruments, indicating, recording and regulating devices for pressure, temperature rate of flow, weights, levels etc.	3.8	25	9.1	24	7.2	45	17.2	44	0.7	32	1.6	49

185	scientific instruments	1.5	94	3.2	112	2.8	126	5.6	137	0.5	94	1.2	104
186	mathematical surveying & drawing instruments	2.3	63	5.1	67	3.4	106	7.7	106	0.6	58	1.4	74
187	photographic & optical goods etc. manufacture and photographic printing paper—others	1.3	115	2.1	164	3.3	107	5.1	144	0.5	93	0.8	162
188	manufacture of watches and clocks	2.8	49	6.4	51	10.0	30	22.1	34	0.5	92	1.3	86
189	jewellery	2.1	68	5.0	68	2.7	129	6.4	125	0.7	31	1.8	28
190	mints	1.9	74	5.4	60	3.8	95	10.6	83	1.1	9	3.1	5
191	manufacture of musical instruments	0.8	169	1.9	170	0.9	193	2.0	194	0.4	133	1.0	142
192	pen and pencil making	1.4	99	3.2	111	3.5	104	7.7	105	0.5	91	1.1	118
193	fountain pen manufacturing	1.0	152	2.4	149	1.1	187	2.6	185	0.5	90	1.1	117
194	button making	2.6	53	6.7	48	4.4	83	11.2	78	0.5	89	1.3	85
195	manufacture of ice	0.2	201	0.1	203	11.0	25	29.5	23	0.4	132	1.1	116
196	plastic moulded goods	1.1	138	2.5	141	3.5	103	7.7	104	0.4	131	1.0	141
197	celluloid articles & manufacturing industries not elsewhere classified —others	1.2	125	2.7	127	2.5	135	5.3	139	0.5	88	1.1	115
198	brooms and brushes	1.1	137	2.5	140	1.6	171	3.6	159	0.1	200	0.4	195
199	games and sports goods	0.9	158	2.1	163	2.0	153	4.8	152	0.6	57	1.5	57
200	toy manufacturing	0.7	177	1.6	182	0.7	197	1.6	198	0.3	164	0.9	157
201	wrapping, packing, filling, etc. of articles	1.0	151	2.3	152	0.9	192	2.0	193	0.6	56	1.3	84
202	bones, ivory, horns, hoofs, claws and similar products (bone crushing)	0.6	188	1.4	188	1.1	186	2.7	183	0.2	187	0.6	186
203	slates and slate products	0.3	198	0.7	200	0.2	201	0.4	201	0.2	186	0.4	194

NOTE :—

1. $\frac{VA}{MH}$ represents value added per manhour (in rupees)
2. $\frac{VA}{NW}$ represents value added per worker (in thousand rupees)
3. $\frac{PC}{MH}$ represents productive capital employed per manhour (in rupees)
4. $\frac{PC}{NW}$ represents productive capital employed per worker (in thousand rupees)
5. $\frac{WB}{MH}$ represents wages & benefits per manhour (in rupees)
6. $\frac{WB}{NW}$ represents wages & benefits per worker (in thousand rupees)

APPENDIX TABLE II

Value Added, Productive Capital Employed and Wages and Benefits per Worker and per Manhour for Different Industries, 1963 — All India

Sl. No.	Industry	VA MH		VA NW		PC MH		PC NW		WB MH		WB NW	
		Value	Rank	Value	Rank	Value	Rank	Value	Rank	Value	Rank	Value	Rank
1	2	3	4	5	6	7	8	9	10	11	12	13	14
1	slaughtering preparation & preserving of meat and other miscellaneous food preparations	2.6	57	5.1	73	4.3	89	8.5	105	0.5	139	1.0	156
2	milk food and malted foods	2.7	52	7.0	43	12.9	18	33.1	17	0.6	105	1.6	70
3	canning & preserving of fruits & vegetables	1.3	133	3.0	133	2.2	146	5.1	142	0.3	184	0.7	179
4	canning & preserving of fish & other sea foods	1.4	123	4.2	89	1.7	165	5.0	147	0.2	196	0.8	173
5	flour mills	2.3	64	5.5	62	5.2	74	12.6	68	0.5	138	1.3	116
6	rice mills	0.8	177	1.5	183	2.2	145	4.0	162	0.2	195	0.5	190
7	dal mills	1.0	159	2.4	153	1.2	183	2.8	180	0.2	194	0.6	186
8	bakery products	2.8	47	6.9	46	3.5	110	8.6	104	0.6	104	1.5	88
9	sugar	1.9	84	4.5	84	6.4	58	15.3	50	0.6	103	1.4	98
10	gur	1.3	132	2.0	168	3.5	109	5.4	137	0.3	183	0.5	189
11	manufacture of cocoa, chocolate & sugar confectionery	2.2	68	5.2	69	3.7	103	8.6	103	0.3	182	0.8	172
12	manufacture of edible oils (other than hydrogenated oils)	1.5	112	3.3	119	3.9	96	8.7	101	0.4	163	0.9	161
13	hydrogenated oil (vanaspati)	3.4	31	8.5	31	8.3	36	20.7	32	0.6	102	1.6	69
14	tea manufacturing	1.7	97	4.0	96	5.4	69	12.7	67	0.3	181	0.8	171
15	coffee curing works	0.5	194	0.9	192	1.8	161	3.3	175	0.2	193	0.4	194
16	cashew nut processing	0.3	198	0.7	197	0.1	199	0.3	200	0.1	197	0.4	193
17	starch	2.9	44	8.0	36	6.6	51	18.1	38	0.5	137	1.5	87
18	cold storage	0.7	184	1.7	179	7.5	41	17.9	40	0.3	180	0.7	178
19	salt	0.9	169	1.9	174	1.7	164	3.5	170	0.5	136	1.0	155
20	distilling, rectifying & blending of spirits (alcohol)	1.7	96	4.1	92	5.3	71	12.5	70	0.4	162	1.0	154
21	wine industries	0.8	176	2.1	166	6.4	57	17.0	45	0.4	161	1.0	153
22	breweries & manufacturing of malt	4.7	15	10.7	17	5.8	64	13.1	63	0.3	179	0.7	177

23	soft drinks & carbonated water industries	4.3	21	10.4	19	7.7	38	18.4	36	0.6	101	1.5	86
24	biri	0.4	195	0.9	191	0.3	197	0.8	197	0.2	192	0.6	185
25	cigar	0.6	190	1.4	187	0.7	193	1.7	191	0.3	178	0.8	170
26	cigarettes	7.4	4	16.1	5	7.9	37	17.3	41	1.2	8	2.8	7
27	snuff	0.1	203	6.2	55	0.1	203	12.0	72	0.1	203	0.8	169
28	zerda	1.4	122	3.0	132	2.0	155	4.3	158	0.3	177	0.6	184
29	other tobacco manufactures	0.7	183	0.8	195	1.6	170	1.7	190	0.4	160	0.4	192
30	cotton textiles	1.3	131	3.2	125	2.0	154	5.0	146	0.7	65	1.9	37
31	jute textiles	0.9	168	2.5	147	1.4	178	3.8	167	0.4	159	1.2	129
32	woollen textiles	1.9	83	4.5	83	3.8	102	9.1	97	0.6	100	1.4	97
33	silk	0.3	197	0.8	194	2.0	153	4.6	153	0.3	176	0.6	183
34	art silk	2.1	74	5.2	68	4.7	81	11.4	76	0.7	64	1.7	60
35	webbing narrow fabrics, embroidery and lace manufacture	1.3	130	3.2	124	2.0	152	4.8	150	0.5	135	1.2	128
36	textiles dyeing, bleaching finishing & processing including mereirising finishing, calenedring, glazing, proofing etc.	0.5	193	1.4	186	1.9	159	4.6	152	0.6	99	1.4	96
37	thread and thread ballmaking	2.7	51	6.3	54	7.0	47	16.1	47	0.6	98	1.5	85
38	carpet weaving	0.7	182	1.7	178	1.1	186	2.5	183	0.3	175	0.8	168
39	knitting mills (hosiery & other knitted goods)	1.3	129	3.1	127	2.1	149	5.0	145	0.4	158	1.0	152
40	cordage, rope & twine industries manufacture of textile n.e.c.	0.2	202	3.5	112	0.1	202	3.8	166	0.1	202	1.0	151
41	cotton ginning, cleaning and pressing	0.6	189	0.8	193	1.6	169	2.2	187	0.2	191	0.3	196
42	jute pressing	4.7	14	2.7	144	10.1	31	5.9	130	1.4	6	0.8	167
43	wool balling and pressing	1.4	121	2.4	152	1.0	189	1.8	189	0.2	190	0.3	195
44	coir manufacture	1.0	158	2.3	160	1.7	163	3.8	165	0.4	157	0.9	160
45	artificial leather & oil cloth and linoleum and similar products	1.7	95	4.1	91	4.8	80	11.3	78	0.5	134	1.2	127
46	gas mantles & manufacture of textiles n.e.c.—others	1.9	82	4.6	81	2.6	134	6.3	128	0.4	156	1.0	150
47	tarpaulins, tents, sails and other made up canvas goods	1.3	128	3.3	118	0.6	196	1.5	195	0.5	133	1.3	115
48	manufacture of footwear	1.3	127	3.0	131	2.6	133	5.8	133	0.6	97	1.4	95
49	clothing and tailoring and others	0.9	167	2.2	164	1.5	175	3.5	169	0.4	155	1.0	149
50	unbrella manufacture	0.8	175	1.8	177	2.4	137	4.9	148	0.6	96	1.2	126
51	saw milling	0.8	174	1.9	173	1.9	158	4 3	157	0.3	174	0.7	176
52	plywood	1.2	144	3.0	130	3.6	107	8.8	100	0.3	173	0.9	159
53	wooden & cane containers & cane smallware	1.1	151	2.7	143	1.3	180	3.1	176	0.5	132	1.2	125

APPENDIX (*Contd.*) TABLE II

1	2	3	4	5	6	7	8	9	10	11	12	13	14
54	joinery and general wood working	1.0	157	2.3	159	2.2	144	5.3	139	0.4	154	1.0	148
55	cork & wood products n.e.c.—others	1.1	150	2.3	158	3.3	117	6.8	119	0.3	172	0.7	145
56	manufacture of furniture & fixture wooden	9.5	192	1.3	189	1.4	177	3.3	174	0.2	189	0.6	182
57	manufacturing of furniture and fixtures —metal and others	1.8	91	3.9	102	3.8	101	8.2	108	0.1	201	0.1	203
58	pulp -woodpulp, mechanical, chemical, including dissolving pulp, paper: writing printing & wrapping and newsprint	2.1	73	5.8	58	9.4	33	25.3	30	0.6	95	1.7	59
59.	Paper board and straw board	1.6	108	4.3	88	4.5	85	11.8	73	0.5	131	1.3	114
60.	Paper for packing (corrugated paper kraft paper, paper bags, paper containers, etc.)	2.1	72	5.0	74	4.6	84	10.8	85	0.6	94	1.5	84
61.	Hard board including fibre board and chip board	3.4	30	8.6	30	12.0	20	29.7	20	0.5	130	1.3	113
62.	Manufacture of paper and paper products & others	2.4	62	5.6	61	3.8	100	9.0	99	0.5	129	1.2	124
63.	letter press & lithographic printing and book binding	1.8	90	3.9	101	2.9	125	6.4	127	0.7	63	1.6	68
64.	other printing including book binding	1.7	94	4.0	95	4.3	88	9.8	91	0.7	62	1.6	67
65.	tanneries & leather finishing plants	1.3	126	3.0	129	2.3	139	5.6	135	0.5	128	1.2	123
66.	leather products except footwear and other wearing apparel	1.4	120	3.6	108	4.6	83	11.2	81	0.6	93	1.5	83
67.	tyres and tubes	9.6	3	22.8	2	16 0	15	38.1	15	1.5	4	3.7	3
68.	surgical & medicinal products including prophylactics & manufacture of rubber products—others	1.6	107	3.9	100	2.8	127	7.0	116	0.5	127	1.4	94
69.	rubber footwear	2.2	67	5.1	72	1.5	174	3.5	168	0.9	23	2.2	19
70.	mixed fertilizers	3.3	35	6.3	53	7.2	44	13.5	60	0.5	126	1.0	147
71.	inorganic fertilizers	3.0	41	7.5	38	25.4	9	62.7	9	1.1	11	2.7	8
72.	inorganic heavy chemicals	3.3	34	8.9	26	11.6	22	31.3	19	0.6	92	1.7	58
73.	synthetic resins & plastics & synthetic rubber	4.5	19	12.2	11	45.9	4	122.4	2	0.8	40	2.3	15
74.	organic heavy chemicals	6.2	7	14.1	7	32.5	6	74.0	5	0.5	125	1.3	112
75.	man-made fibres including regenerated cellulose rayon, nylon etc.	5.6	10	14.7	6	19.2	13	50.8	12	0.1	200	0.1	199
76.	explosives including gun-powder and safety fuses	1.9	81	0.2	202	9.5	32	0.1	203	0.4	153	0.1	202

77.	dye stuffs	7.0	5	17.2	3	22.1	12	54.5	11	0.8	39	1.9	36
78.	turpentine and resin products of fermentation industries other than alcohol and other basic industrial chemicals	4.6	18	12.1	12	10.1	30	26.4	26	0.9	22	2.5	12
79.	vegetable oils, including solvent extracted oils	1.2	143	2.8	138	6.4	56	14.9	55	0.5	124	1.1	140
80.	paints, varnishes and lacquers	4.7	13	10.6	18	7.0	46	15.9	49	0.8	38	1.8	49
81.	glue and gelatine & waxes & polishes etc. (for leather, wood, metal, glass etc)	2.9	43	6.5	52	5.7	65	12.8	66	0.5	123	1.1	139
82.	fine chemical including photographic chemicals	34.2	1	8.2	34	130.0	1	31.3	18	7.1	1	1.7	57
83.	insecticides, fungicides & weedicides	2.8	46	7.8	42	10.5	28	26.3	28	0.8	37	2.0	28
84.	textile auxiliaries & sizing materials	4.6	17	10.3	20	15.8	16	35.0	16	1.2	7	2.6	10
85.	manufacture of miscellaneous chemical products etc.	3.2	37	7.4	39	11.2	23	25.5	29	0.6	91	1.5	82
86.	drugs and pharmaceuticals	5.7	8	12.9	9	10.3	29	23.2	31	0.9	21	2.1	21
87.	soaps and glycerine	6.5	6	16.3	4	10.6	27	26.3	27	1.0	14	2.6	9
88.	perfumes, cosmetics and other toilet preparations	5.5	11	11.9	13	6.1	59	13.1	62	0.7	61	1.5	81
89.	matches	1.8	89	4.0	94	1.8	160	4.2	160	0.7	60	1.7	56
90.	lac including shellac	1.3	125	0.2	201	2.6	132	0.2	202	0.4	152	0.1	201
91	petroleum refineries	16.3	2	39.7	1	91.6	2	222.2	1	1.6	3	4.1	2
92	manufacture of miscellaneous products of petroleum and coal	3.6	29	9.9	23	25.2	10	69.7	6	0.6	90	1.9	35
93	fire bricks	0.6	188	1.1	190	1.5	173	2.6	182	0.3	171	0.6	181
94	refractories and furnace lining bricks—acidic, basic and natural	1.5	111	4.1	90	5.1	77	13.6	58	0.5	122	1.4	93
95	tiles	0.8	173	1.8	176	1.2	182	2.9	179	0.3	170	0.8	166
96	glass hollowware	0.5	191	1.3	188	0.6	195	1.6	193	0.3	169	0.8	165
97	sheet and plate glass	1.2	142	3.4	117	6.5	54	18.0	39	0.5	121	1.5	80
98	glass wool & miscellaneous glassware	0.8	172	1.9	172	1.6	168	3.9	163	0.4	151	1.1	138
99	laboratory glassware	0.9	166	2.2	163	2.1	148	5.1	141	0.4	150	1.1	137
100	chinaware and pottery	0.7	181	1.9	171	1.6	167	4.3	156	0.4	149	1.0	146
101	sanitary ware and whiteware	0.9	165	2.3	157	3.3	116	7.9	111	0.3	168	0.8	164
102	insulators	0.7	180	1.8	175	3.8	99	9.9	90	0.3	167	0.8	163
103	manufacture of cement (hydraulic)	3.0	40	8.1	35	11.0	25	29.5	22	0.7	59	1.9	34
104	asbestos cement	2.9	42	8.3	33	3.9	95	11.1	83	0.7	58	2.0	27
105	humepipe & other cement & concrete products (including reinforced products)	1.1	149	2.4	151	2.9	124	6.4	126	0.5	120	1.1	136

APPENDIX (*Contd.*) TABLE II

1	2	3	4	5	6	7	8	9	10	11	12	13	14
106	stone dressing & crushing	0.9	164	2.0	167	1.9	157	4.2	159	0.3	166	0.7	174
107	grinding wheels and abrasives	4.0	22	10.8	16	10.9	26	29.0	24	0.6	89	1.7	55
108	mica factories	0.6	187	1.4	185	1.2	181	3.0	177	0.2	188	0.5	188
109	manufacture of non-matellic mineral products n.e.c.—others	0.2	201	10.2	21	0.1	201	13.0	65	0.1	199	1.3	111
110	iron and steel (metal)	2.6	56	6.9	45	24.9	11	65.3	8	0.9	20	2.5	11
111	ferro-alloys	3.3	33	9.1	25	14.4	17	39.0	14	0.4	148	1.1	135
112	iron & steel castings & forgings	1.2	141	3.0	128	3.8	98	9.0	98	0.5	119	1.3	110
113	iron and steel structurals	1.8	88	4.0	93	7.5	40	17.0	44	0.6	88	1.4	92
114	iron & steel pipes	2.7	50	6.5	51	6.8	49	16.5	46	0.7	57	1.8	48
115	non-ferrous basic metal industries	4.6	16	11.8	14	16.4	14	41.7	13	0.8	36	2.0	26
116	metal container and steel trunks	2.3	63	5.3	67	4.2	90	9.6	92	0.8	35	1.8	47
117	cutlery, locks etc.	0.9	163	2.2	162	0.6	194	1.5	194	0.4	147	0.9	158
118	bolts, nuts, nails, screws, springs, chains etc.	2.5	58	5.7	59	5.8	63	13.2	61	0.6	87	1.5	79
119	enamelling, japaning & lacquering, galvanising, plating and polishing metal products	1.1	148	2.7	142	1.6	166	4.0	161	0.5	118	1.2	122
120	type-founding	1.6	106	3.6	107	1.9	156	4.3	155	0.5	117	2.2	121
121	welding	1.4	1.9	3.4	1.6	3.4	112	8.1	110	0.3	165	0.8	162
122	safes and vaults	0.6	186	1.6	182	0.9	191	2.2	186	0.4	146	1.0	145
123	razer blades	5.6	9	13.4	8	4.3	87	10.2	89	0.7	56	1.8	46
124	hurricane lanterns	0.9	162	2.3	156	1.1	185	2.9	178	0.5	116	1.3	109
125	hand tools and small tools	2.8	45	6.7	48	6.5	53	15.2	51	0.8	34	1.9	33
126	metal fittings for shoes & leather articles and wearing apparels	1.3	124	3.2	123	2.7	130	6.5	124	0.4	145	1.0	144
127	sanitary and plumbing fixtures and fittings for metals	1.2	140	2.9	135	1.4	176	3.3	173	0.6	86	1.6	66
128	weighis & manulacture of metal prc-ducts except machinery and transport equipment—others	1.8	87	4.3	87	4.0	93	9.2	95	0.6	85	1.4	91
129	boilers and steam generating plants	1.2	139	2.7	141	38.6	5	86.6	4	0.6	84	1.3	108
130	internal combustion engines	0.2	200	0.2	200	0.1	200	0.2	201	0.1	198	0.1	200
131	textile machinery (such as spinning frames, carding machines, power looms etc. including textile)	1.8	86	4.3	86	3.6	106	8.4	106	0.7	35	1.6	65
132	jute machinery	3.7	25	8.7	28	3.5	108	8.2	107	0.5	115	1.2	120

133	sugar machinery	1.4	118	3.1	126	5.2	73	11.6	75	0.6	83	1.3	107
134	tea machinery	1.8	85	4.9	76	3.9	94	10.5	88	0.6	82	1.8	45
135	mining machinery	1.0	156	2.4	150	27.4	8	61.9	10	0.5	114	1.1	134
136	metallurgical machinery and cement machinery	1.6	105	3.6	106	4.1	92	9.3	94	0.9	19	2.0	25
137	chemical machinery	1.4	117	3.5	111	3.6	105	8.6	102	0.5	113	1.3	106
138	pharmaceutical machinery	1.0	155	2.3	155	2.5	136	5.8	132	0.6	81	1.4	90
139	paper machinery	3.0	39	7.2	41	7.1	45	17.2	42	0.7	54	1.7	54
140	construction machinery	1.4	116	3.2	122	4.1	91	9.2	93	0.6	80	1.5	78
141	oil mill machinery	1.4	115	3.5	110	2.2	143	5.3	138	0.6	79	1.5	77
142	rice, dal and flour mill machinery	1.2	138	0.2	199	1.5	172	0.3	199	0.6	78	0.1	198
143	size reduction equipment crusher ball mill etc.	1.1	147	2.5	146	9.1	34	20.2	33	0.4	144	1.0	143
144	conveying equipment bucket elevators, skip hoists, cranes, derricks, etc.	2.0	77	4.7	80	6.6	50	15.1	53	0.6	77	1.3	105
145	mixers and reactors-kneading mills, turbo mixers etc. and centrifugal machinery	2.0	76	4.5	82	5.1	76	11.3	77	0.7	53	1.5	76
146	power driven pumps reciprocating, centrifugal etc.	1.9	80	4.7	79	3.3	115	8.1	109	0.6	76	1.5	75
147	air & gas compressors and vacuum pumps (excluding electrical furnaces)	3.6	28	8.7	27	6.0	61	14.6	56	0.8	33	1.9	32
148	refrigeration plants for industrial use	2.1	71	4.8	77	2.2	142	5.0	144	0.9	18	2.2	18
149	fire fighting equipment & appliances including fire engines	1.4	114	3.2	121	2.2	141	5.0	143	0.8	32	1.8	44
150	ball roller & tapered bearing and speed reduction units	2.4	61	6.6	49	7.4	42	20.0	34	0.5	112	1.6	64
151	machine tools	2.1	70	4.9	75	7.5	39	17.1	43	0.7	52	1.7	53
152	tractors, harvestors, etc.	0.9	161	2.2	161	5.2	72	12.1	71	0.6	75	1.5	74
153	agricultural implements	1.6	104	3.8	103	2.9	123	6.8	118	0.6	74	1.5	73
154	earth-moving machinery & fork lift trucks etc.	1.6	103	3.9	99	4.6	82	11.2	80	0.7	51	1.8	43
155	typewriters and duplicators	4.3	20	10.8	15	6.0	60	15.1	52	1.1	10	2.8	6
156	calculation machines & other commercial office & house-hold equipment	1.6	102	3.2	120	5.6	67	10.6	87	0.7	50	1.3	104
157	air conditioners and refrigerators	1.6	101	3.7	104	2.7	129	6.4	125	0.7	49	1.6	63
158	sewing and knitting machines	2.4	60	5.3	66	3.3	114	7.3	114	1.4	5	3.2	4
159	weighing machines	3.2	36	7.2	40	3.3	113	7.3	114	0.8	31	1.8	42
160	machinery except electrical machinery —others	1.6	100	3.9	98	2.3	138	5.6	134	0.7	48	1.7	52
161	equipment for generation, transmission and distribution of electricity including transformers	1.5	110	3.4	115	11.9	21	26.9	25	0.7	47	1.7	51

APPENDIX *Contd.*) TABLE II

1	2	3	4	5	6	7	8	9	10	11	11	13	14
162	electrical motors	3.6	27	8.6	29	5.3	70	12.5	69	0.7	46	1.6	62
163	electrical fans	2.7	49	6.0	56	2.9	122	6.5	123	1.0	13	2.3	14
164	electrical lamps	2.1	69	5.3	65	4.8	79	11.7	74	0.7	45	1.7	50
165	manufacture of electrical furnaces, x-ray equipment, electrical machinery, apparatus, appliances & supplies—others	1.2	137	2.7	140	3.4	111	7.4	112	0.4	73	1.4	89
166	electrical cable and wire	5.3	12	12.6	10	12.1	19	29.0	23	0.8	30	2.0	24
167	house-hold appliances such as electric irons, heaters etc.	1.2	136	2.9	134	2.5	135	5.8	131	0.5	111	1.1	133
168	storage batteries	3.9	23	10.0	22	7.2	43	18.2	37	0.9	17	2.4	13
169	dry cells	2.7	48	6.9	44	3.6	104	9.1	96	0.8	29	2.2	17
170	telephone	2.4	59	5.4	64	50.9	3	113.0	3	1.0	12	2.2	16
171	telegraph equipment & teleprinters	1.4	113	3.4	114	2.9	121	6.9	117	0.7	44	1.8	41
172	wireless communication, apparatus & radio receivers including amplifying public address equipment	2.2	66	5.1	71	5.6	66	13.0	64	0.7	43	1.8	40
173	ships and other vessels drawn by power	1.5	109	3.5	109	2.7	128	6.0	129	0.8	28	1.9	31
174	boat building	0.7	179	1.6	181	1.5	171	3.4	171	0.5	110	1.2	119
175	railway locomotives	1.2	135	2.8	137	4.9	78	11.0	84	0.8	27	1.9	30
176	railway rolling stock	1.6	99	3.6	105	2.19	147	4.7	151	0.8	26	1.8	39
177	tramway works	1.1	146	2.8	136	1.3	170	3.3	172	0.8	25	2.0	23
178	manufacture of motor vehicles	3.3	32	7.8	37	6.4	55	14.9	54	0.9	16	2.1	20
179	repair of motor vehicles	1.0	154	2.3	154	2.2	140	5.1	140	0.6	72	1.5	72
180	manufacture of motor cycles & bicycles & manufacture of transport equipment n.e.c.	2.0	75	4.7	78	5.8	62	13.5	59	0.8	24	1.9	29
181	manufacture of aircraft	3.8	24	9.2	24	28.5	7	69.1	7	1.9	2	4.8	1
182	surgical instruments	1.1	145	2.5	145	1.7	162	3.8	164	0.6	71	1.3	103
183	water meters, steam meters & electricity meters	3.0	38	6.5	50	6.5	52	14.2	57	0.5	109	1.2	18
184	industrial instruments indicating, recording and regulating devices for pressure, temperature, rate of flow weights, levels etc.	3.6	26	8.4	32	6.8	48	15.9	48	0.7	42	1.6	61
185	scientific instruments	1.6	98	3.4	113	2.6	131	5.5	136	0.5	108	1.2	117
186	mathematical surveying and drawing instruments	2.6	55	5.6	60	5.1	75	11.1	82	0.9	15	2.0	22

187	photographic & optical goods etc. manufacture and photographic printing paper—others	1.7	93	0.3	198	5.5	68	1.2	196	0.6	70	0.1	197
188	Manufacture of watches and clocks	2.6	54	5.9	57	8.7	35	19.5	35	0.6	69	1.3	102
189	jewellery	2.2	65	5.1	70	2.8	126	6.6	121	0.7	41	1.8	38
190	mints	1.9	79	5.4	63	3.8	97	10.6	86	1.1	9	3.1	5
191	manufacture of musical instruments	0.8	171	1.9	170	0.9	190	2.0	188	0.4	143	1.0	142
192	pen and pencil making	1.0	153	2.4	149	2.9	120	6.6	120	0.4	142	1.1	132
193	fountain pen manufacturing	1.0	152	2.4	148	1.0	188	2.4	184	0.5	107	1.1	131
194	button making	2.6	53	6.7	47	4.4	86	11.2	79	0.5	106	1.3	101
195	manufacture of ice	0.2	199	0.1	203	110	24	29.5	21	0.4	141	1.1	130
196	plastic moulded goods	1.7	92	3.9	97	2.9	119	6.5	122	0.6	68	1.3	100
197	celluloid articles & manufacturing industries n.e.c.—others	1.9	78	4.3	85	3.2	118	7.3	113	0.6	67	1.3	99
198	brooms and brushes	1.2	134	2.7	139	2.0	151	4.5	154	0.2	187	0.5	187
199	games and sports goods	0.9	160	2.1	165	2.0	150	4.8	149	0.6	66	1.5	71
200	toy manufacturing	0.7	178	1.6	180	0.7	192	1.6	192	0.3	154	0.9	157
201	wrapping, packing, filling etc. of articles	0.8	170	1.9	169	1.0	187	2.2	185	0.4	140	1.0	141
202	bones, ivory, horns, hoofs, claws and similar products (bone crushing)	0.6	185	1.4	184	1.1	184	2.7	181	0.2	186	0.6	180
203	slates and slate products	0.3	196	0.7	196	0.2	198	0.4	198	0.2	185	0.4	191

NOTE :—

1. $\frac{VA}{MH}$ represents value added per manhour (in rupees)
2. $\frac{VA}{NW}$ represents value added per worker (in thousand rupees)
3. $\frac{PC}{MH}$ represents productive capital employed per manhour (in rupees)
4. $\frac{PC}{NW}$ represents productive capital employed per worker (in thousand rupees)
5. $\frac{WB}{MH}$ represents wages & benefits per manhour (in rupees)
6. $\frac{WB}{NW}$ represents wages & benefits per worker (in thousand rupees)

APPENDIX TABLE III

Value Added, Productive Capital Employed and Wages & Benefits per Worker& per Man-hour in All Industries for Various States, 1963

Sl. no.	States	VA*/MH		VA*/NW		PC*/MH		PC*/NW		WB*/MH		WB*/NW	
		Value	Rank	Value	Rank	Value	Rank	Value	Rank	Value	Rank	Value	Rank
1	2	3	4	5	6	7	8	9	10	11	12	13	14
1	Andhra Pradesh	2.1	2	4.9	14	7.3	2	13.7	7	2.1		1.5	2
2	Assam	1.7	12	4.2	12	6.9	4	17.5	2	1.7	6	1.4	4
3	Bihar	1.7	13	4.3	11	7.1	3	16.8	3	1.7	7	1.3	7
4	Gujarat	2.1	3	5.2	2	6.7	5	15.6	5	2.1	8	1.3	8
5	Jammu & Kashmir	1.3	18	2.9	18	2.8	18	16.1	18	1.3	16	1.0	18
6	Kerala	1.9	7	4.6	8	5.9	7	14.1	6	1.9	9	1.2	10
7	Madhya Pradesh	1.5	14	3.8	14	5.5	10	12.9	10	1.5	10	1.2	11
8	Madras	1.9	8	4.6	9	4.5	15	11.1	12	1.9	3	1.4	5
9	Maharashtra	2.5	1	6.2	1	6.7	6	15.9	4	2.5	2	1.7	1
10	Mysore	2.0	5	5.0	3	4.7	13	11.0	14	2.0	17	1.1	17
11	Orissa	1.8	9	4.7	6	8.0	1	21.2	1	1.8	18	1.2	12
12	Punjab	1.8	10	4.4	10	4.4	16	10.6	16	1.8	11	1.3	9
13	Rajasthan	1.5	15	3.7	15	5.8	8	13.6	8	1.5	12	1.2	13
14	Uttar Pradesh	1.8	11	4.1	13	4.9	11	11.4	11	1.8	13	1.2	14
15	West Bengal	2.1	4	4.8	5	5.6	9	13.4	9	2.1	4	1.5	3
16	Delhi	2.0	6	4.7	7	4.8	12	11.1	13	2.0	5	1.4	6
17	Goa	0.0	20	0.0	20	0.0	20	0.0	20	0.0	20	0.0	20
18	Himachal Pradesh	1.4	17	3.6	16	3.4	17	8.8	17	1.4	14	1.2	15
19	Pondicherry	1.5	16	3.6	17	4.6	14	11.0	15	1.5	15	1.2	16
20	Tripura	0.1	19	0.5	19	0.6	19	2.2	19	0.1	19	0.2	19

*NOTE:—The figures in case of Goa were too negligible and got ignored in the process of rounding.

1. $\frac{VA}{MH}$ represents value added per manhour (in rupees)
2. $\frac{VA}{NW}$ represents value added per worker (in thousand rupees)
3. $\frac{PC}{NW}$ represents productive capital employed per manhour (in rupees)
4. $\frac{PC}{NW}$ represents productive capital employed per worker (in thouand rupees)
5. $\frac{WB}{MH}$ repreesent wages & benefits per manhour (in rupees)
6. $\frac{WB}{NW}$ reprewsents wages & benefits per worker (in thousand rupees)

APPENDIX B

Methodology

When confronted with heterogenous data, the authors have resorted to the normal statistical technique, known as Analysis of Variance or Covariance. The latter provides complete analysis of simultaneous variation in two correlated sets of variables. The data thus dealt with are:

(a) Value added per worker
(b) Value added per manhour
(c) Productive capital employed per worker
(d) Productive capital employed per manhour
(e) Wages and benefits per worker
(f) Wages and benefits per manhour

The total variation under each of the above variables has been partitioned into two components, namely, the variation between the states and the variation between the industries. These variations were tested against 'Error Variance" to see if the variation due to any of these cases is statistically significant or not.

The covariance study deals with

(i) Value added per worker and wages and benefits per worker.
(ii) Value added per manhour and wages and benefits per manhour.
(iii) Value added per worker and productive capital employed per worker.
(iv) Value added per manhour and productive capital employed per manhour.
(v) Productive capital employed per worker and wages and benefits per worker.
(vi) Productive capital employed per manhour and wages and benefits per werker.

For each of the above combinations we have studied the test of significance of regression line, the test of significance of the 'industries-mean' effects and the test of significance of 'States-mean' effects.●●●

Scientology

The cult is merely a remarkable marketing job dreamed up by a former science fiction writer . . .

Its essence is that a person has imprinted on his unconscious mind (or in scientology language the "recreative mind") a painful memory which produces a mental image called an "engram." In this state he is known as a "preclear," and the purpose of "auditing" or "processing" is to release his engrams and free him from the influence of his reactive mind. The object is to let him become a "clear", defined as a "person who can be at cause (sic) knowingly and at will over mental matter, energy, space and time as regards the first dynamic (survival of self.)

A clear is a being who has attained this state by completing the Saint Hill Clearing Course and has been declared clear by the Saint Hill Qualifications Division." Eventually the "clear" should aim at becoming an "operating thetan," with control over matter, energy, space, time life, and form.

But according to the board of inquiry that investigated scientology in Australia, "Scientology is evil ; its techniques evil ; its practice a serious threat to the community . . . " It denounced scientology as evil on three grounds. One of them—that it creates tension within a family and breaks up marriages—may of course equally be true of any religion or cult that is joined by one member of a family and rejected by the others, Much more worrying is the collection of the confessions made during auditing sessions. The Anderson board found no evidence of overt blackmail. But there is at East Grinstead a fire of all that a preclear says to an auditor. The questions supported by an E-meter ("an electronic aid for measuring the mental state and change of state of individuals"), aim at extracting from a preclear everything about him, including details of his sex life, any breaches of the law he may have committed—anything, in fact, that he might feel would incriminate him were he trying to break free.

Labour & Machine Productivity in Spinning

LIKE ATIRA AND SITRA, THE BOMBAY TEXTILE Research Association (BTRA) has done a good deal of good work in the measurement of productivity in cotton textiles within its own jurisdiction. This is really an essay in Interfirm Comparison : a comparison of relative performance of a number of firms, which are members of BTRA : and this is not the first survey in the line. BTRA has so far carried out four Surveys on Labour and Machine Productivity in Spinning ; this is the fourth and the latest. The study contains a good deal of very useful information on employment, production, processing, machines, power consumption, yarn realisation, waste reduction and utilisation etc., etc.

The Survey covered 28 member mills. As 23 of them had participated in the previous Survey of 1945, the relevant statistics enable a broad comparison being made regarding productivity changes, broadly over time, *inter se*, as also of most of the member mills, as individual units.

The publication does not give the statistical background of the computation of HOK, Productivity index Efficiency Index etc., etc., as they had earlier been published in the Survey of 1964. This is a serious handicap not only for the common reader, but even for the trained analyst interested in understanding the basis of the relavant interfirm comparison. However, we must compliment BTRA for the work they have done and presented in this highly useful publication.

From the statistics worked out in the analysis, we find that only five mills out of 28 had a productivity 10 per cent above the base figure, as determind by the agreement between the mills standardised HOK and the standard HOK for 20s carded warp count. As many as nine mills recorded productivity 10 per cent below the base figure, seven mills as much as 20 to 30 per cent lower and four mills 30 to 40 per cent. On the whole, however, as between 1965 and 1967 the productivity index went up by 6 per cent. On the other hand in Machine Productivity (Ring Frame) standardised to 20s, has gone down by four grams. In 1965 the standardised production in grams per spindle-shift was around 132 grams ; by 1967, it had come down to around 128 grams.

Probably of greater significance from the point of view of productivity, is the reduction in the number of operatives per one thousand spindles from 6.85 to 6.41. Between 1965 and 1967, in all sections of spinning, particularly in ring frames, there was a reduction in the number of operatives.

NUMBER OF OPERATIVES PER 100 SPINDLES

	1965	1967
Blow Room	0.39	0.37
Carding and Combing	0.92	0.91
Fly Frames	1.37	1.22
Ring Frames	4.17	3.91
TOTAL	6.85	6.41

There is also some evidence of refinement of work and higher speeds of performance in certain lines; also a visible tendency to extract more from waste.

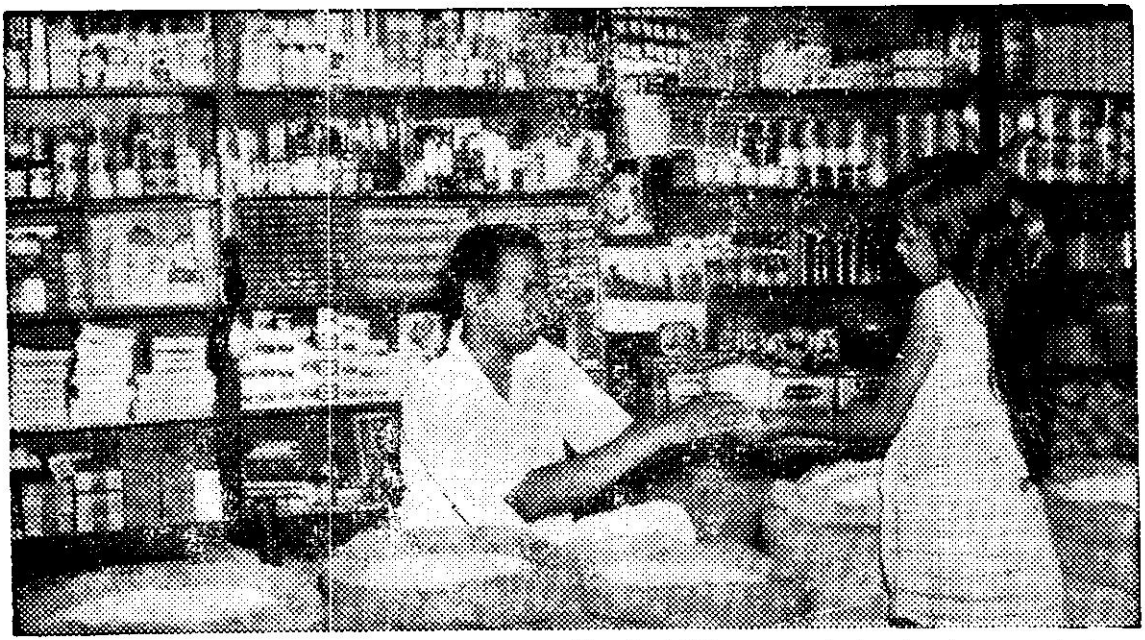
While the Report gives voluminous details, the data as presented cannot lead, for the most part, to any comparable analysis either as between mills or overtime. As for example, we get substantial details of yarn realisation per 100 KG of bale cotton which varied in the latest survey between 70 to 85 per cent. Adding usable waste we get a figure ranging from 86 to 90 Kg. per 100 Kg. of bale cotton. Without any time series, it would be difficult to say whether this is high or low, commendable or otherwise, whether any steps should be taken and in what direction.

As a study in interfirm comparison, the figures of power consumption given on page 98 are highly interesting. Of course, the installed capacity varies from one mill to another and from one section to another: these are understandable differences, but what requires explanation is the enormous differences in power consumption for comparable operations. For example, in the Blow room, the power consumption per 1000 spindles ranges from 1.29 to 3.12 k.W.h. In carding, the range is much larger : 1.02 to 7.54 k.W.h. and there are similar differences in the other sections of spinning. Taking over-all consumption it varies from 16.13 to 32.10 kw for one thousand spindles, as between 28 mills covered by the Survey. This should certainly lead on to an analysis in depth as to what is actually happening in cotton textile mills.

As stated already, the 129 pages of this publication are really a feast in terms of statistical material. Sri C. V. Modi and Sri G.D. Chitnis deserve to be congratulated for the job they have done. It can be easily seen that the mere collection of statistical data of this magnitude from individual mills must have been a highly laborious and very painful job, taking Indian industry as what it is, and this is a traditional one. But with a little more effort it should be possible to build up a series of meaningful statistics both for time as well as between mills. Even a publication of smaller size, containing a time series for all the surveys so far done would be an excellent addition to the literature on productivity and interfirm comparison.●●●

Productivity in Eastern Europe

In tourism as in everything else, Bulgaria is in the process of pulling itself up by its bootstraps. Squads of jolly little fat girls—a Black Sea version of Saint Trinian's—attend schools of tourism all over the country and staff its blossoming resorts. The rate of progress is remarkable—so fast indeed that the State Committee for Tourism has to admit that not everyone has been able to keep up. It is one thing to strike a very good standard in modern architecture and build sparkling leafy resorts on the Black Sea Coast. It is another to turn a mountain girl into the kind of receptionist who sees the point of view of a western tourist after his shower has cut out, just when he had got himself soaped.



Over Rs. 6,250 crores worth of packaged consumer goods are bought and sold every year.

Unless more packages are available, the marketing of consumer goods will be impeded

As more consumer goods are produced, there must be a corresponding increase in the output of the consumer packaging industry. This is obvious. But it must happen without prices rising to uneconomic levels.

Four steps to help ensure that we can help deliver the goods—at the right prices:

1. Increased output of consumer packaging calls for adequate supplies of local raw materials at reasonable prices. *Which means a reduction in levies.*

2. Essential raw materials not locally obtainable, must be imported. Again, at the right prices. *Which means a reduction in import duties.*

3. The healthiest, most progressive units in the packaging industry *must be encouraged* to grow so that economic production, through scale and diversified activity, may be achieved.

4. Continuous access to the mainstream of international packaging technology *must be allowed* to provide consumer goods manufacturers with improved yet less expensive packaging.

Metal Box are ready and willing to do everything in their power to produce more, at reasonable prices. But we need the conditions and materials necessary to function at full capacity.

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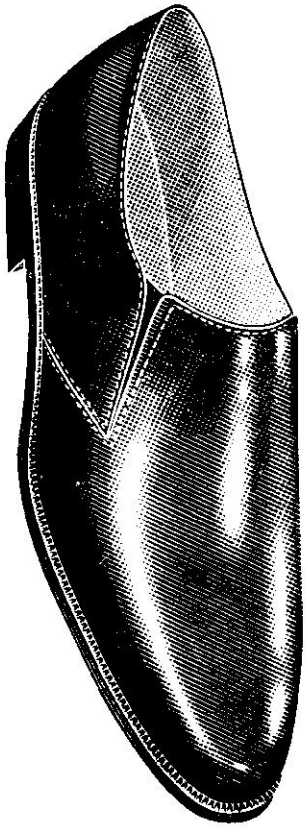

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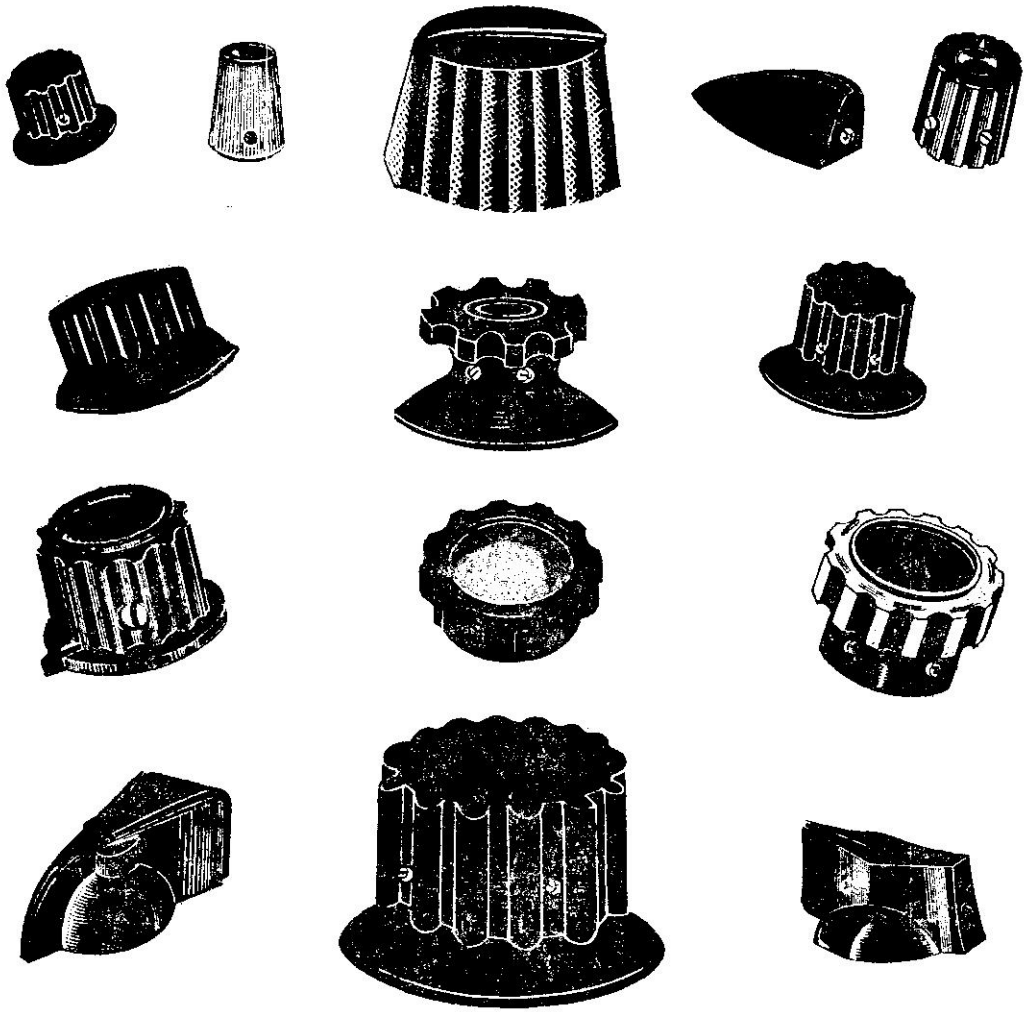

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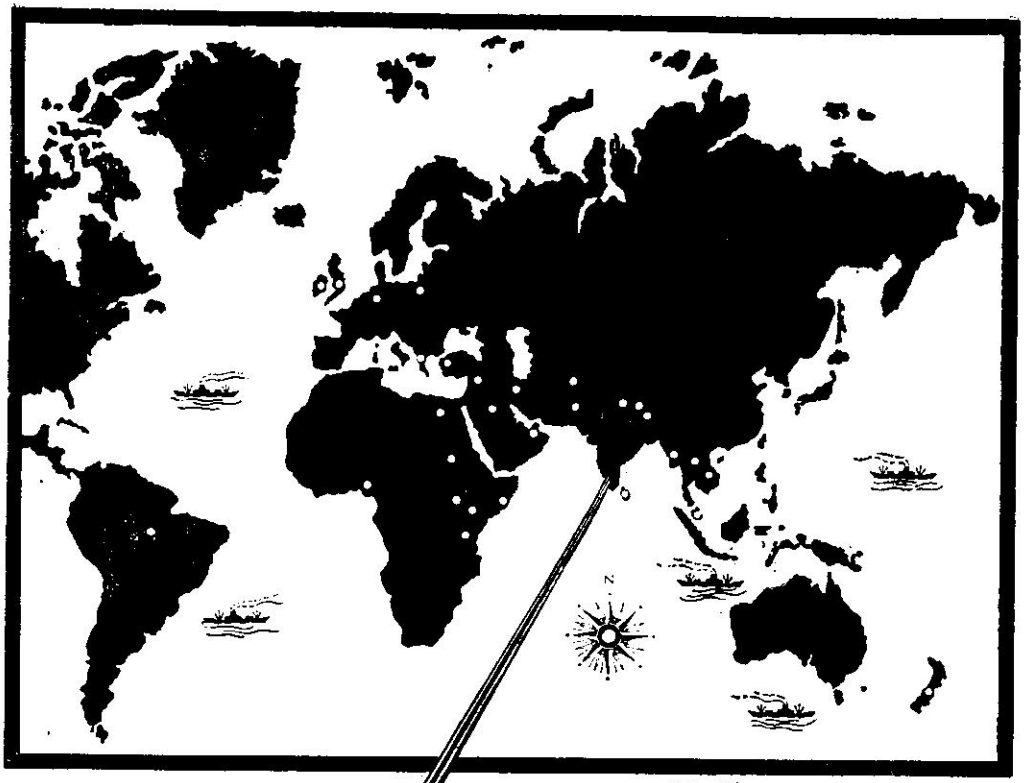

ITI exports equipment worth Rs.1.55 crores to 30 countries

Countries to which ITI has exported its equipment

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- Iran
- Iraq
- Ireland
- Kuwait
- Kenya
- Malaysia
- Nepal
- United Kingdom
- Nigeria
- New Zealand
- Pakistan
- Poland
- Sikkim
- Singapore
- Somali Republic
- Sudan
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Today, ITI is one of India's major engineering exporters earning valuable foreign exchange. It has exported equipment worth Rs. 1.55 crores to 30 countries since 1963-64. In 1967-68 alone ITI earned Rs. 50 lakhs in foreign exchange in a highly competitive international market. Currently, orders worth about Rs. 80 lakhs are under execution. ITI exports to several Asian, African and European countries, besides the U.K. and Brazil which are the largest importers of ITI equipment. ITI has now been commissioned to install a 5000 line exchange in Dar-es-Salaam and a 600 line exchange in a suburb of Kurasini in East Africa. ITI's exports include telephone instruments, automatic exchanges, long distance transmission equipment, loading coils, bank multiples, switches, condensers and piece parts.

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ASP-ITI '67

Accident Proneness

S Chatterji and Manjula Mukerjee*

Accidents in industry have always posed a serious problem from the very wake of industrialisation. Some idea as to the enormous size of the problem can be had from the fact that even as early as 1930, some 99,000 people were killed by accidents of one kind or the other in the USA alone. With rapid industrialisation during the past few decades, the number of persons exposed to risk has considerably increased and it is now estimated that about 46 million Americans are injured in accidents every year. In India, statistics for factories (sending returns to government), mines, and railways are available; even for this restricted group the total number of persons involved in accidents in a recent year was as high as 157,070.

AT THE TURN OF THIS CENTURY, THE LOT OF workers involved in accidents was much worse than it is today. With the introduction of legal safeguards to injured workers in the form of compensation, prevention of accidents has become a matter of major concern for industrialists. As a result of these measures the death rate in industry in the USA has dropped from 25 to 12 persons per 100,000 workers, whereas **no such downward trend is observable in India.** Excluding the cost of medical treatment of the injured workers, industrial accidents include many other costs, such as slowing down of work, the problem of replacing those who are injured, the task of training up the newly appointed workers; to all these must be added the cost of maintaining the safety and welfare departments.

Estimating the cost of accidents in terms of money alone does not tell the whole story. The impact on the individual and the havoc on the family of the injured are beyond evaluation. Most of the families of industrial workers just survive on the margin of existence; and a single accident may mean a complete disaster for the family. The resulting problem has far-reaching consequences on the employee concerned, his family and the society in general.

The safety movement in industry grew out of a concern for both types of causes, mentioned above. Defects in machine designing, and what was termed as carelessness on the part of the worker, were considered as

*Indian Statistical Institute, Calcutta

the sole cause of accidents; and they were sought to be removed by introducing safety posters and providing various safeguards on the machine. Guards were placed on driving belts and other exposed machine parts which appeared as possible sources of danger. Later on, the very same concern for reducing accidents by making machines less dangerous led to the improvement in machine designing and was ultimately reflected in improved layout of machinery and plants. As a result of this the accidents attributable to machines dropped to a considerable extent. Even then the total number of accidents could be reduced by providing mechanical safeguards and proper designing of the plant. Like many other things, however, this was subject to the law of Diminishing Returns.[2] Much, of course, has been done in this direction and the incidence of accidents reduced; other sources, however, should also be explored because instances of accidents are not rare even with machines which are considered "fool-proof".

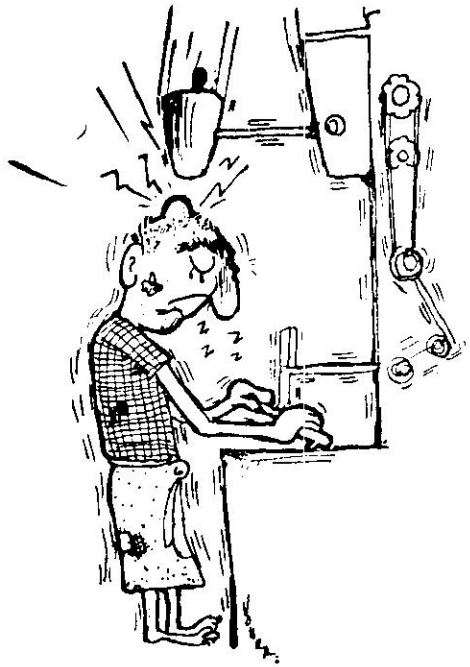
The literature of the safety movement is replete with classification of accidents by the type of machines involved, part of the body injured, etc., but not enough attention has been paid to the psychological factors involved. Carelesseness was the term used to explain away the non-machinery causes of accidents. Carelessness is an omnibus term and in this specific instance serves as a "smoke-screen" which contributes its share in preventing detailed analysis of the factors involved. According to Vitelis[5], about 90% of recent accidents could be classified under this heading. Naturally, interest in studying the constituent parts grew and several studies have been made.

It has been a common observation in industry that **certain persons frequently get involved in accidents,** whereas others do not. Studies have also shown that for those persons who were earlier involved in accidents, the probability to get involved in another accident in future is much higher than for those who never had accidents earlier. This tendency of certain persons to be more liable to get involved in accidents has been termed as **"accident proneness".**

Statistical analysis in several cases has also proved that **accident proneness is a fact.** As early as 1919 Greenwood & Woods[3] and Newbold[5] (1926) studied the accident records in industry and made statistical analysis of the data. They found that even when exposure to risk was more or less constant, the occurrence of accidents was not a matter of chance, and it occurred more to certain specific persons and less to the rest. The nature of these findings indicated that, apart from exposure to risk, various personal factors also contributed to its incidence.

From a study based on the data of accidents among the clients of an insurance company, Marbe[6] also found that accident proneness existed and he questioned the wisdom of the prevailing system where premium rates were fixed on the basis of the risk involved. He advocated that the factor of accident proneness should also be taken into consideration for this purpose. However, it should be noted that this tendency is something that is not constant in the individual[4]; it fluctuates with the change in the individual's relation with the environment. For example, hurry, excitement, or any situation which introduces anger or fear are likely to make one more prone to get involved in accidents. Here too, there are individual differences with respect to the degree of environmental change that can produce perceptible change in this direction. Brody[1] describes an accident-prone person in terms of behavioural syndromes and the main symptoms are less personal restraint, aggression, emotional instability, insecurity. According to him he should not be considered just a person involved in accident but the true fact is that he happens to be a maladjusted individual and **involvement in accident is just a symptom of that maladjustment.**

There are methods for spotting out whether accident-prone people are present in a group of workers or not. Newbold[5] has prepared a table from which a rough indication can be obtained from the accident records of a department whether accidents are due to the presence of persons in the group who are accident-prone or whether it is due to some special risk in the department.



Farmer and Chambers[1] were pioneers in the field of measuring some of the qualities by means of psychological tests which were available at that time. These personal qualities are present in the individual in varying degrees and different patterns of their combinations are observable. A closer examination of the jobs shows that the jobs too admit wide variation with respect to the degree of risk involved and also with respect to the particular pattern of these qualities which make a man more liable to accident in that situation. Hence, it is quite logical that **an individual with a particular combination of these personal qualities may be an accident liability in a particular type of job but this very man may be less susceptible to danger in another type of job where the nature of the risk involved is somewhat different.** So it appears that the detection of these qualities in the individual and measurement of their intensity for determining the degree of chronic accident proneness of the individual worker for various types of jobs are most important. Under such circumstances, **the incidence of accidents can be reduced by proper placement in industry and intelligent personal guidance with respect to social and home adjustment.** Hence there is the need, first to spot out those who are habitually susceptible to accident in particular situations and then transfer them to other positions where their particular type of accident proneness does not pose such a serious problem. This should be done as an additional precaution against the incidence of accidents.

Chambers[1] had studied the relationships between accident incidence and other variables like age, length of experience, sickness reporting etc. When the time lost due to reported sickness was compared with the incidence of accidents, no relationship was found to exist but at the same time it is interesting to note that **individuals with several accidents reported sick more often than others.** Another observation which is worth mentioning is that the occurrence of accidents was highest during the first year of exposure to risk. Temperature in the place of work was also found to be an important factor. They observed that when the range of temperature lay between 13°C to 18°C*, the rate of accident incidence was at its lowest and both higher and lower temperatures tended to increase it. It should, however, be remembered in this connection that these studies were based on data collected under conditions different from those of India. Hence, what would be the ideal range of temperature at the place of work in our country is a question yet to be determined through research.

In a study by Farmer & Chambers[1] which was terminated by the outbreak of the Second World War, a large number of tests was used for determining measurable individual qualities, related to accident proneness. The tests were classified under several headings like Sensory-Motor, Intelligence, Mechanical

*Assuming the average to be around 15°C (59°F) the temperature factor would naturally contribute, other things remaining the same, to a higher accident rate in tropical as compared to temperate zones.

—**Editor**

Aptitude, Nervous Stability, etc. It is significant that for those who fell in the lowest 25% on the basis of the combined weighted score on the intelligence and sensory-motor tests, the incidence of accidents was 2.5 times greater than that for the rest of the group. Nervous instability as measured through the psycho-galvanic reflex was also found to be positively related to accident proneness. Similar was the finding with respect to the scores on the tremor test.

When test scores and job performance were compared, it was found that the correlation was 39. It indicates that **those very tests which pick out the persons who are least accident-prone also pick out those who are most proficient in their jobs. It is quite possible that poor job training or inability to profit from job training on account of lack of aptitude, etc., is a contributory factor in the incidence of accidents.** The magnitude of the correlation reported indicates that this approach is promising, but either the measuring instrument or the composition of the test batteries needs some further improvement, and that calls for painstaking research work. The correlation coefficients between the scores on the psychological tests and accident rates obtained from this study and from the results of other studies prove that **there are factors other than intelligence and aestheto-kinetic coordination which cause accidents.** Accident proneness or individual's susceptibility to accidents is related to many other factors, each of which needs considerable investigation. It is unfortunate that the remaining phases of this study could not be completed due to the outbreak of the Second World War.

From what has been said above it seems that poor intelligence, poor motor co-ordination, emotional instability, other personality factors and even a temporary change in attitude attributable to social and other environmental stresses are responsible for incidence of accidents. It is no doubt true that by measuring these personal qualities and then by transferring the persons who are prone to certain types of accidents to other types of work, the incidence of accidents can be reduced to a great extent.

It is also necessary that accurate statistics relating to the incidence of accidents be available, as such information is very essential in planning accident prevention activities and also in assessing the effectiveness of such measures. Statistics of accidents should be maintained in such a way that one can compare the accident rates from industry to industry from year to year, and from region to region. If the frequency rates of accidents in different types of industry are to be compared, the number of accidents must be studied in relation to the number of hours exposed to the risk.

It is worthwhile reiterating that further research in this direction is necessary for improving the measuring tools, for determining other psychophysical qualities and for detecting problems of adjustment of the worker that might be contributing their share towards the incidence of accidents.

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Worker Behaviour and Accident Occurence†

Menon A Sreekumar*

As India is passing rapidly from the traditional agricultural economy to an industrial economy, care needs to be taken to prevent needless suffering consequent on the induction of large masses of rural folks into the hard discipline of factory life. We have the historical record of the Industrial Revolution in which, due to sheer ignorance, man became a sort of fodder for the machine. India can profit by this experience and take timely steps to see that the real cost of industrialisation is not higher than it need be. In this context, the author has taken pains to go over the results of scientific studies in the complex field of Worker Behaviour and Accident Occurence in Factories: complex because men and machines interact in an atmosphere of strain and noise. Alongside a certain overriding discipline and mechanics, characteristic of factory life, a number of disciplines come simultaneously into operation.

INTER-DISCIPLINARY APPRCACH TO THE understanding of industrial problems followed in industries, technological institutes and other specialised institutions in India has covered large areas involving problems of employee training, supervision, employee counsel, labour-management relations and so on. However, the area of industrial accidents has hardly attracted serious attention of researchers.[1] Contrary to this, studies on human aspects of industrial accidents are abundant among those conducted abroad. In view of substantial financial and human costs[2] involved, we ought to break new ground in the line.

ACCIDENT ANALYSIS

Accidents reflect a disharmony between the worker and his work environment. In this context, the following categorisation of accidents has been worked out by the National Safety Council.[3]

†Research Officer at Shri Ram Centre for Industrial Relations, New Delhi and Editor, Psychology Annual.

1. See numbered Footnotes under References

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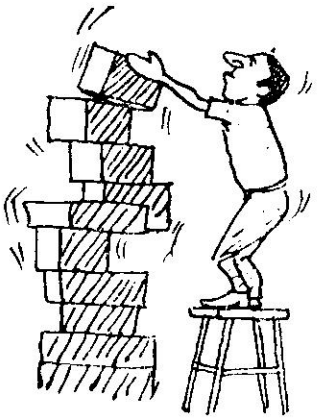

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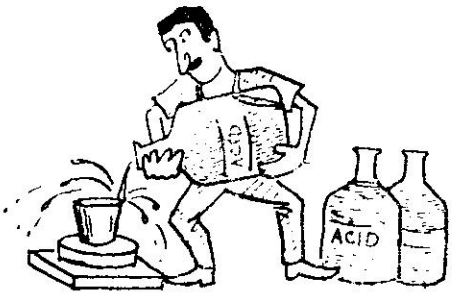

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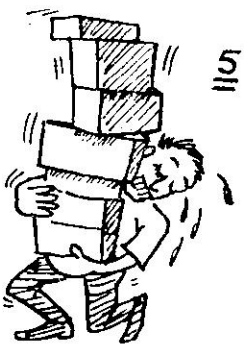

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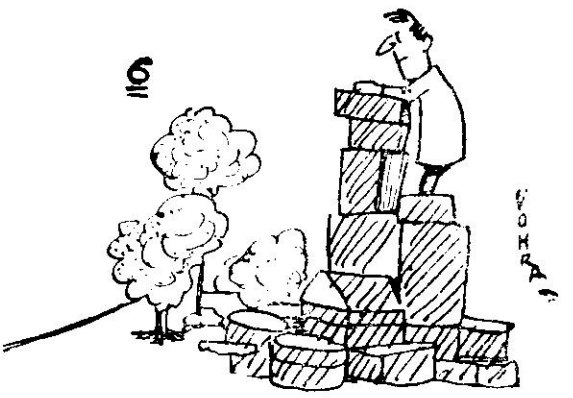
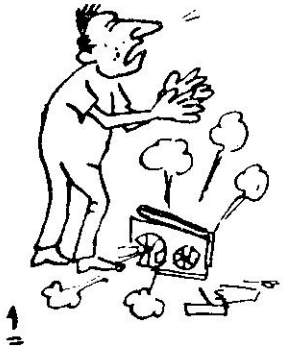


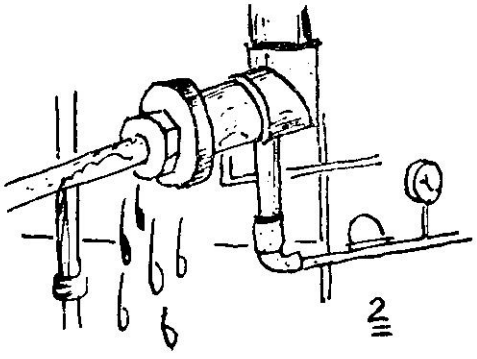
6

FAULTY ENVIRONMENT

1. Hazardous Arrangement

(1) Congested work-place
(2) Unsafe piling and storage
(3) Inadequate aisles and exits
(4) Unsafe processes
(5) Overloading
(6) No safe access to remote or high places





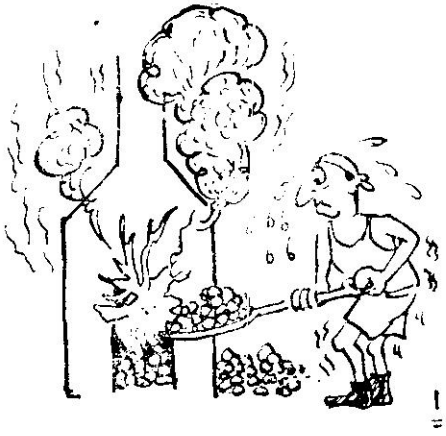
2. Unsafe Material and Equipment

(1) Poorly designed and constructed materials
(2) Weakening of parts by rust, corrosion and decay
(3) Rough and sharp-edged materials
(4) Low material strength (floors, hoisting materials etc.)
(5) Inherently slippery materials

3. Illumination

(1) and (2) Insufficient light

(3) and (4) Unsuitable location of light sources



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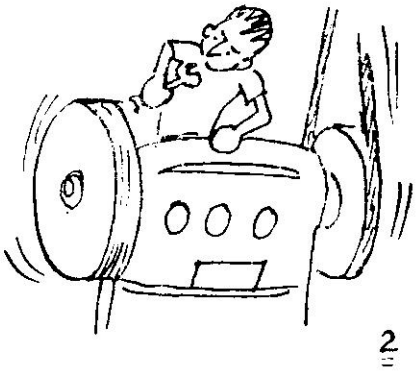

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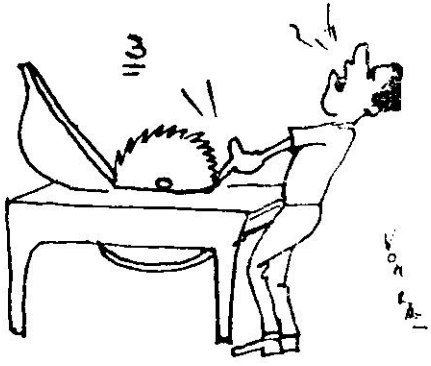

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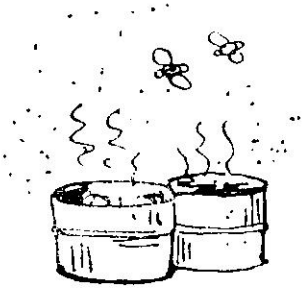

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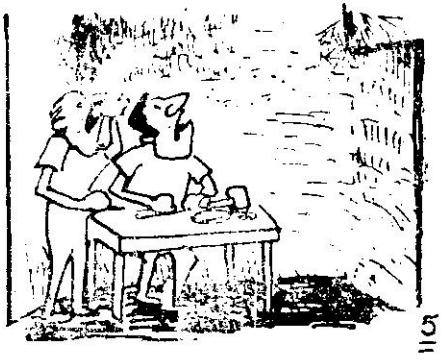

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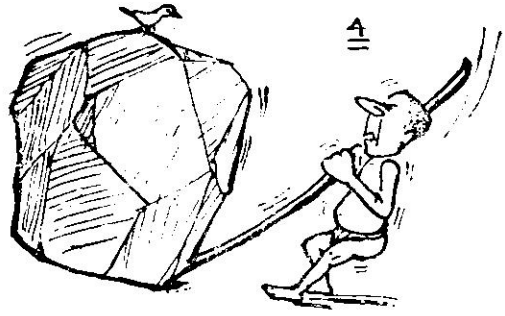
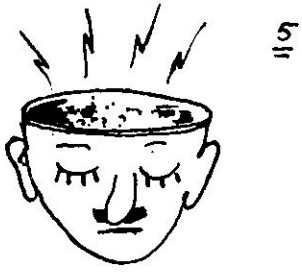
4. Ventilation

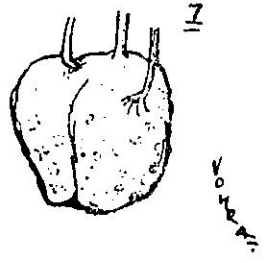
(1) Excessive heat
(4) Contamination by process
(5) Impure air source
(6) Insufficient air charge

5. Moving Machinery

(2) Inadequately guarded
(3) Unguarded



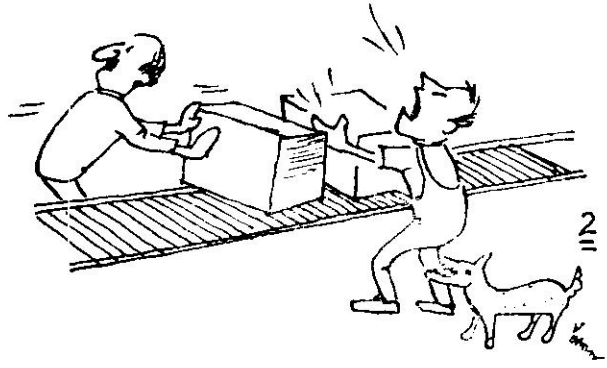




HUMAN ELEMENT

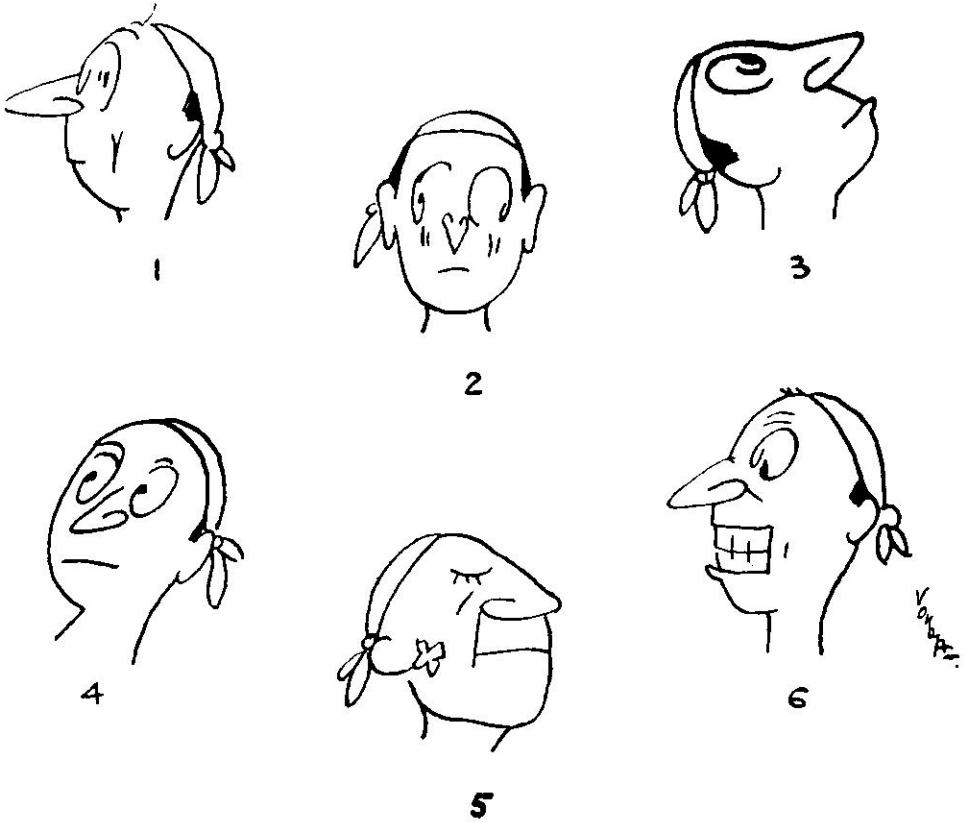
1. Physical and Mental Characteristics

(1) Poor eyesight
(2) Lack of co-ordination
(3) Defective hearing
(4) Muscular weakness
(5) Slow mental reaction
(6) Nervousness and emotional instability
(7) Heart, circulatory and other organic weakness



2. Knowledge and Skill

(1) Ignorance of correct methods
(2) Faulty work habits
(3) Insufficient experience



3. Attitudes

(1) Indifference
(2) Inattention
(3) Indolence
(4) Arrogance
(5) Recklessness
(6) Hostility

Heinrich[4] (1931) estimated that *around 98 per cent of accidents are preventable.* Of them around 90 per cent involve personal or psychological factors such as faulty inspection, inability of the employees, poor discipline, lack of concentration, unsafe practices and mental and physical unfitness for the job. The importance of personal factors in causing industrial accidents became first evident in the study of Stephenson.[5] He pointed out that 90 per cent of accidents were atrributable to failures on the part of human subjects involved in operations. While there may be difference of opinion regarding the relative importance of the personal and non-personal factors, the general consensus on the issue of accident analysis, as pointed out by Dean Keefer,[6] centres around the consideration of both man and machine. Though it is difficult to establish precisely the nature of interactions between human and environmental variables in the causation of industrial accidents, as pointed out by Richard Pollini,[7] an attempt along the lines would be rewarding. In the early stages of the safety movement, the operation of human element was met with by resorting to personal

appeals to employees for cooperation in the promotion of safety and educating them on the importance of safety and techniques of promotion. Such a practice was obviously based on the assumpion that so far as the employees are concerned "carelessness" was the chief cause of mishap. The inadequacy of such a view as pointed out by Bossard[8] becomes apparent when the need for the examination of "more enduring" physical and mental factors is realised.

The approaches to the problem of safety which gained popularity from the 19th century onwards were statistical and experimental (psychometrical) in the form of examining a widely known condition called "accident proneness". Accident proneness implies some personal traits, as opposed to some characteristic of the environment, which pre-dispose some to have more accidents than others in work conditions where the work hazard is equal to all. Accident proneness is essentially the result of the individual's maladjustment to the environment. This personalised phenomenon of accident proneness is considered as a permanent tendency within the organism to engage in unsafe behaviour. This would imply as pointed by Arbous[9] that *accident-proneness is a stable and invariable attribute of the individual, to be considered in much the same way as we regard his general ability, mantal ability etc.*

The generally adopted view of this cryptic phenomenon of accident proneness facilitates quantitative research. Following the view that accident-proneness is the proneness to make inappropriate reactions and susceptibility to accidents as a stable and individual phenomenon, an attempt was made to assess individual (psychological and sensory-motor) qualities by using psychological tests. This method enables the identification of specific factors which determine accident-repeating tendency. The need, in other words, tends to be to determine the measurable aspects in which accident-repeating employees differ from accident-free ones.

The major interest in the four studies reported in this paper is to examine whether the following sensory and psychological factors are related to accidents incurred by factory workers.

1. **Static Visual Acuity (S.V.A.)**
2. **Temperamental characteristics in terms of Cyclothymia — Schizothymia in relation to occupational situation**
3. **Personal adjustments in the areas of**
   (a) Family
   (b) Emotional
   (c) Social
   (d) Mood, and
   (e) Reality aspects
4. **Job satisfaction**

Hypotheses

(1) Personality susceptibility to accidents is functionally related to the degree of visual acuity of employees.

(2) (a) Among employees who do repetitive type of work, those who are having cyclothymic as well as mixed characteristics are more susceptible to industrial accidents than those who have schizothymic temperament.

(b) Among employees who do varied type of work, those who have schizothymic temperamental characteristics are more susceptible to accidents than those who have cyclothymic and mixed temperamental characteristics.

(3) Individual differences in the susceptibility to accidents are related to the degree of (a) adaptability revealed by employees in family situations. (b) emotional adjustability (c) accidents are related to the degree of social adjustment. (d) Individual differences in the susceptibility to accidents are correlated with the degree of mood adjustment.

Hypotheses were framed in order to test the validity of these factors. A large fertiliser factory employing 4000 workers was chosen. Accidents record, for the period from 1-3-1954 to 28-2-1964 were worked into. Two samples were drawn from the whole working population. The first sample consisted of 672 operators who were involved in repeated accidents ranging from 2-7. The second sample consisted of 300 employees who were free from accidents during the same period.

The members of the first core sample varied in their age with a mean of 42.62 years. In

job experience, they had a mean of 15.39 years, and in economic condition, a mean of 210 rupees per mensem.

Similarly, the employees in the second core sample varied in their age with a mean of 42.5 years, in job experience with a mean of 15.21 years, and in economic condition with a mean of 180.48 rupees per mensem. Application of 't' test revealed that the two samples were homogeneous.

EXPERIMENT I

VISUAL ACUITY

This pertains to verification of the relationship between visual skill and acident involvements.

The subjects of this experiment belonged to two groups—Accident-involving and Accident-free. Subjects of Accident-involving group were drawn from the first core sample and those belonging to accident-free group were chosen from the second sample. These two groups were found to be homogeneous with regard to bio-social variables of age, experience and economic condition, as the 't' ratios for the differences between the two groups in these factors were far from significant at 0.05 level.

Apparatus and Method Used

Snellen lettered wall chart was used to measure keenness of vision. The opthalmic chart was exposed under conditions of illumination with 30 volts. Judgment regarding subject's ability to read letters from a distance of 20 feet from the chart was taken down under conditions of right eye vision (R.E.V.), left eye vision (L.E.V.) and binocular vision (B.V.). The performance was scored in accordance with Snellen notations. Statistical method: Mean differences were tested by computing critical ratios.

EXPERIMENT II

TEMPERAMENTAL CHARACTERISTICS

Experiment II was conducted to probe into the relation between the job situation and the temperamental characteristics.

360 employees involved in repeated accidents were drawn from the first core sample. Half the number of employees were found to be engaged in repetitive type of jobs and the other half were engaged in varied kinds of jobs. The employees who were on repetitive jobs were grouped into those belonging to high accident group, and those belonging to low accident group. Similarly, the employees who were on varied jobs were also classified. The criterion for classifying employees into high accident employees and low accident ones were the median number of accidents. Those involved in a number of accidents, equal to or less than median number of accidents were grouped into Low Accident category and those involved in a number of accidents greater than the median number were brought under High Accident category. The two sets of high and low accident groups with reference to two types of job situations were found to be homogeneous regarding bio-social variables of age, experience and economic condition, as the 't' ratios were not significant at 0.05 level of confidence.

Method

Cyclothymia—Schizothymia Questionnaire (C.S.Q.) (developed by Krishnan,[10] 1947) was made use of. The individuals were classified into three temperament groups, viz., (i) Cyclothymes (ii) Schizothymes, and (iii) Mixed, according to the norms provided in the manual.

Statistical method (Chisquare test) was used in testing the variation in frequencies.

EXPERIMENT III

PERSONALITY ADJUSTMENTS

(Family, Emotional, Social, Mood and Reality)

Two samples of workers were drawn from the first core sample, consisting of accident-repeating workers. The first sample, called High-Accident group, consisted of 65 employees and the second sample called Low-Accident group consisted of 45 employees. Employees who figured in accidents greater than those shared by the group were included in the first

sample and those who figured in accidents less than or equal to the average number of accidents shared by the group were included in the second group.

Phychological Test and Methd wed

The Malayalam version of Mysore Personality Inventory (Standardised by Krishnan[11]) was made use of. The use of this inventory helped to assess the adjustment levels of the workers in the five areas of family, emotional, social, mood and reality. Scoring was done in terms of maladjustment categories. For the purpose of comparison, standard scores with mean 50 and standard deviation 10 were used.

Statistical Method : Mann Whitney U (12, 13) test was employed.

EXPERIMENT IV

FOR SATISFACTION RELATED TO SAFETY-MINDEDNESS

The same set of samples as for Personality Adjustments was used.

Statistical Test : Mann Whitney U (12, 13) test was used.

RESULTS AND INTERPRETATION

Experiment No. 1 On Visual Acuity

TABLE I

Visual performance scores of operatives with 't' ratios

Accident Involving Group			Accident Free Group	't' ratios
R. EV.	Mean	50.00	51.34	1. 01 N.S.
	S.D.	4.68	9.99	
L.EV	Mean	50.30	49.91	0. 25 N.S.
	S.D.	8.42	9.91	
B.V.	Mean	50.14	50.15	6.001 N.S.
	S.D.	10.01	9 26	

Table I shows that accident-involving group yields a mean visual index of 50 with right eye vision, 50.30 with left eye vision and 50.14 with binocular vision. On the contrary accident-free group yields a mean visual index of 51.34 with right eye vision, 49.91 with left eye vision and 50.15 with binocular vision. Right eye vision and binocular vision indicate a slight superiority of accident-free employees over accident-involving ones on visual skill. But with regard to left-eye vision, accident-involving group would seem to excel accident free employees which may appear to be contrary to normal expectations. Judgment of such differences on the basis of 't' ratios would show that the differences observed between the two groups on visual skills are due to chance. As such, it may be pointed out that the findings of the present experiment do not lend evidence to support the contention that the employees were involved in accident due to deficiency in visual skill. In view of these findings the hypothesis formulated stands rejected. However a note of caution may be added in judging the findings obtained in this study. It may be hoped that the use of more sensitive visual apparatuses like orthoraters, tele-binoculars etc., would probably bring out better results. The truth in this statement can be realised from the studies of Burg[14] who could detect accident potentials of motor coach operators by making use of Dynamic Visual Acuity Test.

Although the present study on visual acuity does not lend support to positive relation between visual skill and personal safety, it encourages further exploration of this area.

Experiment II on Temperamental Characteristics

TABLE II

Distribution of employees having different temperamental characteristics among high accident and low accident groups in repetitive jobs.

N=180

		Cyclo-thyms	Mixed	Schizo-thyms	Total
High-Accident Group	F	32	30	28	90
	P	35.55	33.33	31.12	100
Low-Accident-Group	F	19	31	41	90
	P	21.11	34.44	44.45	100

F = Frequency
P = Percent

Chisquare = 5.4476/0.01

TABLE III

Distribution of employees having different temperamental characteristics among high-accident and low-accident groups in varied jobs.

N = 180

		Cyclo-thyms	Mixed	Schizo-thyms	Total
High-Accident Group	F	29	22	39	90
	P	32.22	24.44	43.44	100
Low-Accident Group	F	41	27	22	90
	P	45.55	30.03	24.42	100

F = Frequency P = Percent

Chisquare = 7.3048 $<$ 0.01.

Tables II and III summarise the distribution of employees having cyclothymic, mixed and schizothymic temperaments among High and Low accident groups engaged in repetitive and varied kinds of jobs. The examination of frequency with which employees having different affective predispositions involved in high as well as low rate of accidents, while they are in repetitive type of work, indicates that the workers having cyclothymic and mixed temperaments are more susceptible to accidents than those having schizothymic temperament. On the contrary, in the case of those in varied type of work, operators having schizothymic temperament have been found to be more prone to accidents when compared to those having cyclothymic and mixed temperaments. The finding that cyclothymics are more susceptible to industrial accidents in repetitive jobs may resemble the Eysenekian[15] finding that extroverts are more liable to sustain accidents. Similarly the findings that schizothymics are more liable to accidents in work conditions of varied type may again resemble Kundu's[16] finding that introverts are more liable to accident involvement. However, the findings seem to be encouraging. They bring out the role of personality characteristics in relation to different occupational situations in the causation of accidents. It is quite possible that this information can be utilised in helping better placement of workers in different workshops depending upon their personality characteristics and the nature of workshop requirements.

EXPERIMENT III

ON PERSONALITY ADJUSTMENTS

TABLE IV

Results of Mann Whitney U Test Analysis

Area of Adjustment	Family	Emotional	Social	Mood	Reality
The distribution from which V Value is derived	R_2	R_2	R	R_2	R_1
Z values	0.12642	0.34958	—16123	—0.05472	0.44990
Probability values	0.4483	0.3632	0.1230	0.41801	0.33

R_1 referes to distribution yielded by Low-Accident Group

R_2 refers to distribution yielded by High-Accident Group

Examination of the results incorporated in Table IV reveals that the high-accident group is not inferior to low-accident group in the matter of family, emotional, social, mood and reality adjustments. Z values pertaining to all the five areas yield probability values, all of which are greater than 0.01. As such it is to be inferred that the differences shown

between the groups could have happened due to chance. An attempt to interpret the status of the two groups may apparently show that only in the case of social and mood adjustment the low-accident group is better than the high-accident group and in other areas the low-accident group stands excelled by the high-accident group. But such conclusions of superiority cannot be made and it may be stated that the use of Mann Whitney test lends support to the view that the two groups cannot be differentiated on the basis of personality characteristics of adjustments.

EXPERIMENT IV
JOB SATISFACTION RELATED TO SAFETY-MINDEDNESS

TABLE V

Comparison of Low-accident group and High-accident group on job satisfaction through analysis by using Mann Whitney U Test

Average rank related to distribution of job satisfaction among L.A.G. (R_1)	46.44
Average rank related to distribution of job satisfaction among H.A.G. (R_2)	61.77
The distribution from which U value is derived	R2
Z Value	—2.48
Probability Value	0 0066

The examination of results in Table V in terms of average rank scores shows that the Low-accident group is superior to the High-accident group on Job satisfaction because the mean rank score of the former group is almost one and a half times less than that of the latter group. The characteristic nature of U Value (derived from distribution R_2) as well as Z value indicate that the degree of job satisfaction is higher in the Low-accident group than in the High-accident group. Reference to the table of probability values associated with value as extreme as observed value shows that $Z \pm 2.42$ has one tailed probability under hypothesis of $P < 0.0066$. Since this P value is smaller than 0.01, it may be inferred that the obtained difference in the degree of job satisfaction between Low-accident and High-accident groups is beyond what could have been expected on the basis of chance. Thus the finding born out of this experiment supports the hypothesis formulated.

Conclusions

The following conclusions may be arrived at regarding "worker behaviour and accident occurrence":

1. Visual skill is not related to workers' susceptibility to accidents.
2. Personal safety is determined by the interaction of temperamental characteristics and the job situation.
3. Family, emotional, social, mood and reality adjustments of the workers are not related to their liability to accidents.
4. Job satisfaction is related to personal safety. In other words, susceptibility to accidents was found to be decreasing, corresponding to increase in satisfaction on the job.

The facts that accident susceptibility is determined both by the temperamental characteristics of the workers and the job requirements as well as job satisfaction bear much practical implications, as these characteristics could be made use of in detecting who would be more susceptible to accidents under certain specific work conditions. Accordingly it is suggested that further work along these lines may be undertaken profitably.

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Public Sector in UK

British Road to Socialism

The Select Committee on Nationalised Industries has now produced, for the first time, a critical examination of how the public sector works, together with some fundamental suggestions for improvement . . . . .

One principal reason why the public sector has failed to expand is that it is a collection of semi-autonomous corproations, sponsored, to use the official jargon, by different ministers. Thus, no single minister, even under Labour, has felt a primary, personal responsibility for the well-being and future of the public sector as a whole. Equally, no one minister has been entrusted with the overall task of ensuring their efficiency; on the contrary, this efficiency has frequently been impeded by ministerial conflicts between different sponsors. The Committee's chief recommendation goes to the heart of this problem. It divides ministerial responsibility into two categories, policy-making, that is the manner in which each industry is to serve the public interest; and executive, that is the duty to ensure that these policy aims are secured with the maximum efficiency. The responsibility for policy, it says, should continue to be exercised by the appropriate government ministers (Transport, Power, etc.); but executive functions should be grouped under a single Minister of Nationalised Industries, who would appoint all the boards and supervise their execution of government directives When policy and profitability are in conflict, the cost would be borne on the estimates of the ministry laying down the policy. Thus, in one stroke, everyone's responsibilities would be clarified, the accountancy of the public sector would be placed on a permanent, rational basis, and the confusion between public-service and commercial aims removed

The beautiful simplicity of the plan has already aroused opposition from entrenched interests, notably the Treasury (Finance) and it will be attacked by all those who wish to keep the public sector as a begrimed and indigent Cinderella, forever wailing for subsidies—an ubiquitous and awful warning of the dangers of socialism. By ensuring that these industries will get expert (as opposed to amateur) ministerial guidance, by giving them opportunities to effect vast economies of scale and to make the fullest use of managerial and technological advances, the plan would release the nationalised sector from its economic ghetto. Perhaps even more important in the long run, the creation of a single ministry, to provide the techniques, presided over by a powerful minister, to provide the leadership, would transform the sector from a static to a dynamic element in the economy. Ultimately, it will not only cease to be a drain on the Exchequer but will become a prime source of revenue to finance the social services.

—Leading Article in the *New Statesmen*, 13 Sept '68

Accidents and Anxiety Among Factory Workers

AK Prasad & Sushil Jha

In the industrial world of today, high efficiency machines and techniques have created problems of which accidents and the associated anxiety among workers have proved most intractable. The United States Department of Labour estimated that even in the immediate post-war period — more than two decades ago — the financial cost of industrial accidents worked out to $3.5 billion, that is nearly half the entire budget of the Government of India at current prices. In terms of personal tragedy the real cost is incalculable, for even twenty years ago, when the US economy was much less sophisticated, nearly 2 million workers were injured in accidents, several thousands fatally. In the poor countries of Asia and Africa, there is, of course, no count*; but the problem is serious enough. It has, therefore, rightly attracted the attention of social psychologists, industrial and labour experts.

THE TERM 'ACCIDENT' HAS BEEN DFFINED BY laymen as "an event that takes place without foresight or expectation and results in some type of personal injury or damage to equipment or property." This meaning restricts the connotation to industrial situations. Encyclopedia Britannica (Chapter 3) refers to industrial accidents as 'industrial injuries' and includes all injuries to workers which arise in the course of and out of their employment. The term 'injury' includes injuries caused by accidents as well as those brought by exposure to poisonous chemical or other harmful substances.

Framer and Chambers[4] for the purpose of their study defined accident as "an attendance at the factory surgery for reasons other than sickness or redressing as a result of an injury incurred in the plant." These definitions, however, suffer from certain limitations as they involve an indication of causative factors operating at the moment of accident.

A more comprehensive definition has been suggested by HW Heinrich who considers accident as "an event in which the contact of a person with an object, substance, other persons or conditions or the movement of a person causes personal injury or suggests probability of such injury." The injury is

*Several years ago, when HG Wells visited East Bengal, he wrote, seeing the pathetic conditions of the people : ". . . Bars and bolts cost money ; men cost nothing. . . ." That was the situation even in England at the time of the Industrial Revolution, as late as the second half of the 19th Century. When the great economist, Prof. Alfred Marshall was asked why he called British Factory Legislation a disgrace, he replied that even the elementary safeguards for safety of the very life of the workers had to be enforced by Acts of Parliament—**Editor.**

invariably caused by an accident and the accident in turn is always the result of the factors immediately preceding it. The five factors in sequence are: *social, environmental, fault of person, unsafe act, mechanical hazard.*"

As a matter of fact, an accident is caused by so many factors which may be broadly classified under two sections: (i) impersonal causes including atmospheric conditions, illumination, day *vs.* night shift, severity of work, length of work period and rate of production, (ii) personal causes consisting of salary, promotion, age and experience, length of service, educational level, health, physique, and psychological factors involving interest, intelligence, aptitude and personality factors. These two factors interact upon each other and lead to the unfortunate effect called "accident".

Various investigations have been conducted by psychologists working in the field of industrial psychology and social sciences : Marbe (1923), Hildebrandt (1926), Newbold (1926), Minzand Blum (1949), Tiffin, Parker and Harbersat (1949), Maffic and Alexander (1953), Kalla (1953), Kundu (1957), etc., etc. Of the studies, those conducted by Greenwood and Woods (1919), Kalla (1953), Larson (1955), Mclean (1956), Lavinson (1957), Davids (1957) and Kundu, are worthy of note.

Greenwood and Woods formulated three hypotheses :

The first hypothesis assumes that positions on accident frequency scale held by the workers are determined by pure chance and thus distributed among them according to normal curve.

The second hypothesis assumes that in the beginning of any type of work all people are equally liable to accident, but anyone who has had an accident becomes psychologically more susceptible to further accidents than others, because occurrence of one predisposes him to further accidents.

The third hypothesis is based on the distribution of unequal liability, assuming that not all people start on an equal basis: some are inherently more liable to accident than others.

In order to test the foregoing hypotheses, workers were divided into three groups. The first group consisted of workers with no accident record. The second group was 'one accident' group and the third 'multiple accident' group.

The second and the third hypotheses fitted the actual occurrence of accidents much better than did the hypothesis of simple chance distribution.

The relationship of human factors to the causes of Industrial accidents was analysed by Larson at New York University (1955). He concluded that majority of pre-employment procedures through tests, job history, biographical data revealed poor adjustment or personality defects.

A simple research by Alan Mclean (1956) on accident and the human factor revealed that *accidents occur to impulsive and irresponsible people, who have a strong resentment towards people in authority.* Age and temporary emotional stresses are important factors in accidents.

A very interesting study was done by Harry Lavinson (1957) under the topic of "the illogical logic of accident prevention." The study indicates that human reasons for accidents appear illogical only if we try to understand them from the point of view of conscious or systematic thinking. In fact the study aimed at probing the unconscious mind.

An investigation by Vibert[9] suggests that the most frequently mentioned causes of accidents given by working men fell into two categories—"personal causes" such as carelessness of the workers, and "inadeuquate protection from machinery". Correlations show that workers who are satisfied with their jobs are more inclined to attribute the accidents to personal causes; while dissatisfied workers mention "non-personal" causes, involving the responsibility of the company.

Kundu[5] classified workers according to three personality traits: *extrovert, introvert* and *ambivert,* and found there was no marked

difference among them in respect of accidents except that introverts were involved in accidents a little oftener than extroverts or ambiverts.

Hardly any study showed a clear-cut relationship between accident and anxiety: a factor to be inferred from the above studies. Believing that the factor is yet missing, the authors decided to explore it. A study was undertaken to find out :

(1) Whether or not there exists a valid relation between accident and anxiety.

(2) Whether or not there exists a valid relation between accident and wages.

(3) Whether or not there exists a valid relation between accident and length of service.

Measuring Anxiety

For measuring anxiety, a scale consisting of 70 questions (in Hindi) relating to different aspects of anxiety was prepared and given to expert judges to point out the items suitable for measuring anxiey. Items regarding which there was complete agreement among the judges were selected, and the rest excluded. In this way the original scale was reduced to 50 items. In order to find out the reliability of the scale, it was applied in respect of 50 workers selected at random during the test situation; and after a lapse of 16 days it was again applied to them. The collected data was then correlated, giving the value of 0.8 which is significant beyond 0.1 level of confidence. To find out the validity of the scale it was correlated with the scores obtained by Taylor's manifest anxiety scale. The value was .67 which was significant beyond 0.01 level of confidence.

Sampling

Two types of groups were selected—accident group and non-accident group. The criteria of selection of the accident group was that 80 such workers committed one or more accidents during a specified period. For the non-accident group 60 such workers were selected who were not involved in a single accident during the same period. The sample was usually representative of the whole population, being drawn from a larger sample in a random way.

Administration

The scale was administered individually on each subject constituting the sample which consisted of 140 workers altogether. A *rapport* was established with workers to gain full cooperation. The investigators explained that the study was purely academic and their responses would be treated as strictly confidential. The items of anxiety scale had to be answered either in 'Yes' or 'No.' The workers were convinced that there were no right and wrong answers; rather it was a matter of opinion differing from person to person; hence there was no cause for feeling, if some persons gave differing answers to the various items.

The investigators had to read the inventory to the workers and mark their responses themselves. In no case were they allowed to assign their responses themselves because most of them were not so educated as to be able to understand the inventory by reading it themselves and answering correctly. In order to maintain uniformity the answers to the questions were marked by the investigators themselves.

In measuring anxiety 'I' score was given for the item indicative of *anxiety* and 'O' for the item indicative of '*no anxiety*'. The trigonometrical ratio (t) between accident and non-accident groups in respect of the scores of anxiety, wages and length of service, was calculated, and tabulated (See Table I).

Table I shows that the mean anxiety value of accident group is 27.05 and the mean anxiety value of the non-accident group is 25.60. The difference of 1.45 reveals that workers who suffered from anxiety were involved in accident more than those who did not so suffer. But since it is statistically insignificant at .05 level it may be said that the indication of the difference between them is due to chance. The table further shows the mean wages values of those two groups as 221.00 and 198.75. The 't' ratio is 1.56 which is insignificant at .05 level. Thus the difference

TABLE I

Variables	Groups	Number	Mean Value	SD	DFL	t	Significant Level
Anxiety	AG†	80	27.05	10.05	138		insignificant at .05 level
	NAG*	60	25.60	11.95			
Wages	AG	80	221.00	97.00	138	1.56	insignificant at .05 level
	NAG	60	198.75	67.75			
Length of Service	AG	80	17.74	9.76	138	1.15	insignificant at .05 level
	NAG	60	19.62	9.16			

of 22.25 in the mean wage values may also be due to chance. The 't' ratio between the length of service of workers in accident and non-accident groups is 1.15 which too is not significant, indicating that the difference of 1.88 between the mean values for the two groups is not significant.

Table II shows that the mean accident values of high and low anxiety groups are 24.90 and 20.5 respectively. This indicates highly anxious persons involved more in accident than the low anxious subjects. But the 't' ratio between the two means is 1.43, which is insignificant at .05 level. This indicates that the difference of 4.40 is not significant. Table II also shows that the 't' ratio between high and low wage groups of accident scores is .08 which is not significant at .05 level. Thus the difference of 2.00 between the mean values of those two groups is not statistically significant. The means of accident scores of longer and shorter length of service are 14.74 and 14.78 respectively. The 't' ratio is .02 which is not significant at .05 level, showing that the difference of .04 between them is also not significant.

TABLE II

't' ratio between the accident scores in high and low anxiety, wages and length of service groups

Variables	Groups	N	M	SD	DFL	't'	Significant Level
Anxiety	H.A.G.[1]	50	24.80	15.65	78	1.43	insignificant at .05 level.
	L.A.G.[2]	30	20.5	13.25			
Wages	H.A.G.	50	259.50	114.50	78	.08	insignificant at .05 level
	L.A.G.	30	261.50	109.50			
Length of Service	H.A.G.	52	14.74	7.24	78	.02	insignificant at .05 level
	L.A.G.	28	14.78	8.16			

†Accident Group
*Non-Accident Group
[1]H.A.G — High Anxiety Group
[2]L.A.G. — Low Anxiety Group

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Quality and Manufacturing Cost

KS Narasimhan*

In the wake of the keen competition now experienced for sale of products, both for internal consumption and for exports, the urgent need of the hour is to find ways and means of manufacturing quality products at competitive costs. This throws a challenge for industries to utilise to the utmost applied research and to strive for successful employment of all techniques of cost reduction. The author claims to provide a positive approach, based on his personal experience at the Institute for Management Science, Delft, Holland.

QUALITY IS UNDERSTOOD BY DIFFERENT persons in different ways: A researcher views it as a limit of technical possibility and a designer as a product meeting all its functional requirements. A salesman judges it by external appearance. A serviceman views it as a product with few failures and disturbances and few complaints from customers; and "the King Customer" views it as a product which is dependable, of good design and particularly not very expensive. Integrating these viewpoints, we may define quality as "*the measure to which the product approximates to the requirements of the Customer for whom it is made.*"

An analysis of the above definition indicates the need for consideration of the following aspects:

(i) ***Functional Aspect:*** This aspect is determined by the use that is made of the product

—good functioning — long life
—little maintenance — safety
—good design

The functional requirements are laid down by the Customer. The sales department records these requirements (market research) and informs the management.

(ii) ***Manufacturing Aspect:*** This aspect is determined by the functional requirements which are translated into instructions to the workshops, drawing office, etc.

Criteria:

—tolerance — humidity
—surface finish — specifications of materials
—heat treatment

The design department, in cooperation with the sales department, has to find a compromise (what are the requirements of the Customer? —what does the Customer want to pay?—what is the market for the product?).

This is an economic problem and it centres on the three factors stated as follows :

(a) *Quality level:* The measure to which the compromise approximates to the requirements to the Customer.

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(b) *Quality of Design :* The measure to which the design approximates to the quality level (it depends on the skill).

(c) *Manufacturing Quality :* The measures to which the product approximates to the design.

Thus quality is the product of the above three factors.

(iii) **Cost Aspect :**

This aspect is determined by commercial value.

Criteria :

—choice of quality standard

—ability of the Customer to buy the product

How to Reduce Manufacturing Cost

Having defined quality and having analysed the aspects and factors that need consideration in defining quality, it is possible to indicate the factors of quality which are related to manufacturing cost. In the following analysis, it is pointed out how the manufacturing cost can be reduced.

(a) *By Establishing Correct Quality Level :* Fixing of finer quality levels than required for consumption involves unnecessary extra cost of manufacture.

It can be seen from Appendix 1 (a) that an increase in quality gives an increase in commercial value only up to a certain level. Above this level, there is only an increase in manufacturing cost with little increase in commercial value.

In Appendix 1 (b)—an extension of Appendix 1 (a)—it is shown clearly how the quality level 2 is the most economical. A drop to quality level 1 reduces cost of quality (manufacturing cost) by 'A' but reduces the commercial value (value of quality) by 'B' which is greater than 'A'. A rise to level 3 increases the commercial value (value of quality) by 'D' but increases the cost of quality (manufacturing cost) by 'C' which is greater than 'D'.

Appendices 1 (a) 1 (b) indicate the methods by which quality of design may be established most economically.

Closely linked with the economies of quality of design is the economics of quality of conformance. A higher quality level than what is required, involves increased cost either due to *tight quality control* or due to *loss arising out of increased defectives* (because of increased quality level).

(b) *By Establishing Correct Levels of Conformance to Prescribed Quality of Design* : After establishing the quality of design, it is essential to conform to it. In this, a balance must be struck between the cost of quality control and the loss due to defectives (rejects and rework).

Appendix 2 indicates the following :

(i) Apart from the basic or minimum manufacturing cost, additional cost is required to be incurred to conform to quality of design.

(ii) This additional cost is either due to establishment of a tight quality control to have no defectives or due to loss arising out of defectives as a result of not having any quality control.

In Appendix 2, it is indicated that the level 'Z' is the most economical level of quality control to be established and the percentage of defectives to be permitted because at this level, the total cost is the lowest.

In the above discussions, it is analysed how the total manufacturing cost is influenced by the quality level. It is also pointed out that a constant study of the market and the requirements of customers is essential, as based on this need of the customer alone, the quality level can be prescribed.

We may now deal with specific factors and try to establish a relationship between quality and manufacturing costs and locate areas where cost reduction may be achieved. The study is confined to the engineering industry where the operations were mostly carried out on universal production machines. The organi-

sation where this investigation was carried out, has well qualified staff for design, work planning and quality control.

Though the exact quantitative relationship was not known at the beginning of the study, a preliminary study was made on the hypothesis that other conditions remaining constant, an increase in quality requirements (close tolerances) would lead to an increase in manufacturing costs. Accordingly a schematic model (Appendix 4) was drawn up; and a method was developed for investigation of the problem allowing direct measurement in the course of normal production. The relationship established between quality and manufacturing cost for a particular group of work pieces is shown in Appendix 3. These preliminary investigations led to a confirmation of the hypothesis, enabling a more detailed analysis to be made. Provisional data, illustrating the quantitative relationship, were established and possibilities for improvement were found. (Possibilities leading to a decrease of the progressiveness of the total-cost curve is shown in Appendix 5).

The main study aimed at a detailed investigation of the multiple factors that influenced the problem. The relationship between tolerances and manufacturing cost was established for various (external and internal) turning and grinding operations. The tolerance usually varied between IT 5 and IT 12 for diameters of 10-180 mm. (IT—International Tolerance Standard, as established by International Standards Organisation). Larger diameters were not considered. The study was restricted to the manufacture of products made of steel of high and low alloy and cast-iron.

The sub-problems that contributed to economisation and reduction of costs, are detailed below :

(i) the influence of tolerance and special requirements (accuracy of shape and surface finish) on the production costs.

(ii) Optimisation between roughing and finishing operations (turning and grinding).

(iii) the establishment of correct metrology (length, width, thickness, etc.) in relation to the requirements for quality and for various production processes.

(iv) the influence of metrology on the accuracy of the process and the importance of the metrology for the control of the process.

(v) Assembly problems.

The improvements that are possible for cost reduction relate to various sectors of enterprise, such as design, work planning, workshop, quality control as well as assembly. For an effective solution, an overall approach is essential.

Appendix 5 indicates the cost reduction possibilities through better manufacture control in the workshop.

In Appendix 6, a schematic diagram is presented, indicating the influences of a change of quality requirements on the various cost elements, as seen by the work planning functions. This function determines the manufacturing plan from which the job instructions are derived for the workshop for assembly, for quality control, and for placement of subcontracting orders, material issue etc. The lot size is also a central factor, influencing the inter-relationship between factors that need consideration in the calculation of the production costs.

(c) *Overall Management Control of Quality and Manufacturing Costs*

During the study, a significant difference was found between the required tolerances and the actual measure of the work pieces, manufactured in the workshop. The conformity or the discrepancy between prescribed and actually manufactured tolerance can be classified according to the five types as shown in Appendix 7.

The economic disadvantages due to lack of managerial control, as indicated by a general discrepancy of prescribed and actually manufactured quality, can be classified under three

groups as follows:

(i) unnecessary high costs, caused by too stringent requirements of the design department.

(ii) non-economical manufacturing methods, due to faulty selection by the work planning department.

(iii) avoidable reject and repair costs, due to manufacturing deficiencies in the workshop.

The data on the quality-cost relationship and other findings obtained from the investigations provide the basis to the elimination, or at least reduction, of avoidable losses.

An approach to the overall control of quality and manufacturing costs in shown in Apendix 8. This control requires the co-operation of sales, design, work-planning production (including stores, workshop, quality control and assembly). Interrelationship between the various departments (and factors) do, of course, occur but are only shown in a simplified manner. The Appendix does not indicate any hierarchy, but rather the respective responsibilities in determining the general and detailed design specifications, the manufacturing plan, materials supply and the manufacture, which represents the successive steps in the completion of a product and mark the decisive points in the control of quality and costs.

Details of Study

The method and steps of actual research done in arriving at a relationship between tolerances and manufacturing cost, may now be presented.

(a) *Study Object*

Bush of a crankshaft of the "solex motor." The material of the object is a steel alloy consisting of 1.5% Cr, 0.35% Si, 0.35% Mn.

(b) *Machine Used for Manufacture of Bush* A.I. Lathe No. 783; Capacity of motor 1 H.P., Speed— 45 rpm to 1540 rpm, Feed 0.02 mm/revol. to 2.60 mm/revol.

(c) *Operation Under Study*

Turning of inner diameter of work piece. The design requirement of diameter is

—0.01

—0.04

10

(d) *Material of Cutting Tool Used*

The cutting tool is made of high-speed steel alloy, with 18% W, 4% V, 0.8% C and 5% Co.

(e) *Measuring Apparatus Used*

(i) "Solex Tolerance Apparatus"—Tampon A (indicating measuring instruments Gicleurs No : 10193).

(ii) "Go and not go" gauge.

Apparatus under (i) above is used for setting up and during cutting. Apparatus under (ii) above is used only for inspection on a random checking of 1 to 20.

Readjustments for diameter are made with the help of a watch "Stockvis" Rotterdam Joh Kafer Scheveningen A. N. —0.01 mm—made in Germany, fixed on the machine. The readjustment is done by turning the wheel of the slide.

Choice of Machine and Workpiece

(a) *Machine* : Since this machine (AI Lathe) was recently overhauled, the condition of machine was good and it could be depended for accuracy of work.

(b) *Workpiece* : This work-piece (product) is regularly in production. An analysis of production schedule indicated that during the preceding year 86,000 work-pieces of this component were produced in batches of 1,000 (plus 5% for scrap).

Technological Conditions of Work

Having chosen the machine and the work-piece (product) for investigation, the optimum

cutting conditions were calculated and found to agree with those prescribed in the work preparation made by the factory.

Determination of Optimum Working Conditions

From table (*beitrage Zu din Arbeits--and Zeitstudien Kefer, Heft I*) it is found that for a quality of IT 9, a feed of 0.06 mm/rev. can be chosen. Correspondingly a cutting speed depending on a standing time of 300 minutes on high speed steel cutting tool and on the material of the work-piece was chosen.

In the table (*A. Pomes, Richtlijnen voor de metaalbewerking*), for standing time of 60 mins, a cutting speed of 20-30 m/min. is recommended.

For a standing time of 300 minutes, it is taken at 85% of the mean of the cutting speed and the feed and speed thus arrived at for a tolerance of 30μ is furnished as follows :

Cutting Speed $= 25 \times 0.85 = 21.5$ m/min.

$$\text{RPM} = \frac{\text{Cutting speed}}{\pi \text{ d}} = \frac{21.5}{\pi \times 10} = 685$$

(The RPM nearest to 684 available in this machine is 630)

The above was determined for a tolerance of 30μ (μ=.001 mm). Similarly the feeds and speeds were determined for tolerances of 20μ and 15μ and they are stated as follows:

Tolerance (μ)	Feed (mm/rev.)	Speed rpm
30	0.06	630
20	0.05	630
15	0.04	630

(The turning conditions were checked to find whether they suited the electrical capacity of the machine of 1H.P. and found suitable).

Operation and Work Study Data

The study object was turned in series for three batch sizes of 200 pieces under the following feed, speed and tolerance conditions :

Tolerance (μ)	Feed (mm/rev.)	Speed (rpm)
30	0.06	630
20	0.05	630
15	0.04	630

Operation analysis and time study were made for the above three series. Based on the above study, the time which depends on Quality and that which does not depend on Quality were determined as follows :

Group A

Time which does not depend on Quality

1. Pick up work piece and place
2. Bring slide to work piece
3. Start machine
4. Bring back slide
5. Pick out work piece and place
6. Remove tool from tool-holder.

Group B

Time which depends on Quality : Related to

(a) Machine type (related to construction of machine, holding of the cutting tools; measuring apparatus fitted to machine, holding of work piece etc.)

(b) Length of work piece

(c) Tolerance range

i. Automatic Turning (machine time)

ii. Readjusting the tools (this does not include the readjustments made during the period of set up of machine).

Group C

Time which depends on Quality : Related to

(a) machine type

(b) Tolerance range

i. Measuring (In the present investigation, since measuring is done during the period of automatic turning on the work piece, this time is not taken into account)

Group D

Time which depends on Quality : Related to

(a) Tolerance range

(b) Batch size

i. Set up of the tool

ii. Set up of machine for feed and speed

iii. Adjusting the tool (for turning inner diameter in the present investigation), during the period of set up.

(N.B.—The time for set up of tool given in S. No. 1 under Group D, indicated only the time for fixing the tool in the tool holder and the adjustments made before the completion of turning on the first product after it is passed by inspection).

The details of time study data are furnished in Appendix 9.

It may be noted from this data that the process time increases with increase in quality, that is, with narrowing down of tolerance.

The average time in centiminutes for a batch of 200 pieces based on tolerance requirement is furnished as follows :

Group	Tolerance		
	30μ	20μ	15μ
A	3,840	3,840	3,840
B	6,861	8,347	10,676
C	..	..	..
D	351	358	1,273
Total in Centiminutes	11,052	12,545	15,789

A graph indicating the relationship between Tolerance and manufacturing time is furnished in Appendix 10.

Cost Formula

$$C=\frac{100+O_x}{100}(TW_x+M)+\frac{U_x}{100}HW_x^1$$

Where C= manufacturing cost depending on tolerance quality

O_x= percentage of scrap (irrepairable products), depending on tolerance quality

T_x= manufacturing time in hours, depending on the tolerance quality

W= workshop cost per hour (includes direct labour and factory overhead)

M= Material and preparation cost (i.e., cost of previous operation(s)+material cost)

U_x= percentage of repairable products (rework) depending on tolerance quality

H_x= time for repairing (rework), depending on tolerance quality.

W^1= repairing cost per hour (rework cost) (in most cases W_1 is taken the same as W^1)

T_x= Total time of groups (A+B+C+D)

Analysis of Work Study Data

Series I

Tolerance=30μ

Upper & Lower limits=between 9.98 mm and 9.95 mm

Theoretical Mean=9.975 mm

Actual Mean=9.959 mm.

Actual Standard Deviation=3μ

The fault of off-centreness=(9.965—9.959)=.066 i.e. 6μ

The distribution was checked and found to be a normal distribution.

Results

1. There were neither rejects nor rework in this series
2. There is no fault of off-centreness
3. The cost is calculated as Rs. 34-61 for 200 pieces

Series II

Tolerance=20

Upper & Lower Limits = Between 9.98 mm. and 9.96 mm

Theoretical Mean = 9.968

Actual Standard Deviation = 2.9μ

The fault of off-centreness=(9.970—9.968)=0.002 i.e. 2 μ

The distribution was checked and found to be a normal distribution.

Calculation of Rejects

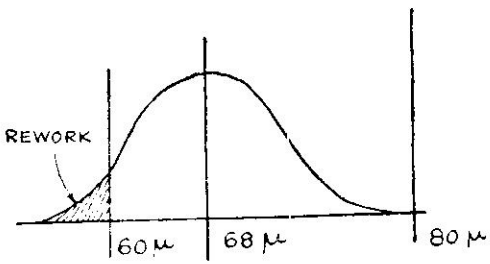
$$\frac{68-60}{2.9}=\frac{8}{2.9}=2.758.,\ \text{i.e., } 2.75\mu$$

From tables (0.5—0.497) = 0.003

i.e. 0.3 per cent rejects on the whole and it is repairable reject

Results

1. The repairable reject (i.e. rework) is 0.3 per cent.
2. There is no scrap.



3 (a) The cost is calculated as Rs. 35.89 for 200 pieces with fault of off-centreness.

(b) The cost is Rs. 35.86 for 200 pieces, without fault of off-centreness.

Series III

Tolerance=15μ

Upper & Lower limits=between 9.98 mm. and 9.965 mm

Theoretical Mean=9.9725 mm.

Actual Mean=9.9655 mm.

Actual Standard Deviation=2.4μ

The fault of off-centreness=(9.9725—9.9695)=0.003 i.e. 3μ.

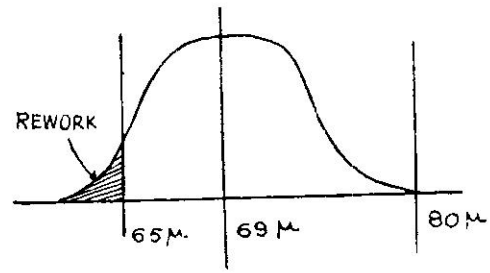
The distribution was checked and found to be a normal distribution.

Calculation of Rejects

$$\frac{69-65}{2.4}=\frac{4}{2.4}=1.66$$

From the tables

(0.5—0.450)=0.050



Results :

1. The repairable rejects (i.e. rework) is 5 per cent.
2. There is no scrap
3. (a) The cost is calculated as Rs. 39.22 for 200 pieces with fault of off-centreness

   (b) The cost is Rs. 38.56 for 200 pieces, without fault of off-centreness.

Based on the cost calculations for the above three series, two cost curves are drawn for three Tolerance quality, with tolerance quality as the abcissa and the cost index as the ordinate (the cost tolerance quality of 30μ is taken as the base) and they are given in Appendix 11 (a & b).

Appendix 11 (a) indicates the actual cost curve for the three tolerance quality (with faults of off-centreness wherever exists).

Appendix 11(b) indicates the cost curve, without the fault of off-centreness for the three tolerance quality.

Improved Technological Working Conditions

A further investigation was made in the direction of the improvement of technological working conditions to get a decrease in time for the required tolerance based on increased speed and a slight decrease in

conditions of operation. The results are furnished as follows :—

Series IV :

Tolerance	= 30μ
Speed	= 1540 rpm
Feed	= 0.05 mm/rev.
Upper & Lower Limits	= Between 9.98 mm and 9.95 mm
Theoretical Mean	= 9.965 mm
Actual Mean	= 9.974 mm

Actual standard deviation= 2.77

The fault of off-centreness= (9.974−9.965) = 0.009 i.e. 9μ.

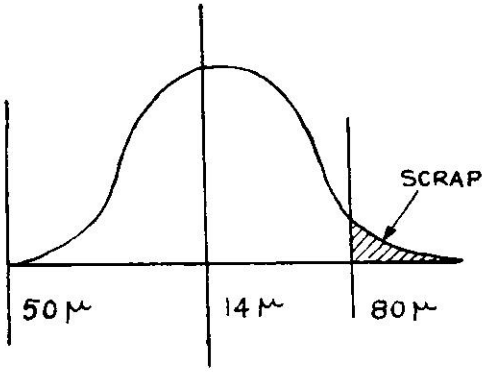
The distribution was checked and found to be a normal distribution.

Calculation of Rejects :

$$\frac{80-74}{2.8}=\frac{6}{2.8}=2.1$$

From tables, (0.5−0.482)

=0.018 i.e., 1.8 per cent of scrap on the whole.



Results :

1. The scrap is 1.8 per cent
2. There is no rework
3. (a) The cost is calculated as Rs. 32.33 for 200 pieces, with faults of off-centreness
   (b) The cost is Rs. 31.66 for 200 pieces, without faults of off-centreness
4. The time study data for 200 pieces based on technological improvement are furnished as follows:

	Centiminutes	
Group A	3,840	(Same as series I to III)
Group B	3,400	(Automatic turning)
	84	(Readjusting tool)
Group C	..	
Group D	190	
Total time	7,514	

For Series I & IV, a histogram (Appendix 12) is drawn for two speeds (630 and 1540) with the speeds as abcissa and cost index as ordinate (The cost of the tolerance quality of 30 at speed 630 rpm is taken as the base). For Series I & IV, the tolerance is 30μ. From the above research, the following conclusions are drawn :

(a) *Relationship Between Tolerance and Manufacturing Cost* :

1. When the fault of off-centreness is avoided, cost saving can be effected. The loss due to fault of off-centreness increases with increase in quality (closer tolerance).
2. Machine time increases with increase in quality (closer tolerance), thereby increasing manufacturing cost.
3. The setting and adjustment time increases with increase in quality (closer tolerance).
4. The quality has to be controlled by a control chart and the frequency of measurement increases with increase in quality (closer tolerance).
5. The scrap and rework percentage increases with increase in quality (closer tolerance).
6. For quality tolerance of IT9 and above, the manufacturing cost is fairly constant. For quality tolerance below IT9 the difference in cost is sharper, with decrease in tolerance. Hence it is noted that whenever we prescribe tolerance below IT9, the need for such close tolerance must be justified.

(b) *Areas Where Cost Reduction Can be Achieved*

1. By avoiding the fault of off-centreness. For this, control chart and inspection methods, whether it should be 1 in 10 or 1 in 20, must be established. Workmen are apt to work to safety on the upper tolerance limit which will involve rework. This should be avoided.
2. By investigating work at optimum speed, feed conditions. This will reduce machine time and will yield good saving. Here the cost due to no fault of off-centreness at lower speed should be optimised with cost with fault of off-centreness at higher speed.
3. By reducing re-adjustment using control charts, rework of rejects may be minimised, thereby effecting reduction in cost.

Conclusion

The aim of this article is to provoke thinking on the subject of "QUALITY AND COST" and to provide information obtained through research. The dealing of the subject is by no means complete. It is only an attempt to enthuse those interested in this field to continue further in this research to benefit the industry by its results.

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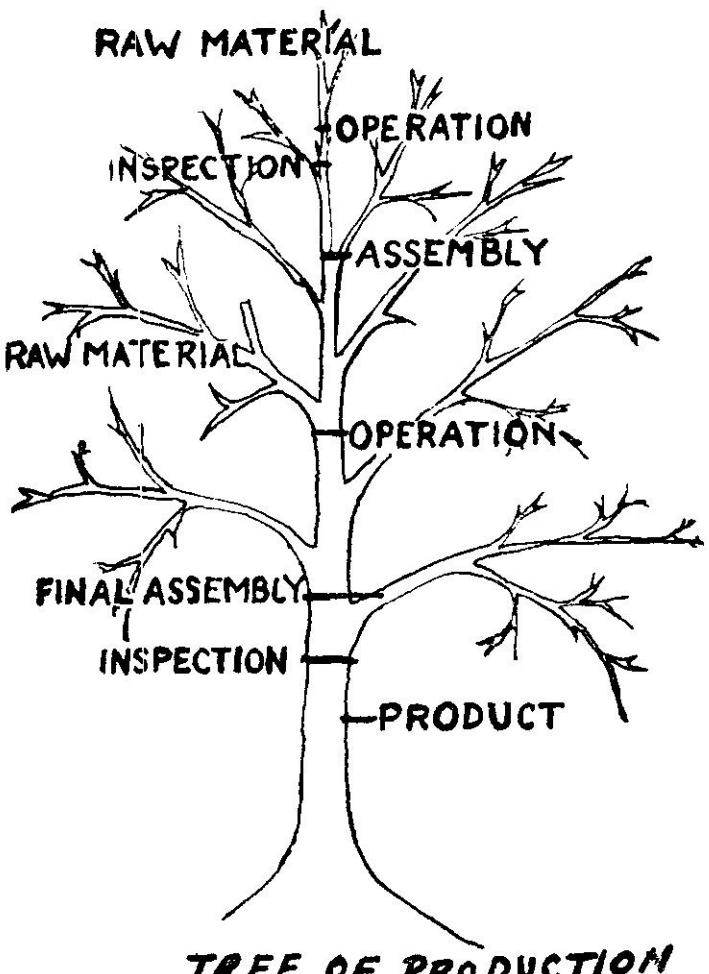
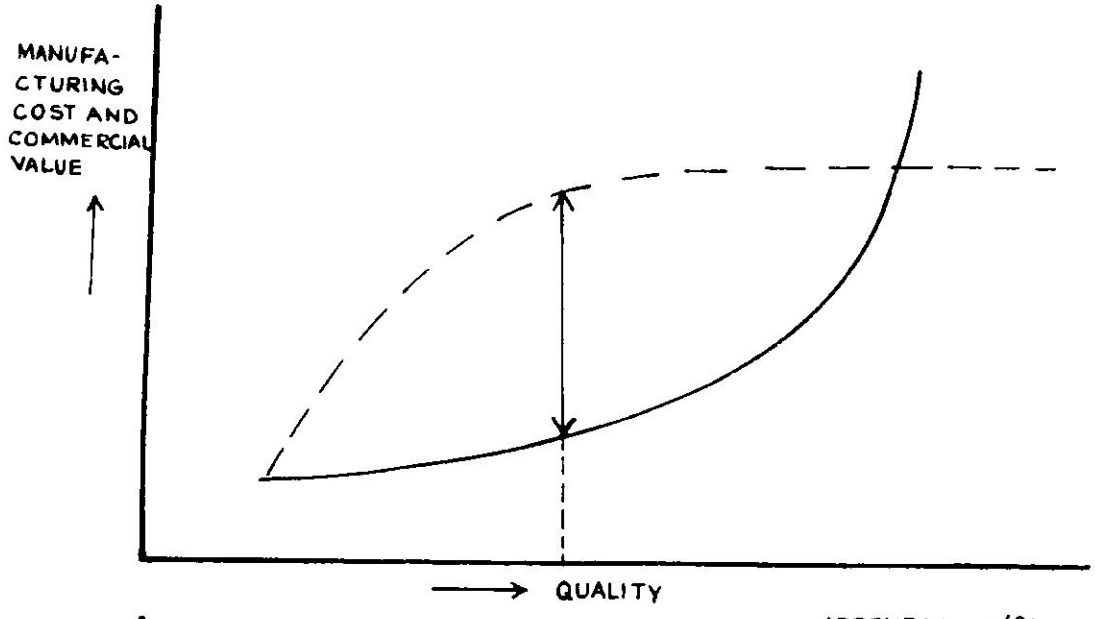
APPENDICES FOLLOW

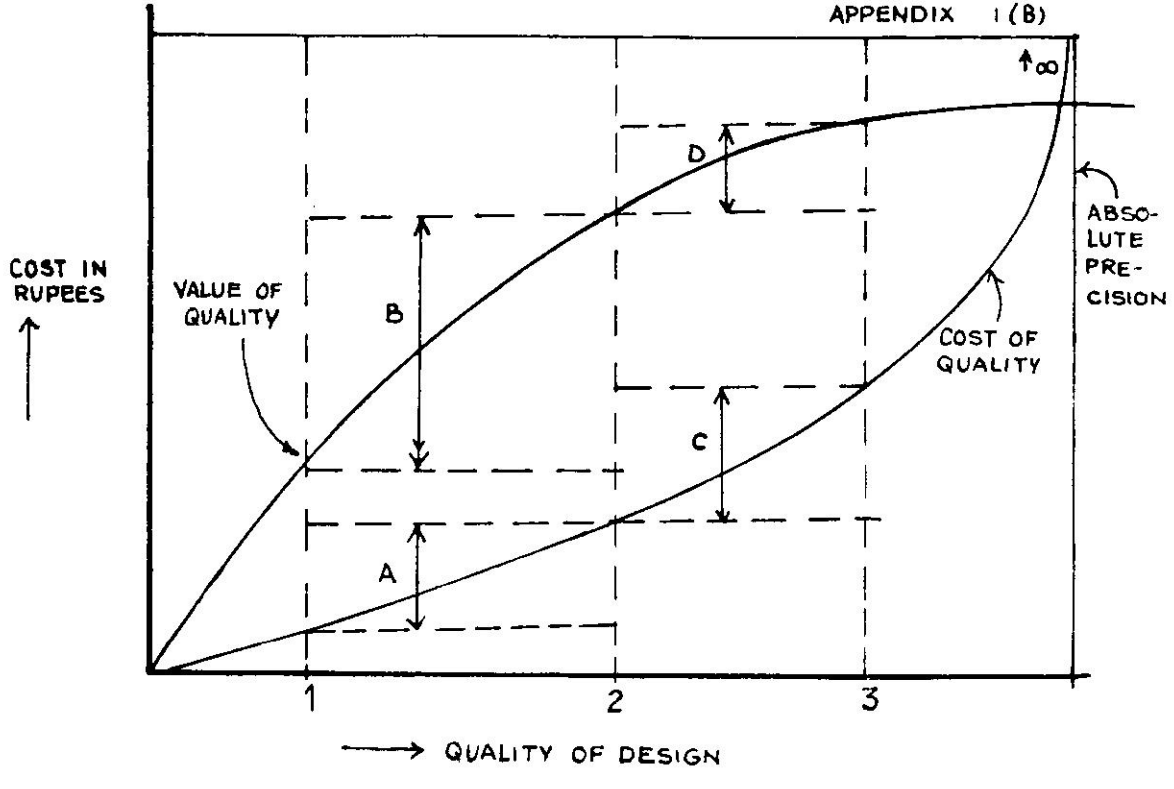


TREE OF PRODUCTION

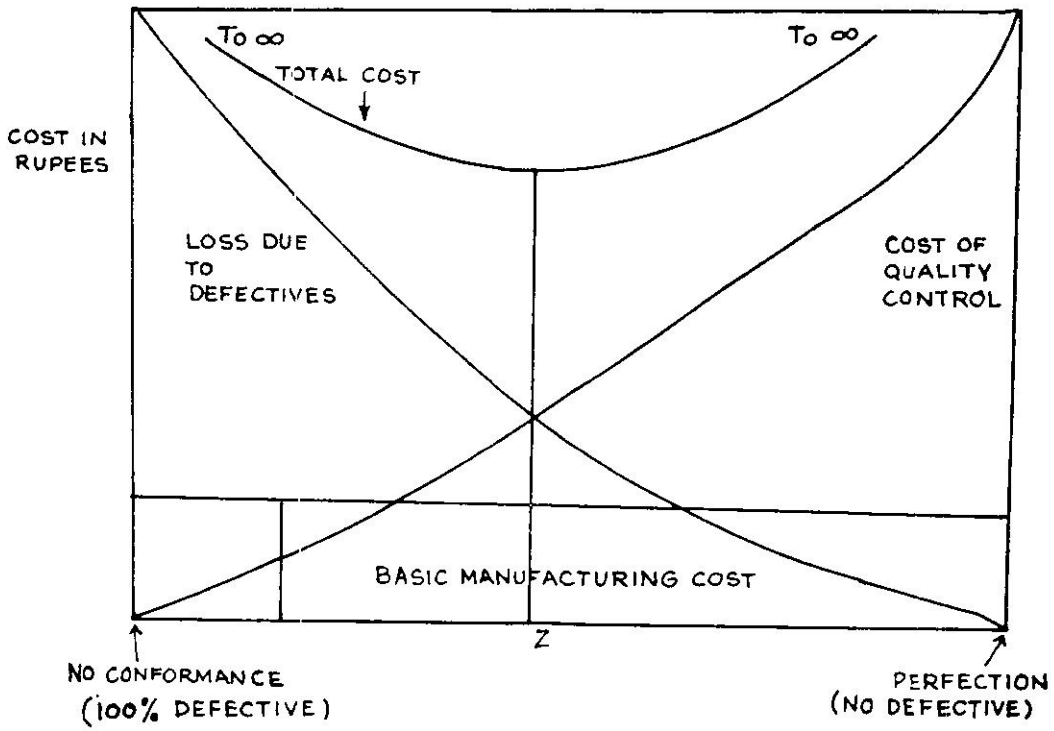
APPENDIX 1(A)

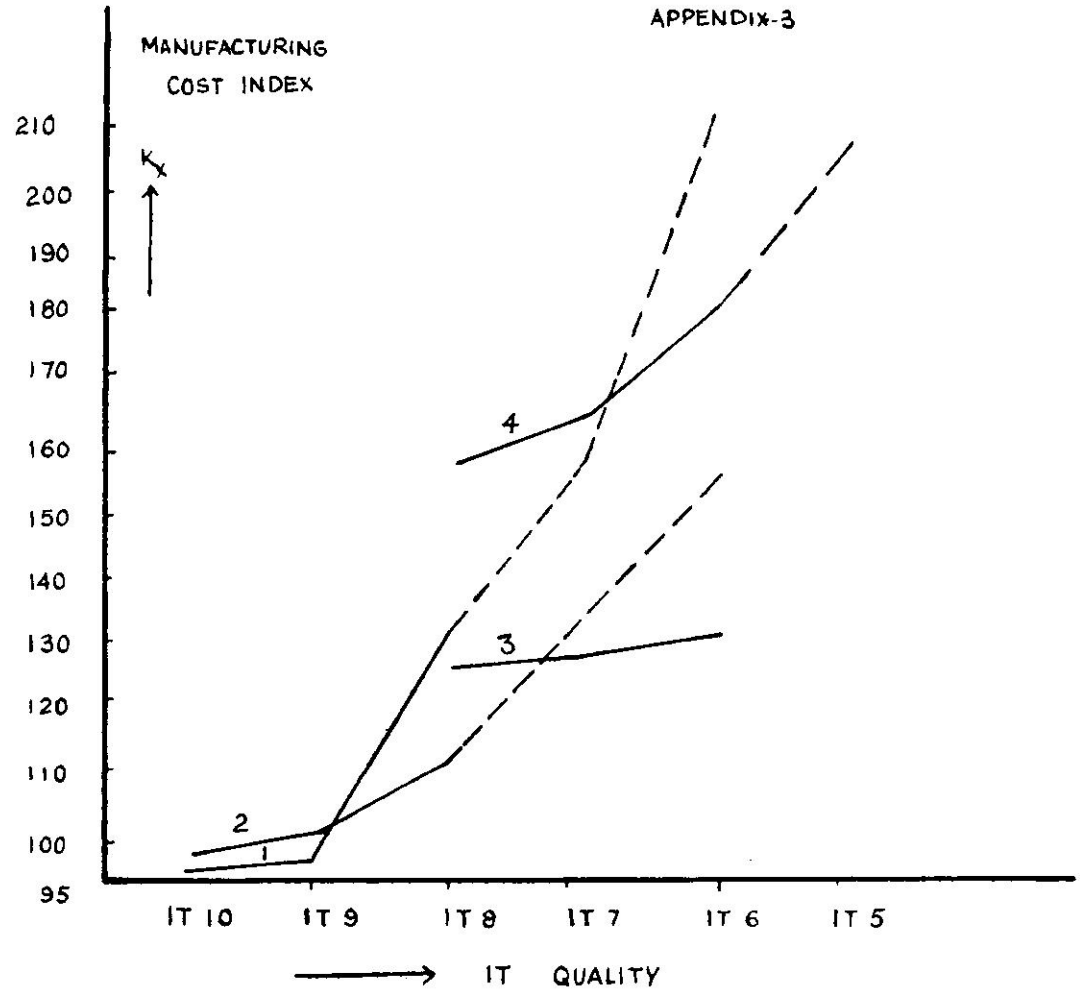


APPENDIX 1 (B)



APPENDIX : 2


To ∞
To ∞
TOTAL COST
COST IN RUPEES
LOSS DUE TO DEFECTIVES
COST OF QUALITY CONTROL
BASIC MANUFACTURING COST
Z
NO CONFORMANCE (100% DEFECTIVE)
PERFECTION (NO DEFECTIVE)



Data : The above exhibit related to processing of outer diameter 18-30 mm.

Ratio manufacturing Cost $\frac{\text{Grinding}}{\text{Turning}} = 1.2$

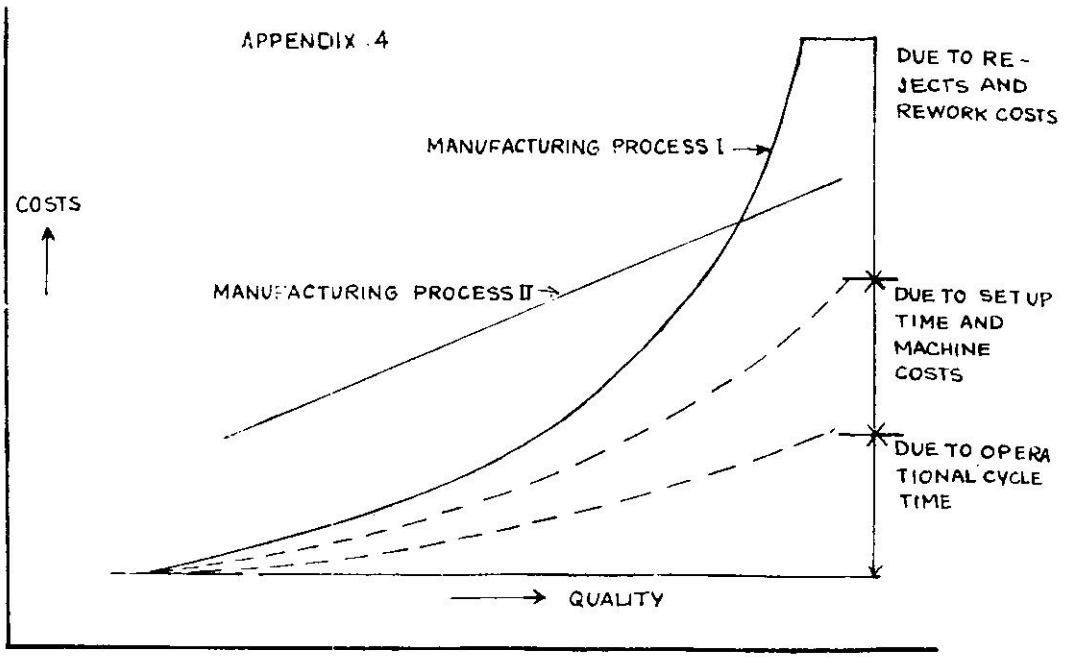
Measuring instrument = Micrometer

Ref : 1. Turning with tool in square holder

2. Turning with box turning tool
3. Centreless grinding
4. Grinding between centres.

——— = Normal production

— — — — = Special experimental batches



Data : Schematic model for the preliminary investigations on "Tolerances and Manufacturing Costs".

The schematic model was based on the following assumptions :

— 3 major factors are contributing to increase of costs in relation to quality : operational cycle time, set-up and machine costs, costs due to rejects and rework. These are shown in relation to manufacturing Process I

— These factors, however, do not exert influence at the same point along the quality scale, nor to the same extent. For this reason the total cost curve is assumed to be progressive.

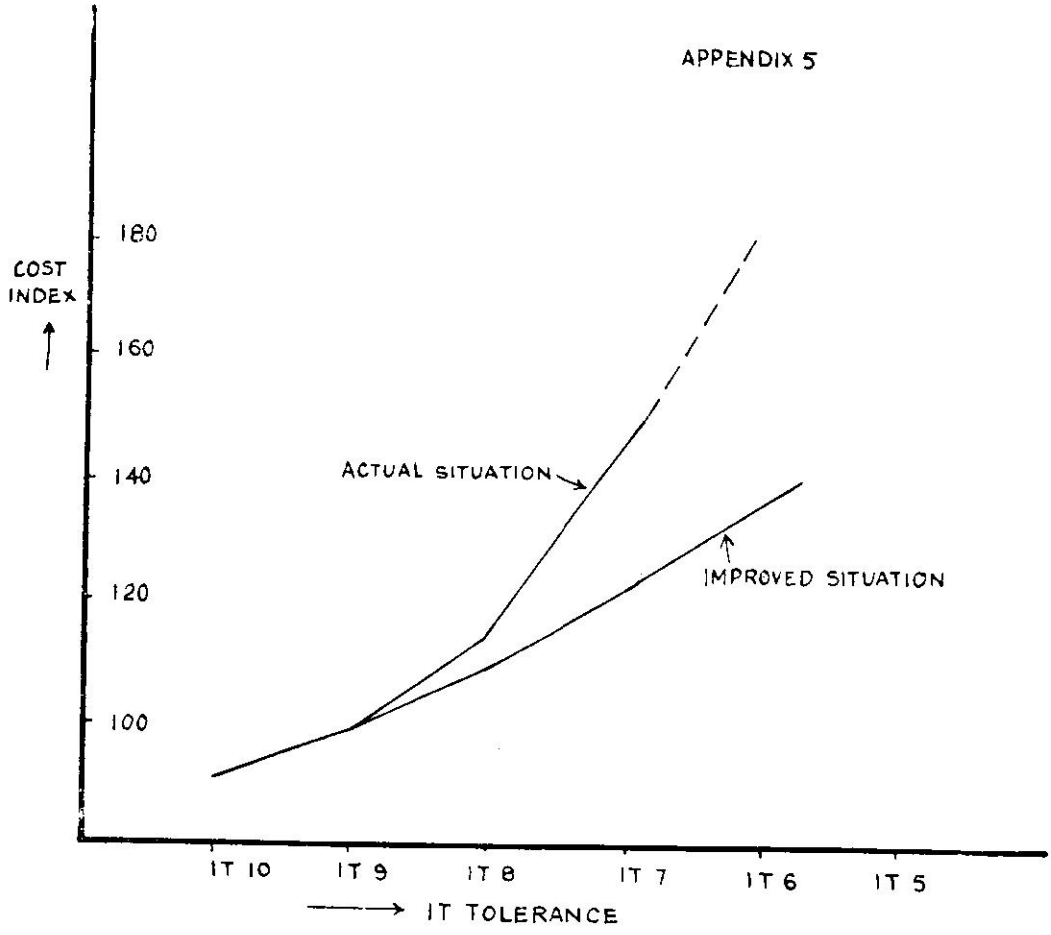
Hypothesis

— For each manufacturing process, a distinctive quality cost relationship of the described nature can be established.

— For each quality a most economical manufacturing method exists.

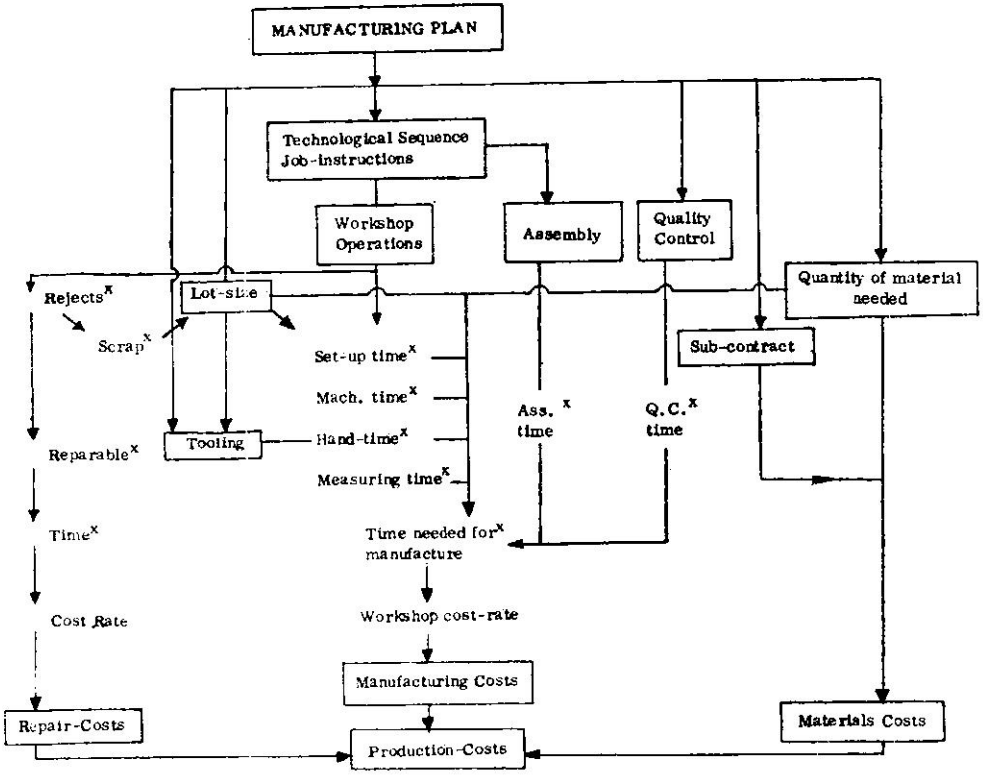
— By a control of the relationship between quality and costs a decrease in the progressiveness of the total cost curve is possible, leading to a more economic manufacturing process.

APPENDIX 5



Ref : Cost reduction possibilities through better manufacture control in the workshop.
Quality-Cost curve for external turning of mild steel (ST 37) in a machine shop with turret lathe and box tool, 18-30 mm dia.
Cost index IT 9 = 100

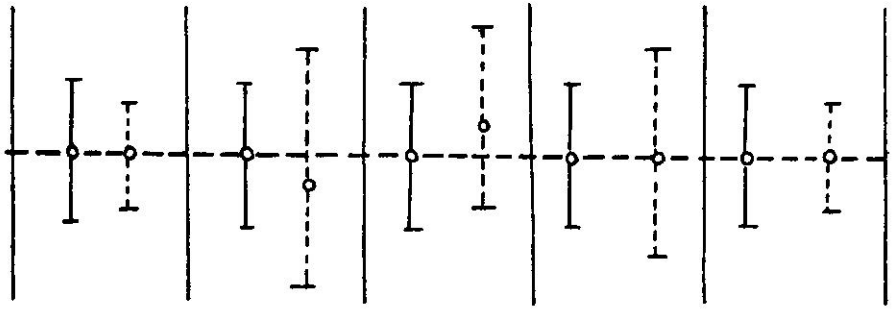
APPENDIX 6



The influence of quality and costs as seen by the work planning function

x = cost-elements influenced by change of quality requirements

APPENDIX 7

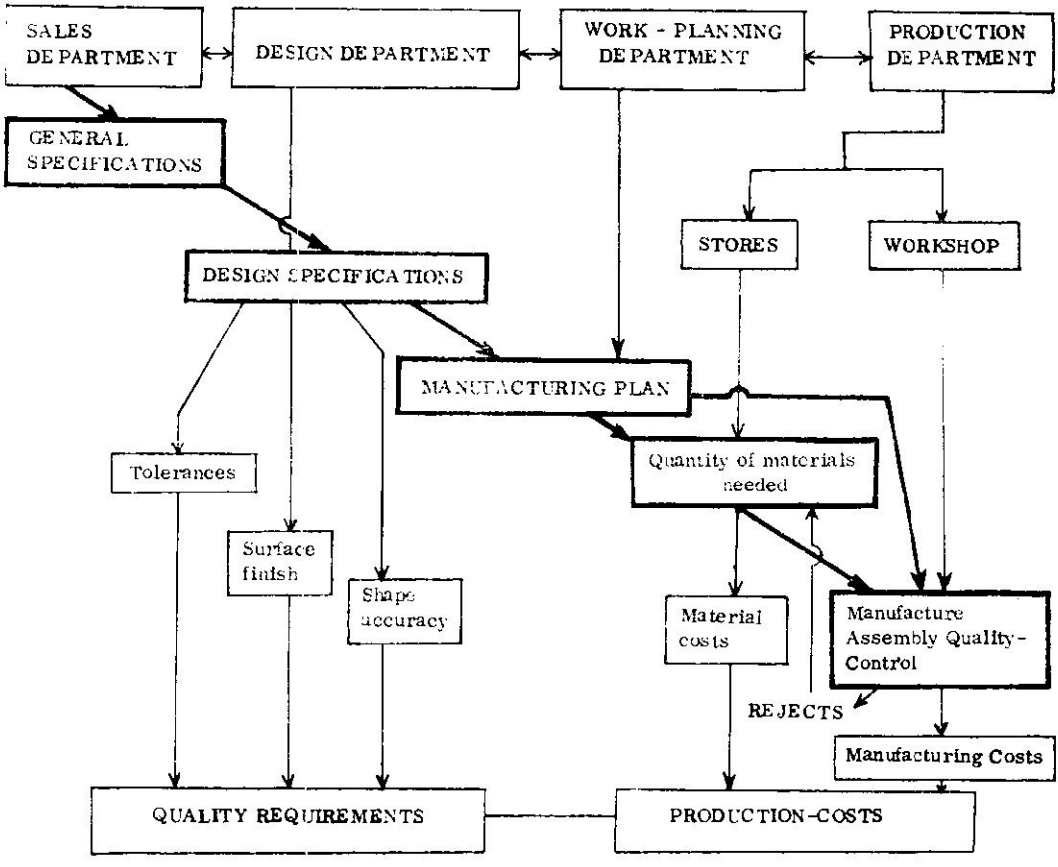
Type No	I	II	III	IV	V
Graphical Representation					
Accuracy of Process	correct	too inaccurate	correct	too inaccurate	too inaccurate
Adjustment of mid point	correct	incorrect	incorrect	correct	correct
Cause for discrepancy might be due to	—	design, work planning workshop	design, workshop	design, work planning	design, work planning

x) ⎡⎢⎣ = represents the tolerance prescribed by the design dept.

⎡⎢⎣ = represents the actually produced tolerance by the workshop.

o = representa midpoint (average of a number of work pieces)

APPENDIX


SALES DEPARTMENT
DESIGN DEPARTMENT
WORK - PLANNING DEPARTMENT
PRODUCTION DEPARTMENT
GENERAL SPECIFICATIONS
STORES
WORKSHOP
DESIGN SPECIFICATIONS
MANUFACTURING PLAN
Tolerances
Quantity of materials needed
Surface finish
Shape accuracy
Material costs
Manufacture Assembly Quality-Control
REJECTS
Manufacturing Costs
QUALITY REQUIREMENTS
PRODUCTION-COSTS

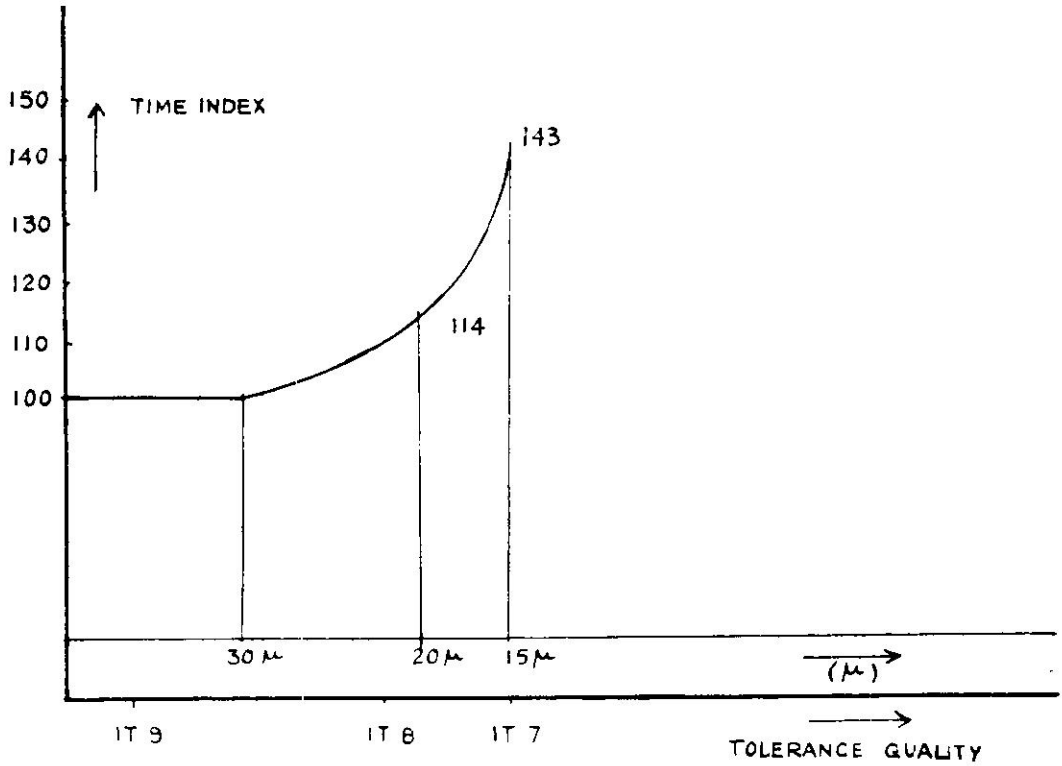
APPENDIX 9

DETAILS OF TIME STUDY DATA FOR SERIES I TO III

Time in Centiminutes

Sl. No.	Operation	30 μ 630 rpm 0.06 feed	20 μ 630 rpm 0.05 fee	15 μ 630 rpm 0.04 feed
	Group A			
1.	Pick up work-piece & piece	5 x 200	5 x 200	5 x 200
2.	Bring slide to workpiece	5 x 200	5 x 200	5 x 200
3.	Start machine	2 x 200	2 x 200	2 x 200
4.	Bring back the slide	5 x 200	5 x 200	5 x 200
5.	Pickout work-piece	2 x 200	2 x 200	2 x 200
6.	Remove tool from tool-holder	40	40	40
	Total for 200 work-pieces	3,840	3,480	3,840
	Group B			
1.	Automatic turning	6,800	8,200	10,400
2.	Readjusting the tool during the period of production)	61	147	276
	Total for 200 work-pieces	6,861	8,347	10,676
	Group C			
1.	Measuring : (This is done during the period of automatic turning. Therefore it is not included for calculation)	..	..	..
	Group D			
1.	Set up of the tool	206	212	398
2.	Set up machine for feed and rpm	75	75	811
3.	Adjusting tool for turning inner diameter (During the period of set up)	70	71	64
	Total for 200 work-pieces	351	358	1,273
	Grand Total of (A+B+C+D) for 200 work-pieces	11,0522	1,545	15,789

APPENDIX 10

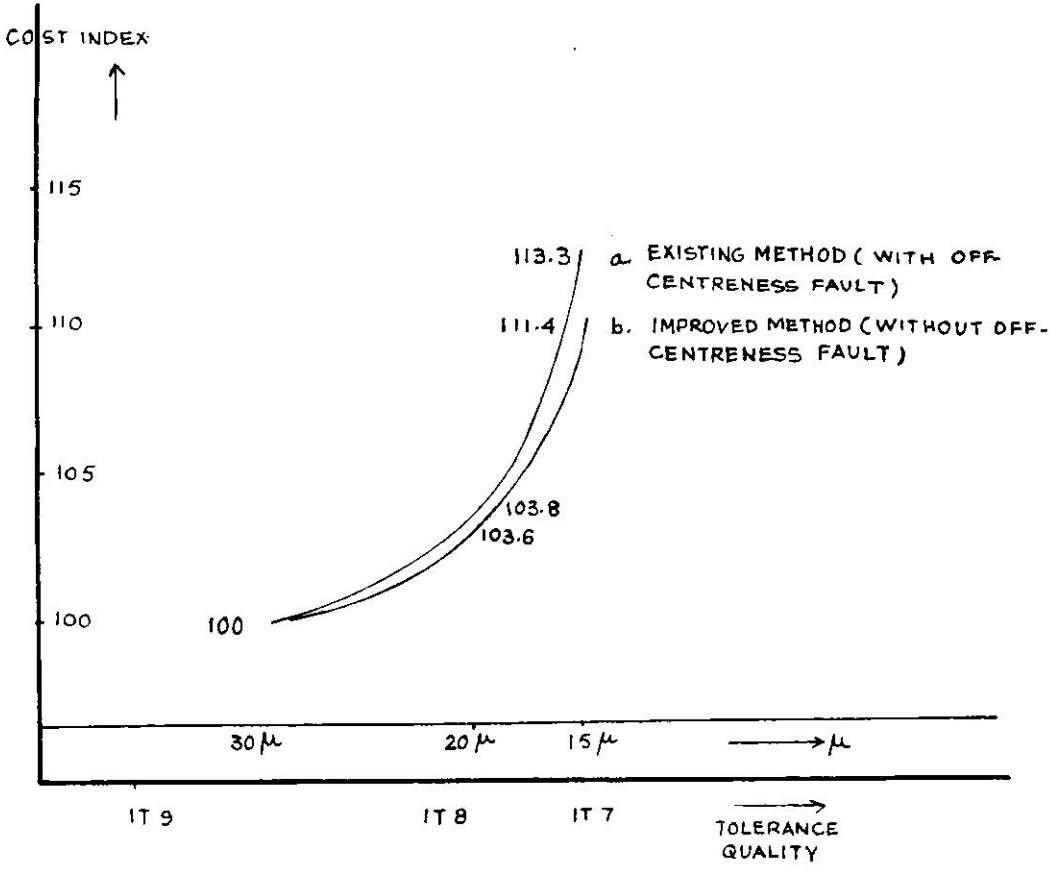


Quality - Manufacturing Time Curve

Speed 630 rpm
Quality 30μ—Feed 0.06 mm (rev.)
Quality 20μ—Feed 0.05 mm (rev.)
Quality 15μ—Feed 0.04 mm (rev.)

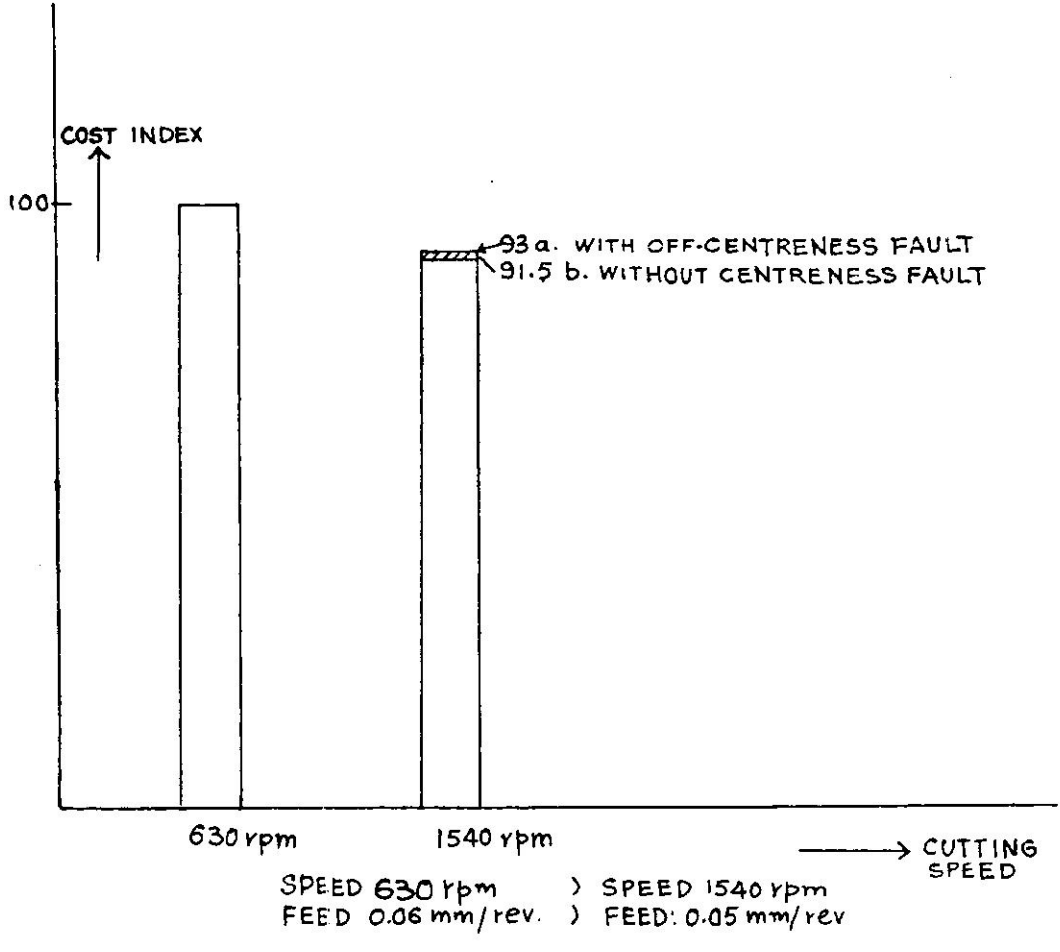
APPENDIX. II (a & b)

QUALITY- MANUFACTURING COST CURVES



APPENDIX: 12

CUTTING SPEED MANUFACTURING COST HISTOGRAM



Quality Control in A Tiles Factory

SV Rathinam*

The Tiles Factory under study is a long-standing one, established 30 years ago. It is a leading concern in the Madras area. A stream of technicians, geologists, metallurgists and, sometimes, foreign experts visit the Factory and offer suggestions to increase output. One such suggestion was regarding the introduction of SQC, which is the subject of this article.

A STUDY OF THE FACTORY FROM THE POINT OF SQC brought about tangible results: as the Managing Director himself remarked, the study led to unpercedented, almost remarkable achievements in effecting economies ; and others in the line admitted that the approach was quite different and that they were learning lessons from the study.

To understand the operation of SQC in a tiles factory, the production process needs to be described. Plastic clay fit for tile making is excavated, stacked in stacks after breaking the clods and exposed to sun and rain for weathering. The clay is profusely watered so that the entire lot gets completely soaked, after which the stack is allowed to dry to a consistency. The clay thus treated is made to pass through a pair of high speed rollers and crushed to a fine structure. The crushed clay is carried over a rubber belt conveyor which feeds a pair of rollers mounted on a mixer. At this stage the clay is finely ground, properly mixed and stored in a pit.

The clay is then passed through a pair of crushing rolls mounted on a pug-mill, which extrudes it through a mouth-piece, lubricated with oil. The block coming out is cut into slabs. Each one of the slabs is fed to the mechanical power presses which are of revolving type. The pressed fresh tile is initially dried in cupboards and humidity dryers and then taken to kilns for firing. The tiles are removed from the kiln and examined individually for quality.

Quality of Clay

The quality of clay varied at different depths and at different locations of the clay pit. Apart from the composition of certain chemicals, an inherent sand-content is an essential feature of tile-making. The factory was adding 15-16 per cent of sand with all clay excavated from the pit, assuming the natural sand as 9 per cent, thus increasing the required proportion in a tile to 25 per cent of sand. Sampling tests

*Senior Investigator, Indian Oil Corporation Ltd., Madras

were conducted in the pit and the clay samples were analysed for sand content. The analysis of variance showed that the inherent sand content in different cross-sections was significantly different at various places, the range being 3-19 per cent. Because of this variation the sand content in 15 sample tiles ranged from 11 to 28 per cent. The factory modified the procedure of "mixing components" and provided for regular clay tests and added only the relevant proportion of sand after taking into account the quality in each locality.

Moisture Content

The analysis of green tiles showed the moisture content ranging from 18-27 per cent against the allowable proportion of 15-20 per cent. The weight of a tile is mainly influenced by the moisture content. If we increase tile weight by adding more water, it results in sheer increase in the consumption of fuel at the time of firing. During initial curing also such tiles take a long time for drying while other tiles having comparatively standard weights dry well. By suitable methods to keep the thickness of green tiles under control (3/8") more attention was paid to keep control over moisture.

The weights of 20 tiles were correlated with their crushing strength. But the result was only 0.215 : it was thus clear that increase in tile weight was in no way useful.

20 samples of 5 items of green tiles were weighed and a control chart for mean weight was drawn. 3 points fell outside the upper control limit and most of the points were nearing the upper limit; the actual weight fell between 3450 gms and 3800 gms.

Drying Of Tiles

The green tiles are allowed to dry on racks or wooden shelves free from gusts of wind. They remain there till they are dry enough to be handled without damage to the tile. Secondly, they are stacked in shelves in humidity dryers and the temperature of the air inside is gradually raised to an optimum level. This is to prevent case hardening of surface that tends to either warping or breakages. 20 samples of 5 items each were chosen at random from the tiles unloaded from the humidity dryers and weighed. The control chart showed 5 points above the upper control limit and 6 points below the lower control limit. Most of the tiles were not properly dried and it was highly improper to send them into kilns. Wet tiles will go defective when put under sudden firing. The weight of tile at this stage ranged from 2700 to 3100 gms and it was proved that the humidity dryers were not fully utilised for the purpose for which they were set up. Some of the thermometers were replaced and arrangements were made to see that the optimum temperature is reached inside the humidity dryers and the readings checked at regular intervals. The length of tiles revealed lack of control, varying from 16.1" to 16.66" at this stage.

Firing of Tiles

Twenty samples of 5 items were drawn from the tiles unloaded from kilns after firing and weighed. Data collected in the line showed deviation in their weights from 2400 gms. to 2700 gms. Two points fell above and below the upper and lower control limits respectively. There was lack of uniformity in firing.

The company incurred heavy losses due to bad firing, and 'over burnt' and 'low burnt' tiles were the common feature.

The factory was advised to maintain daily records of output—dryer output, kiln output and of shipping. It is important to know the coal used in the firing, kiln by kiln in order to reduce the quantity to a minimum. Some kilns use more fuel than others and there must be a reason for it. In any kiln operation, temperature recording is essential to know the trend. By making such records we will be able to shorten the duration of the burning, thus reducing coal consumption. If we could eliminate the breaks and falls in temperature and carry the curve up parrellel to the normal advance we would reach the final temperature sooner than otherwise. As it is, we took care to see that no wet tile was sent into the kiln, since wetness increases the time of burning, causes scum, creates strain on the tiles from the condensations and gives bloated ware.

After introduction of the SQC, firing was done by dropping coal powder through feed-holes (six in number for each chamber) and the feeding of coal stopped after the tiles were seen to have attained the optimum temperature required. Temperature at different hours after starting firing was noted in different chambers. It was observed that the temperature was not uniform in all parts of the same chamber. After 8½ hours, chamber 19A attained the maximum temperature and gave an average of 930 °C in the three feed holes. But chamber 2A could not catch this maximum even after 13½ hours firing. Its mean temperature was only 900 C. After 10½ hours, the average temperature in chamber IA was 867 with a range of 70 C. But Chamber 19A attained a temperature of 913 ° after 8½ hours and the variation between feedholes also was less than 10 C. Comparative studies of the above nature were taken up in respect of all kilns and several improvements suggested.

In certain chambers the temperature near the front wall was attained slowly and there were low burnt tiles near the wall. Modifications were made in placing the tiles inside the kiln to ensure uniform firing and the interval of automatic feeding was increased. Orders were placed for the purchase of Sagar coves, Thermocouple pyrometer etc., in order to bring firing under control and to ensure good firing. Training was imparted to young men who conduct firing, special care being taken to check the temperatures at night.

In the course of improving firing it was found that unburnt coal was also found inside kilns, estimated from 1 to 2 tons per day.

Process Control Charts

The simple statistical techniques on Quality Control were taught to production assistants and process control charts were introduced at important stages of the manufacturing process, *viz.* (1) defectives at the time of initial drying, (2) defectives at humidity dryers, and (3) at the time of unloading from chamber kilns. Charts were revised according to improvements suggested.

General Observations

The cause-wise analysis of 100 tiles showed 40 per cent rejections classified as: side cracks (6 per cent), leg cracks (9 per cent), head cracks (7 per cent), tail cracks (8 per cent) and lip cracks (9 per cent). Some of the defects had been caused by mistakes in the dies. Out of 250 tiles pressed by die 1, 202 had cracks at right head. Similarly out of 300 tiles pressed by another dye, 275 had defects in lips. All these cracks were in the same place and they were caused by die defects. Periodical replacement of dyes was ensured. The total rejections at the green stage were counted and it was found that 63 per cent were due to rough handling of tiles. In some cases the wooden pallets on which the tiles rested got bent and resulted in warping and cracking of tiles. Workers were specially deployed on holidays to check the pallets and replace the defectives. Careless and rough handling of green tiles was reduced by warning the workers against the consequences. Wages were reduced for excess rejection due to malhandling. The Statistical Quality Control application eliminated various defects and enabled the factory to increase the overall output by 10 per cent.

Conclusion

An urgent need of a Tiles factory is the standardisation of quality at various stages of manufacture, right from clay pit down to the burnt tiles. We must arrive at standard moisture, standard weight of green tiles, standard temperatures. Once standards are fixed, there must be a Statistical Quality Control man to ensure that the specifications are strictly adhered to. ● ● ●

"After all, we now exist one telephone call from Doomsday..."—JB Priestley

Control of Foundry Rejections

G Surya Kumar*

THE JOBBING FOUNDRY IN QUESTION HAD two main wings :—

(i) The Iron Foundry, manufacturing about 250 tonnes of grey iron castings per month. The castings are of various shapes and sizes —from bearing plates weighing 1 kg. per piece to locomotive cylinders weighing as much as 1200 kg. per piece.

(ii) The Brass Foundry, manufacturing about 135 tonnes of castings per month. Majority of the items are of bronze, with a few random castings of aluminium and brass.

On an average, about 45 different items are manufactured in the Iron Foundry and 35 items in the Brass Foundry.

The 'quality' performance of the foundry was judged by comparing monthly rejection percentages by weight and by number. All efforts were directed towards lowering these percentages. Though this practice had been continuing from the inception of the foundry, it did not seem to be a rational parameter to judge the efficiency of a foundry. It could so happen that in a particular month, some heavy foundation blocks may have been cast and some of these may have been rejected, causing alarm to management, as it would increase overall percentage of rejections by weight, whereas in a subsequent month, heavy rejections of some light but extremely intricate castings may go unnoticed as it may not have any appreciable effect on overall rejection percentage. From the financial point of view, performance in the latter month may have been far more disastrous.

*Production Engineer, N.E. Railways Workshop, Gorakhpur

A monthly review was made of foundry rejections by the Production Engineer, Chemist and Metallurgist, and by the Foreman. At this monthly meeting, the inspector put up a register indicating rejection percentage of all items and he also displayed samples of rejected castings with higher than average rejection percentage. At this monthly review, cases were not uncommon when only six numbers of a simple inexpensive casting may have been cast, out of which three may have been rejected, showing 50 per cent rejection percentage. The loss in this particular case may have been only a couple of rupees, yet considerable time was wasted in investigating into it merely because the percentage looked shockingly high. On the other hand, the rejection of axle boxes may have slipped up from 2 per cent to 3 per cent causing a loss of Rs. 500 and yet it would not have raised even an eyebrow. One felt content that the rejection in this case was well within "the target".

This paper describes how the above drawbacks were overcome by evolving a scientific method of representing and controlling the rejections.

The Brass Foundry was first tackled : the first step undertaken was to estimate the cost of a rejection in terms of rupees. For each item, two costs were obtained : one showed the cost of a rejection in the rough stage, viz., noticed at the time of fettling — and the second showed the cost of a rejection in the Machine Shop when a blow-hole or some other flaw was noticed, subsequent to machining.

The cost of a rough reject on the foundry floor consisted of :

(a) Moulding manhours converted to rupees. If an item is rejected, the moulding time expended on it goes waste.

(b) Melting loss. The melting loss for bronze varies from 4 to 6 per cent. Whereas a rejected casting goes back to the crucible for remelting, the melting loss is irrecoverable.

(c) Average cost of handling.

The cost of a rejection in the Machine Shop consisted of the above plus cost of machining before the flaw, blow-hole, etc., is noticed.

We thus obtained an estimate as to how much a particular reject costs the administration. ABC analysis was then applied to the cost of rejections of a particular month. The steps involved in this technique are given below:

(i) The number of rejections of each item in a particular month is noted (see column 3, 4, 5 of Table I)

(ii) The cost of rejections, itemwise, is then obtained from the above figures (col. 6).

(iii) The items are rearranged in descending order of cost. The item incurring maximum loss is placed as number 1, the next one as number 2 and so on.

(iv) The cumulative total of "loss due to rejections" is then shown in the last column (col. 7)

(v) From the table so prepared, a graph was drawn, showing number of items *vs.* cumulative cost. The resultant graph obtained is the familiar ABC curve used in Inventory Control.

From the ABC curve it will be seen that 5 of the items contribute to 80 per cent of the loss due to rejections (called A items), 7 items contribute to 14 per cent of the loss (called B items) and 18 items contribute to 6 per cent of the loss (called C or "chicken feed" items).

The above graphs were drawn for three consecutive months and the ABC items listed. A rational base was thus obtained to define the essentials. It was decided that for A items a separate graph would be plotted for each item, showing the monthly variation of rejections. Even small fluctuations in these were to be investigated by the Production Engineer, Chemist and Metallurgist and the Foreman. The graph for two A items is shown in Fig. 2.

For B items, the control was left to the Foreman. For C items, the control was left to the Chargeman and "Mistries". Thus, when

FIG. 1: CUMULATIVE COST OF REJECTIONS VS. NO. OF ITEMS.

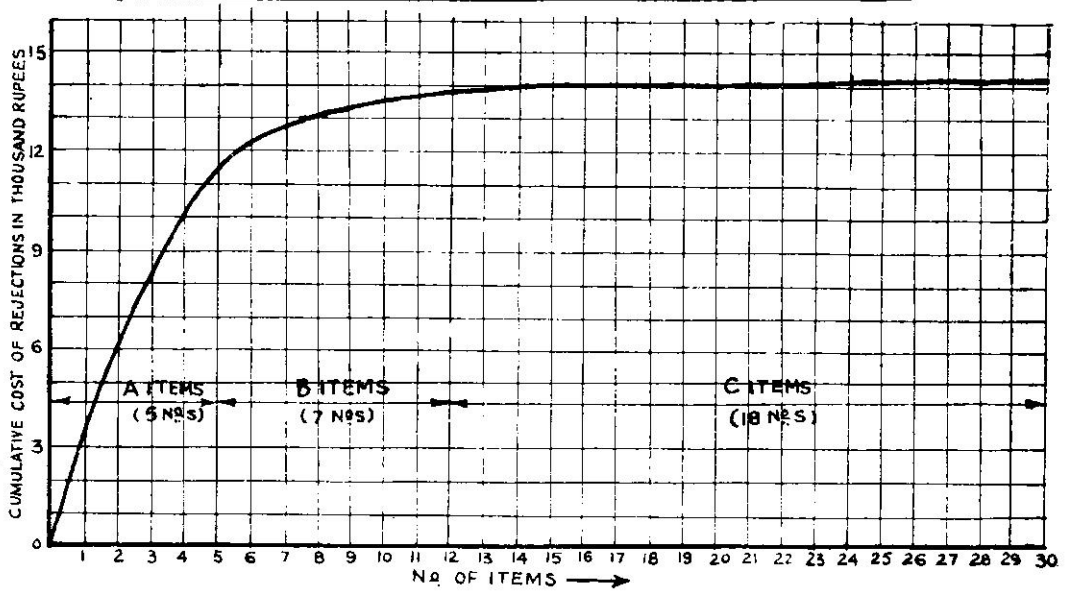


TABLE I

Cost of Rejections

Sl. No.	Items of Manufacture	Rejections			Cost of Rejection in Rupees	Cumulative Cost of Rejections in Rupees
		Rough	Machine Stage	Total		
(1)	(2)	(3)	(4)	(5)	(6)	(7)
1.	Coupling Rod Floating Bush.	15*	117	132	3918	3918
2.	Axle Boxes	3	18	21	3423	7341
3.	Cross Head Liners	14	127	141	2681	10022
4.	Big End Bushes YG	5	59	64	1614	11636
5.	Liner Bronze YP	1	33	34	398	12034
6.	Combing Cone 9 mm	4	114	118	307	12341
7.	Bush for Eccentric Crank YG	16	110	126	302	12643
8.	Bearing Brass $9\times4\frac{1}{2}$	35	64	99	294	12937
9.	Wear Plate	..	12	12	274	13211
10.	Face Liner YL	4	15	19	246	13457
11.	Gauge Column Cock	1	15	16	151	13608
12.	Spindle YP YG	4	5	9	81	13689
13.	Bush for Comn. Lever	68	40	108	80	13769
14.	Bushes Bronze WD	..	17	17	75	13844
15.	Pressure Cock	5	5	10	58	13902
16.	Face Liner YP	5	..	5	47	13949
17.	Plug YP. YG	6	8	14	34	13983
18.	Overflow Valve Stop	7	11	18	32	14015
19.	Follower Nut	12	..	12	30	14045
20.	Big End Bushes YL	..	8	8	28	14073
21.	Body WD	..	2	2	21	14094
22.	Delivery Cap	1	3	4	16	14110
23.	Valve Cover	2	5	7	15	14125
24.	Axle Box Bearing 7×4	5	5	10	15	14140
25.	Bushes Radius Rod	..	6	6	10	14150
26.	Bushes Union Link	..	4	4	7	14157
27.	Plug YL	1	5	6	6.50	14163.50
28.	Spindle WD	1	1	2	6	14169.50
29.	Delivery Cone 9 mm	..	3	3	5	14174.50
30.	Stop Cock	2	4	6	2	14176.50

*The figures given are imaginary

FIG.3. HAND BRAKE COLUMN (W/BG-1104)

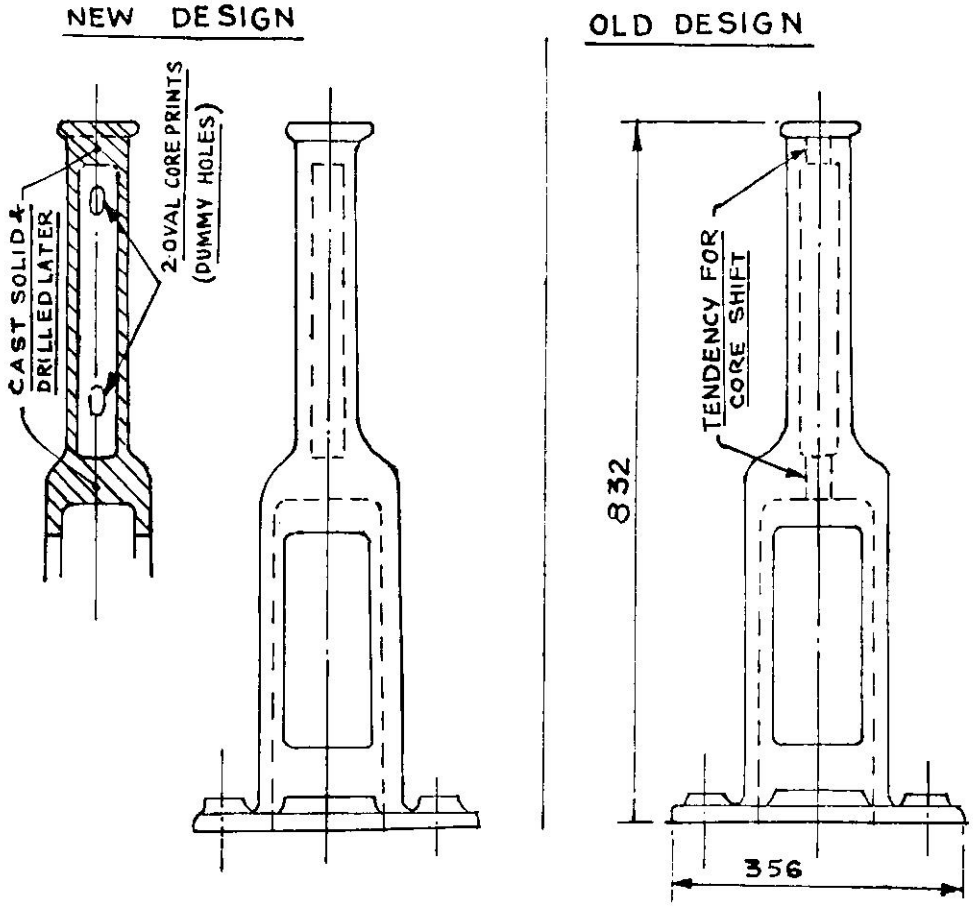
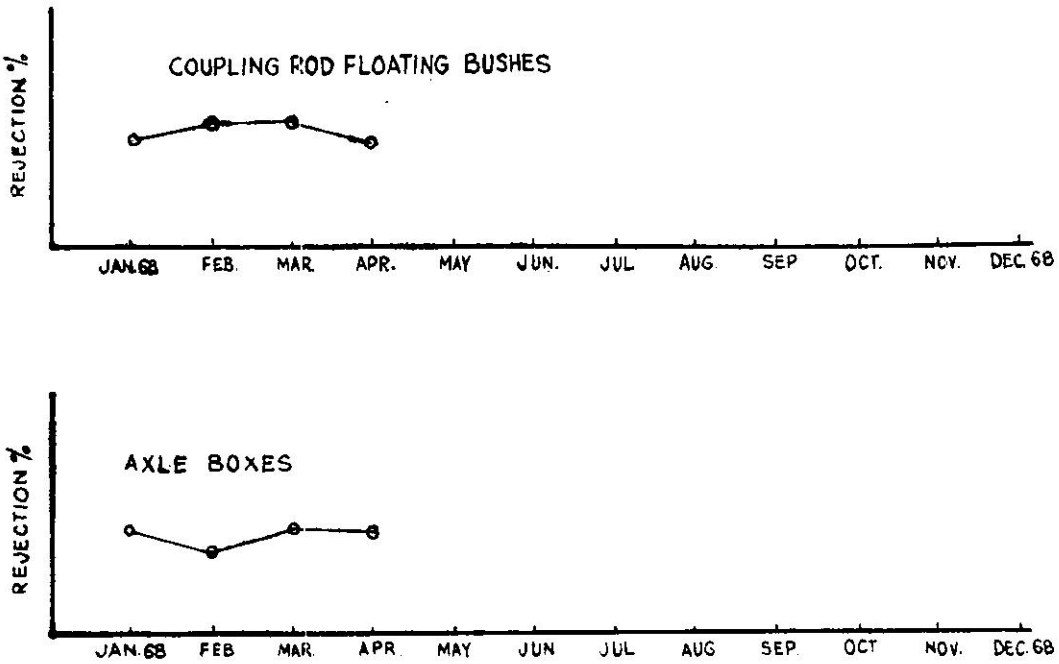


Fig2: REJECTION PERCENTAGE OF "A" ITEMS



the register for itemwise rejections was put up, the items were clearly demarcated as A, B or C and control exercised at different levels. The rejection percentage of the foundry as a whole was represented as a percentage of the cost of rejection in rupees to the cost of useful output in rupees.

As a result of this review, it was noticed that in the Iron Foundry, the loss due to rejections of Hand Brake Column was very high. It was even feared that some brake-vans being manufactured may have to be stabled unless the rejections were brought down. The main difficulty experienced was that the item had a very long and slender core which was unsupported in the middle. During pouring, the core invariably shifted. All heads were put together to find a solution to this problem. Reinforcement by chaplets did not help. It was suggested that the holes at the ends may be cast solid and then drilled. Even this did not help. It was even suggested that the item should be fabricated. Fabrication, however, was found uneconomical. Finally one person suggested that we could provide two additional oval core-points to support the core in the middle. It was noticed that this did not affect the performance of the part. This suggestion was finally adopted and the rejections came down to almost zero, making it a C item. Fig. 3 is a sketch showing the old and the new design.

From the short description of the method thus evolved, it will be seen that the representation of foundry rejections and their subsequent control was thus put on a very sound footing. ●●●

Dining Delays in Coffee House

S Dandapani*

In a Coffee House organised under the public sector in Eastern U.P., a time study was undertaken with a view to determining objectively the productivity of the 'dining space' on the one hand and for eliminating delay in service on the other. In the article printed here, the author methodically covers what is essentially a piece of research in a line that has, for many years past, not only caused delays and diseconomies but also losses in terms of frayed tempers and wasted energies. In a 'Coffee House' civilisation that is emerging in the country, high productivity in the line would save money and time and space, and be a blessing to many of us who are always on the rush . . .

THE TERMS OF REFE ENCE OF THIS STUDY were as follows :—

(i) "Total average time taken by a customer from the time he enters the Coffee House till he gets out be ascertained

(ii) "Extent of delay in service be quantified at each stage by a careful time analysis

(iii) "Having quantified the part of service from that of the period of consumption, quantitative analysis be undertaken with a view to determining the possible causes contributing to any inordinate delay in service."

hodology and Research Design

Since delay in service was peculiar to the period, it was decided that the time study undertaken between 1830 and 2130 hours, busy period for the Coffee House. Instead of adopting a sampling method, census method was followed, as it was possible to cover the entire lot in 3 hours' time with adequate "observers". A few supervisors were drafted for this special assignment and were suitably briefed in advance. They were given observation sheet with columns for recording the time of arrival of each customer, the time when the bearer took the order; the time when the dish was made available; the time when the customer completed the food and the time when he left the Coffee House.

The study was exploratory in character and the non-participant observation method was adopted. There was no "sampling" and so there was no chance of error. The limiting factor to the observation method, particularly when human behaviour was under assessment, was the psychological impact on the minds of those who were connected with the study. The bearers, managers and other staff were aware that there was some special observation by over half a dozen officials and it was quite possible that they would have been more alert

*Dr. S. Dandapani is Deputy Director, Cooperative xieties, Ministry of Railways, New Delhi

at the time of observation than on normal days. The findings suffer from this limitation.

Seating Capacity

The Coffee House had 16 tables and 64 chairs. However, 2 tables were sent for certain repairs, and the seating capacity came down to 56. Details of the location of tables and chairs on the date of study were as follows :

Location	No. of Tables	No. of Chairs
Main Hall	7	28
Family Room	2	8
Verandah Hall	5	20
Total	14	56

Percentage of Occupation

The number of customers visiting the Coffee House between 1830 and 2130 hours on the day of observation and the percentage of occupation of the chairs on that day were as under :

Location	Seating Capacity	No. of Customers	Percentage of Occupation
Main Hall	28	95	339·3
Family Room	8	7	87·5
Verandah Hall	20	76	380.0
Total	56	178	317·9

During the period of study, 178 customers visited the Coffee House against the seating capacity of 56, each chair having a turn round of 3.17 times. As was expected, the turn round in the ordinary chairs in the Verandah Hall was the greatest, the family room the least and the main hall moderate. Persons who got into the family room spent more time in talking after the meal and thus deprived the management of an adequate turn round. *The privacy usually cherished by a customer in the provision of a family room, unless compensated by increased quantum of sales, is a drag on the productivity of the dining space in the Coffee House.*

Details of the number of sittings and the customer occupation collected are tabled below.

While the total number of sittings in 3 hours was 87, the "per-table" average for the Verandah Hall and Main Hall was 7.4 and 7 respectively; whereas the family room average worked out to only one! The general average for the entire Coffee House works out to 6.2—or every 30 minutes there is a turn round in the matter of "sitting".

An interesting point that has come to notice is that while 178 customers did visit the Coffee House, they had come in groups and the average number of persons per sitting was only 2. There is a general tendency that when 2 persons enter a Restaurant, they look for a table which is empty. They know that each table has four chairs, and perhaps there may be chairs, vacant at certain tables, but they would look for an empty table with four chairs of which they occupy two, leaving the remaining two empty.

Number of Sittings and Customer Occupation

Location	No. of Tables	No. of Sittings	Average Sitting per Table	Total Number of Customers	Average No. of Persons Sitting
Main Hall	7	48	7	95	2
Family Room	2	2	1	7	3·5
Verandah Hall	5	37	7·4	76	2
Total	14	87	6.2	178	2

full occupation of all the chairs is an "ideal" ordinarily never achieved; but there is certainly :ope for improving the occupation ratio with view to obtaining optimum productivity of g space.

me Taken by the Waiter

Data collected in respect of the time taken / the waiter for taking order and serving food as under:

Time Taken By Waiter

Location	No. of Sittings	Total Time Taken by Waiter for Taking Orders (Minutes)	Average Minutes	Total Time Taken by Waiter for Service of Food from the Time of Order (Minutes)	Average Minutes
Main Hall	48	78	1.6	244	5.1
Family Room	2	6	3.0	8	4.0
Verandah Hall	37	98	2.7	221	6.0
Total	87	182	2.1	473	5.4

While there were 87 sittings, the time puted between the arrival of the customer the waiters' calling for taking order was 32 minutes, or on an average 2.1 minutes ere taken by the waiters for only taking the order. After the order was taken, the time taken for serving the snacks was 73 minutes, or on an average 5.4 minutes per er. From the time the customer occupied seat till he actually got what he ordered here was a time lag of (2.1+5.4=7.5 minutes) 5 minutes on an average.

Time Taken by the Customer

Data was also collected in regard to the time taken by the customer for consuming the food and the time spent on post-meal conversation. The position is tabled below the page.

On an average passengers have been taking about 10 minutes to consume snacks and coffee and spend about 4.4 minutes after completing food and payment of bills. This is considered reasonable. The leisurely manner in which the occupants of the Family Room consume food may be seen from the fact that they take 15 minutes against the general average of 10 minutes. Similarly for post-meal conversation, the Family Room occupants take 18 minutes against the general average of 4.4 minutes.

Total time spent in the coffee house by every customer

Total time taken by a customer, from the time he occupied a seat till he got out after

Time Taken By Customer

Location	No. of Sittings	Total Time Taken for Consuming Snacks and Coffee (Minutes)	Average (Minutes)	Total Time Taken by Passenger to Leave Coffe House After Payment of Bill (Minutes)	Average (Minutes)
Main Hall	48	552	11.5	186	4
Family Room	2	30	15.0	36	18
Verandah Hall	37	289	7.8	159	4.3
Total	87	871	10.0	381	4.4

taking his snacks, coffee, etc. was computed as follows :

Location	No. of Sittings	Total Time Taken (Minutes)	Average (Minutes)
Main Hall	48	1060	22
Family Room	2	80	40
Verandah Hall	37	767	20.5
Total	87	1907	22.0

On an average, each customer spent 22 minutes inside the Coffee House on the day of study. Those who occupied the Verandah Hall took the least time, viz., 20.5 minutes, and those in the Family Room the most time, viz., 40 minutes.

As a result of the voluminous data collected and research carried out in regard to the time spent by customers in the Coffee House during peak hours, we arrived at the following conclusions :

(a) On an average passengers take about 22 minutes from the time they occupy the seat till they get out of the hall after finishing the meal and making the payment.

(b) Of the 22 minutes spent in the Coffee House, 2.1 minutes are taken by the bearer to attend on the customers to take orders and 5.4 minutes for serving the food before them. In all, the time taken by the waiter from the time the customer occupies the seat till food is made available to him is 7.5 minutes on an average.

(c) The customer takes about 10 minutes on an average to consume food and takes another 4.4 minutes for a post-meal chat after payment is made. In all, the time taken by the customer for consumption in the Coffee House is 14.4 minutes on an average.

As regards the general average of 22 min per customer, it is felt that this is not a period and one should be able to budget much time for getting into a restaurant snack, tea etc. To use the well-known Wes dictum, "food is not expected to be through a conveyor belt in restaurants". customer is usually prepared to spend 20 to 25 minutes in a Restaurant or Co House of the type where interior decor wi colour schemes, lighting, furnishings etc., been provided.

From the point of view of business working efficiency, however, it is felt there is scope for improvement in the of delay in service particularly as it affe the utilisation of dining space and consequent the "business". While the average time by a waiter to attend to a customer has recorded to be 2 minutes which would fairly reasonable, there is still scope for cutti it down to 1 minute on an average. Similarl barring a few items of food and snacks whi had been prepared after the issue of the it should be possible to ensure supply of tea, coffee in less than 2 minutes after orders have been obtained. By the appli tion of the law of average, the "demand cu will have to get stabilised in a Restaurant peak periods and it should be possible to many of these items ready for service. is, therefore, considerable scope for up the service and stimulating the with an incentive scheme.

It is considered reasonable that a should take, on an average, about 10 minut to consume the snacks and beverages, but post-meal chat which stretches to 4.4 on an average should be discouraged by means. This can only happen when demand for seats intensifies itself and passengers are compelled to leave the realising the need for making room for othe This will call for great efforts on the of the management who should un examination of selling rates, quality and "demands" on the one hand and their ap for "image building" among the customers the other. ●●●

Technological Forecasting*

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a at Glasgow (UK), the first European Inter-Disciplinary Conference on Technological orecasting. Scientists from many fields were ented: Market Research, Economics, Analysis, Mathematics, Logic, Socio-, the physical sciences, pure and applied. popularity of the Conference can be magined from the fact that while 170 people expected to attend, the actual attendance as 270; and it's the big companies who had their representatives to find out what it as all about, for industry has found out by erience how costly it is to apply in practice ne results of scientific research, particularly nen large-scale manufacture has become ibly capital-intensive.

This Technological Forecasting is really hree problems in one. In the first instance, each science, the expected advances have to e plotted against a time scale; and then a ber of time scales for various sciences have be studied together, for a whole conglomera- of scientific advances must be simultaneous a given technique can be put on the ket. If you and I are going to play tennis, need the will, the time, court, rackets, balls, eather, and it's surprising how often one of lacks one of these vital pre-requisites. The of the atom—its basic fundamentals— as long known; and the uranium atom was fact split *before* the Second World War out in 1939, but it took six long years of mous effort and investment to perfect a very system, which proved such a tragic experience for the people of Hiroshima and Nagasaki. In fact "progress can only be as fast as the slowest technology....." This really corresponds to the idea with which economists have long been familiar, namely, that the efficiency of a system is really governed by the factor with the lowest efficiency level.

Technological forecasting is a really complex business, for it does mean not only forecasting scientific changes but also market demand, to correlate market and science so as to forecast the nature and timing of technological changes.

In actual practice, however, such forecasting is being done by modern governments and big corporations and it works reasonably well, provided the system is sufficiently flexible and constantly updated, as some inventions do occur "out of order".

While foreasting is essentially a mathematical business, a rigid line on the application of mathematical formulae is likely to mislead. Mathematics is a great help; relationships can be derived from the past and computers can do the sums. But mathematics cannot foresee discontinuities† and may fail to predict a continuous process if some relevant facts have been omitted. To help on this score, various logical devices have been brought in, three-dimensional diagrams, relevance trees, matrices and so on. Although many of them seem to complicate rather than simplify, they do have a purpose.

Really the basic governing factor is the rate of economic growth, not technical refinement: it dominates a product's market potential.

*This is based on an article on 'A Superior Snakes and ers', published in the *Economist* (London) dated July 1968, page 53. The 'quote' marks relate to sages taken from the article.

†See JM Keynes on 'Pseudomathematical Economics' printed in the last issue of the Journal.

Productivity of American Steel

IT IS OFTEN FORGOTTEN THAT DURING WAR time the United States built up a steel capacity of 120 million tons! Its full utilisation, however, has been materially affected by a number of factors, particularly the labour situation in the Steel Industry. Nevertheless, this enormous capacity has enabled the United States to be a substantial exporter of steel in the post-war period. However, due to the building up of steel capacities throughout the world, particularly in Japan and Germany, the U.S. position has been materially affected; in fact the U.S.A. has become a net importer of steel. Last year while imports rose above 11 million tons, U.S. exports declined to well below 2 million tons. Nearly half of the imports came from Japan and the remainder from the European Common Market countries, particularly Germany. Britain has also made an entry into the U.S. market.

The fact of the matter is that in equipment and technology other countries are now on par with the United States; and the opening of the St. Lawrence River to ocean-going traffic has facilitated the entry of foreign steel into the interior of the United States.

The contention of the U.S. steel industry is that the major cause of its inability to meet the internal demands of the U.S. market is its high "employment costs". For the U.S. industry the employment cost works out to $ 63 per ton while European Common Market countries pay only $ 35 to 40, an Japan as low as $ 20 to 25; hence with lo tariff barriers, foreign steel is at an adv in the U.S. market. There is, therefore, demand in the United States for the imposition of a quota system on imports of steel. Natu rally, Japan and German manufaturers ha also set up a lobby, which canvasses agai the imposition of import quotas. In f Japan is now working on the basis of a grov rate of 10% a year in exports to U.S Obviously Japan's productivity is rising to much higher level than the American; an Japan's productivity in steel is based imports of iron ore from India!

One of the most astonishing facts of histo is that India is the only country credited geologists with inexhaustable resources of ir ore : '*inexhaustable*' is the geologists' wor yet we have built up a steel capacity of onl 5 to 6 million tons, while China in the sam period (post-war) has built up a steel capac exceeding 15 million tons: even this may be an outdated figure. As it is, we are boggling at Bokaro, while Japan imports iron ore and exports finished steel to the Unite States!

British Tycoonery and Productivity

In a recent article Mr. Roger Opie has exposed the Fallacy of Tycoonery through odd calculations of the relative productivity of tycoons and common mortals, blasting the arguments commonly put forward in favour of inequalities to maximise Social Productivity. The following extracts from Mr. Opie's article are printed below for the enjoyment and enlightenment of the readers of the NPC Productivity Journal.

MR. JOCELYN HAMBRO, THE WELL-KNOWN political historian and banker...has just raised his salary by £24,279, or 21 per cent, to £225,145 per annum...in addition to *this mere pin-money*, Mr. Hambro also receives a hefty sum in what is known, more truthfully, as unearned income. As a banker Mr. Hambro of *course knows a great deal about money and so naturally has a lot of it*. He may also be, for all one knows, a very skilful banker, although one guesses that *the greatest skill he ever exercised in his life was in choosing the right bed to be born in*.

But does he do as well as that? Or since (as his son Rupert put it) *the salary increase was really by way of a productivity bonus*....

He has (we presume) increased his contribution to our welfare by no less than the total value of the output of four average skilled Englishmen working full-time. In 1966 Mr. Hambro was as good as any 20 average Englishmen, in 1967 as good as any 24 such chaps..... think of Mr. Owen Aisher of Marley Tiles, who is *worth 92 ordinary average Englishmen*!

And yet one wonders. There is no way of knowing but no reason to believe that Mr. Aisher is twice as productive as, say, Sir Donald Stokes of BMH-Leyland or four times as productive as Sir Ronald Edwards of Electricity Council, let alone ninety-two times as productive as the average skilled chap in industry...

Usually, one or more of five excuses are used. First, the rich deserve it, as reward for their efforts, skills, hard work. But talent, like virtue, is its own reward. Its possessor has done nothing but inherit it—why should he be paid for it as well ?

Or if the talent is not inherited but acquired, should we pay him more as a reward for that? That depends on how he acquired the talent. Why should, for example, a graduate be paid more for the rest of his life just because he enjoyed (often at the taxpayer's expense !) two more years at school and three or more years at University? He should be paid less thereafter, not more.

Or we might move on to the next argument: that high salaries are a necessary incentive to mobility and to hard work. Anyone who uses this argument must be opposed to inheritance... surveys don't confirm this argument—money ranks very low among the motives for shifting jobs. Indeed, Sir Donald Stokes 'works because he likes working'. And how

many are free to choose the amount of effort they exert? this is not to deny of course that we would all like some more, and that in some jobs small differentials for overtime or for piece-rates will get results. But not a differential of 92.

Or thirdly, are high incomes necessary to compensate for heavy responsibility or unpleasant working conditions? But *responsibility is in itself a big attraction. Why pay for it as well?* High incomes should, if anything, compensate for the tedium, frivolity and lack of satisfaction of non-responsible jobs. And again, the really unpleasant jobs in society—abattoir men, sewage workers—are the worst paid, not the best. *It is much more generally true that the best paid jobs are also the most pleasant—who has the large, quiet, cool offices with the small, quiet, cool secretaries, the penthouse and the chauffeur-driven cars? Not the floor sweeper.* The most oily argument for high salaries is that the top chap must have a high salary, not of course for himself but to give room to the chaps down below to give them something to strive for. The headroom argument has everything in its favour—selfless, plausible, vital—except evidence. *No one I know would turn down the chance to be boss whatever the pay*—indeed one could remind those who use the headroom argument that *in many fields one would naturally reject people who are only interested in the money.* In other words, if we were to iron out these salary scales we might actually get people placed in the hierarchy for the right reason—they want to do a decent job for its own sake.

More important, inequality distorts corrupts the whole of economic and socia life. The pattern of output is determined the pattern of expenditure which is determin by the distribution of income—the triv whims of the rich are satisfied before the n of the poor. In an era of full employment an rising living standards this is no longer serious or so offensive as it has been throu human history. But *we still live in a a c where more than one-fifth of the houses no bathroom—at a time when for instance the Hamble River alone, there are* 3,000 *yach insured for a total sum of £*20*m. No incen left in this Country? Ha!*

It will be argued that we have to pay top managers high incomes or they will em This is nonsense—they are much too c i emigrate anywhere, and *many of them scarcely earn a penny outside the old family* In any case, we don't need to pay each of a fortune just to retain those youngsters might otherwise emigrate. Nor is there evidence that people emigrate just for money. *And if tycoons argue that by U standards they're miserably paid, by U.S. ards they're miserably inefficient too.* E survey shows that American managers in UK are more efficient than the British, British managers in the U.S. are less effi than the American.....●●●

Government by Bluff

A real story was told by Gandhiji in the *Harijan*, commending the handling of affairs, at a critical moment, by the Governor of the North West Frontier. In the stormy days of the Red Shirt Movement, the Khan Brothers threatened to hoist the National Flag on Government House. The army was lined up and the Governor stood on the steps of Government House, ready to give orders to shoot. The non-violent Red Shirt volunteers prepared to walk up the steps of Government House, but there was no order to shoot! Instead they were allowed to go up. The Governor took the National Flag from them and himself hoisted it on Government House, but the Governor had concealed behind him a Union Jack. He took it out and hoisted it higher than the Congress Flag! Thus was terrible bloodshed prevented; and Gandhiji went out of his way in commending this non-violent way of governing men.

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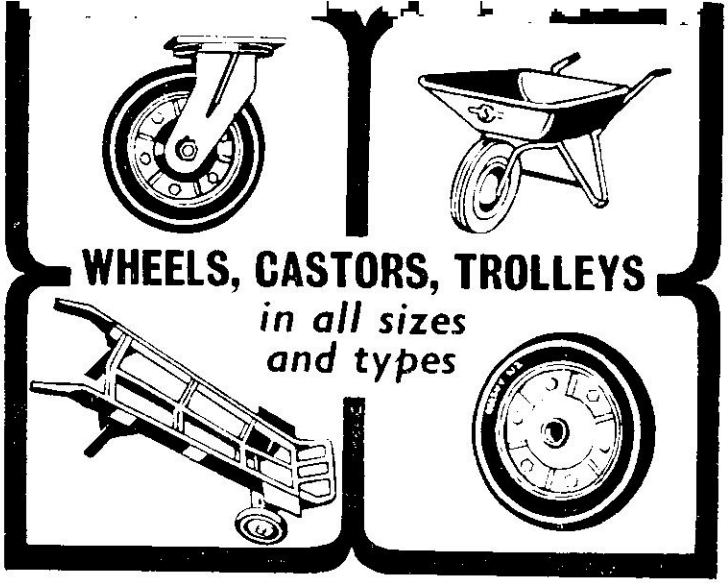

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