ANALYSING INDIA'S EXPORT SIZE AND COMPOSITION

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A failure on the part of the planners to take into account the implication of change in the size and composition of India's export may cause immense damage to the economy

In course of her economic development, obviously, the composition of export of India is changing. Now it is definitely useful to identify the structural implication of the changes in the size and composition of export. This paper demonstrates how input-output technique can be used to trace the economic impact of the changes in the composition of the export. An expanded input-output framework incorporating the more complete interaction process has been employed to show that some sectors which seem apparently insignificant in the context of our export basket, emerge as significant contributors to our export in the ultimate sense. The structural implication of the shift from traditional sectors to non-traditional sectors on the export front has been explored both in the standard and the extended input-output frameworks.

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Free international trade tends to promote economic growth of nations through the operation of the principle of international division of labour. Of course, there are many non-economic considerations influencing the effective degree of participation of any country in the international trade. Often, through the passage of time and in course of economic development, the nature and size of trade involvement of nations tend to change. Mostly, the changes materialise through the interplay of various economic and non-economic forces operating within and without the country. In fact, certain equilibrating mechanism operates to determine the volume of export and import of each nation. Of course, certain national level or international level control instruments may be effective to a certain extent to divert the direction and composition of equilibrium volume of trade of a country.

However, it is our objective in this paper neither to analyse the economic forces determining the equilibrium volume and composition of trade nor to design the policy instruments for the control of trade but to trace the repercussion of the trade activity particularly of the export and we intend to identify the exact pattern of change in the composition of India's export in the last decades and the impact it generates on the entire economy. It is easily understood that in course of economic growth in India, the interdependence of various economic sectors is also on the increase. Now, when we have a look at the export basket of India of today, some sectors/commodities seem to be more prominent than others and it could easily happen that some other sectors/commodities had more prominence yesterday. Now simply identification of the more dominant sectors in the export basket does not give any idea about the pattern of change of export of India.

If the implication of growing interdependence among various economic sectors is recognised in its true sense, then it will be clear. Why the change in the contents of the export basket as it just looks will not lead to the full understanding of significance of the pattern of change of export.

The input output analysis can help us enormously in tracing out the repercussion throughout the economy of a 'given' change even in the remotely connected sector. It helps us to identify the nature, extent and location of the impacts of given changes in the levels of activity of any one or more sectors. We observe that the notion with regard to the significance of a certain sector/commodity judged by its direct contribution in the export basket may be to a large extent revised when rounds of repercussions on the economy are considered. It may further be noted that the repercussion estimates captured through standard I/O model is incomplete. So an expanded I/O framework has been designed to

facilitate the capturing of the complete interaction process and to be in a better position to trace the impact of the change on the composition of the export.

This paper attempts to (1) discuss the standard Leontief Input-Output model and the expanded framework for projecting the complete rounds of repercussions of export, (2) indicate the pattern of change in the composition of direct export basket of India in the last decades, and (3) project the direct and indirect output requirements of the export sector of India for the recent years with the help of both the standard I/O model and the expanded model describing the results of the analysis.

The Standard Input-Output Model

With the transformation of the mode of production from primitive self-contained to more elaborate processes leading to increasing interdependence, specialisation and exchange, the need to investigate the interwoven web of economic interdependence, both in its theoretical and empirical aspects, became more and more urgent. The standard Leontief model is just a landmark in offering an empirically manageable tool to analyse the phenomenon of economic interdependence. A simple Leontief system can be described in terms of a set of simultaneous linear equations as follow:

$$x_i = \sum_{j=1}^{n} X_{ij} + F_i \qquad (i = 1, 2, \ldots\ldots n) \qquad (1)$$

where x_i stands for gross output of the ith industry, x_{ij} is the output of the ith industry used as input in the jth industry and F_i denotes the output of industry available for outside consumption, export, government consumption, capital formation, etc. If we postulate that every commodity is produced by only one given process and denote $x_{ij} = e_{ij}\, x_j$ $(i, j = 1,2\ldots\ldots n)$ where a_{ij} stands for the amount of the ith good used to produce a unit of jth product, we can rewrite the system of equations (1) as

$$x_i = \sum_{j=1}^{n} a_{ij}\, x_i + F_i = \qquad (i = 1, 2, \ldots\ldots n)$$

Equation system (2) constitutes the fundamental relationship of a simple Leontief system.

It is a multisectoral model of an economy which is divided into n number of sectors and involving no joint production. It assumes one process per commodity and uses constant input coefficients. Such an assumption, apart from making the model analytically more manageable, enables us to have a one-to-one correspondence between industries and products.

In matrix notation, the balance relations may be written as

$$AX + F = X$$

where $A = (a_{ij})$, $x = (x_j)$, $F = (F_j)$ i.e. A, the input Coeff. matrix, F = Final demand vector,

X = output vector.

The solution may be obtained as

$$X = (I-A)^{1}F$$

X may be viewed as the total output requirement (direct plus intermediate) for the final demand vector F, the $(I-A)^{-1}$ matrix captures the circular interaction process in the intermediate output requirement.

The Extended Input-Output Model

The simple Leontief model captures the circular interaction in the processing of indirect output requirement. The income and consumption of the household sectors are treated as exogenous to the system. Now, in the processing of output requirement for any exogenous vector income is generated which leads to demand for consumption and thereby generating a further cycle of output requirement. Obviously to capture the circular interaction process in a more complete sense income and consumption of the household sectors requires to be endogenised. This leads to developing an extended variant of I/O model. In addition to the familiar assumptions of the standard I/O model, the following assumptions are made.

(1) W_{ki}, the income generated to the kth household sector in ith processing sector, is a linear function of the output level X_i in ith sector.

(2) Again, the consumption of the ith processing sector by kth household sector is an assigned proportion of income of the kth household sector.

The balance relations in the standard model may then be

written in a partitioned matrix form as,

$$\left(\frac{A\ C}{V\ O}\right)\left(\frac{X}{W}\right) + \left(\frac{F}{O}\right) = \left(\frac{X}{O}\right)$$

given $\left(\frac{F}{O}\right)$ We can solve for $\left(\frac{X}{W}\right)$

We get, $\left(\frac{X}{W}\right)$

$$= (I - A^*)^{-1}\left(\frac{F}{O}\right)$$

Where $A^* = \left(\frac{A\ C}{V\ O}\right)$

Now if we define $\left(\frac{F}{O}\right)$ as the export vector then $(I-A)^{-1}$ F (1) and $(I-A^*)^{-1}$ F (2) will give the

(1) direct plus indirect output requirement vector;

(2) direct plus indirect plus output requirement stimulated by feedback effect of induced consumption.

Changing Composition of India's Export

There was a near stagnation in the value of exports in the first decade of planned economic development (1951-61) of India. From the beginning of the Third Plan we observe some remarkable signs of upward movement in the value of our exports. That is why we have chosen 1961-62, the first year of the third plan as the base year of our study on the pattern of export composition. June, 1966 devaluation is supposed to have some impact on the size and composition of our export. Hence, we have considered 1967-68, a suitable intermediate year for the study of implication of change in the pattern of export. As the year 1973-74 and 1978-79 mark the beginning of the Fifth Plan and the beginning of the Sixth Plan, respectively we have chosen these two years also as two terminal points of our study.

For the purpose of sensible comparison over years and to derive meaningful economic implication of the pattern of change of export, everything is measured in money values and at constant prices (1960-61 prices). In 1961-62, aggregate value of the export basket of India amounted to Rs. 574.10 crores of rupees. In 1967-68, it jumped to Rs. 705.8 crores of rupees. In 1973-74, the export basket of India valued Rs. 905 crores of rupees. In 1978-79, aggregated value of export of India amounted to Rs. 1303 crores of rupees. If we take the 1961-62 as the base year (100) the index of export in the year 1967 becomes 122.94, in 1973-74, 164-60, the index became 227.00 in 1978-79. Now, let us have a look into the pattern in which the composition of the export basket of India has undergone changes during the period 1961-62 to 1978-79. In the sixties, the engineering and investment goods industries contributed very little to our export basket and this will be revealed from the following observation. In 1961-62, the share of electrical equipment in the export basket was .26 per cent, of transport equipments .20 per cent and of non-electrical equipment .24 per cent. In 1967-68 marginal increase in the shares of these sectors in the export basket took place—electrical equipment .73 per cent, transport equipment .84 per cent and the non-electrical equipment .67 per cent. In value terms, of course, between 61-62 and 67-68 there was 239 per cent increase in the export of electrical equipment, 240 per cent increase in the export of transport equipment and 236 per cent increase in the export of non-electrical equipment. As between 1961-62 to 1967-68, there was much greater increase in the size of contribution of the other sectors, the share of these sectors could not increase substantially. In the seventies, these sectors accounted for substantial contribution in the export basket. In 1973-74, the contribution of these sectors were Rs. 16.74 crores, (1.77 per cent), Rs. 32.80 crores (3.47 per cent) and Rs. 88.94 crores (9.47 per cent), respectively. Compared to 1961-62 values, there were 11 times increase in the export of electrical equipments, 18 times increase in the export of transport equipments and 63 times increase in the size of export of non-electrical equipment. In 1978-79 we observe further increase in the contribution of export both in value terms and in terms of shares in these sectors basket: electrical equipment Rs. 32.12 crores (2.32 per cent), transport equipment Rs. 55.82 crores (4.04 per cent) and non-electrical equipment Rs. 247.13 crores (17.92 per cent). It is interesting to note that non-traditional and comparatively modern sectors captured sizable share (about 25 per cent) in the 1978-79 export basket. Iron and Steel Industry had

almost a consistent pattern of increase in both the size and share in the export basket of India: 1961-62 (1.68 per cent), 1967-68 (4.80 per cent), 1973-74 (4.20 per cent), 1978-79 (5.55 per cent). The index number of export of iron rose from 100 in 1961-62 to 792 in 1978-79. The share of the other metals and non-metals in the export basket increased from 7.60 per cent in 1961-62 to 12.03 per cent in 1967-68. Then, it declined remarkably to 2.72 per cent in 1973-74 and thereafter declined further to 2.57 per cent in 1978-79.

Size of export also decreased. The sector 'Cement' did not contribute at all to export in 1961-62 and 1967-68. In 1973-74, the share of cement in export is as much as 4.99 per cent and in 1978-79 it is 4.41 per cent. The share of 'Leather and Leather Goods' increased from 5.57 per cent in 1961-62 to 12.39 per cent in 1967-68 then it decreased to 11.16 per cent in 1973-74. A further decline by .96 per cent in the share of the sector occurred in 1978-79. The sector 'Food Industry (including Plantation Industry)', a traditional export sector of India, is steadily losing its share in the export basket of India and the unfortunately the sectors is losing in absolute size also since 1960-61. In 1961-62, in the export basket the sector 'Textile' contributed Rs. 195.80 crores (34 per cent share), in 1967-68, the size of the contribution came down to Rs. 166 crores (23 per cent share), in 1973-74 a further decline occurred to Rs. 144 crores (15 per cent share), in 1978-79, the size of the contribution increased to Rs. 175 crores but the share in the export basket declined to 12.20 per cent. 'Agriculture and Animal Husbandry' is contributing roughly a constant share in the export basket (around 10 per cent). 'Chemical Industry', a non-traditional sector is slowly gaining share in the export basket of India. From 1.36 per cent share in 1961-62, the sector has obtained a share of 1.67 per cent in 1967-68, then to 4.95 per cent in 1967-68 and then 7.0 per cent in 1978-79. Wooden products and glass wares had no contribution to the export basket in 1961-62 and 1967-68. In 1973-74 the sector has contributed a share of 1.95 per cent and in 1977-78 the share has decreased frcm 1.95 per cent to 1.74 per cent. In the critical sixties the sector 'Fuel' had some marginal contribution to the export basket. Quite understandably, in seventies, as India has to depend to an increasing extent on import for the supply of fuel for its increasing fuel requirement, the question of export of fuel does not arise at all. Rubber Industries though did not contribute at all in the export basket during sixties, in seventies, it has emerged as a contributor to export basket, though marginally.

Projecting Output Requirements

A 19 sector production coefficient matrix and a 22 sector augmented matrix developed by the present author (1976) has been used here to project: (1) direct and indirect output requirement for the various export vectors of different years (2) projecting the total optput requirement which includes the intermediate output requirement and the output requirement due to feedback effect of induced consumption as well. As we are concerned in this paper to have the picture or repercussion on the economy of variation in the composition of the export vector, we need these projections. Now, for the purpose of subsequent discussion and for ready reference we call the direct export basket of different years as the basket 1, the basket containing direct and indirect output requirement in various years as the basket 2 and the basket containing direct and indirect output requirement plus the feedback effect of induced consumption as the basket 3.

At first let us examine how the total size of basket 2 and that of basket 3 has altered resulting from the change in the size and composition of the basket 1. If the size of the basket 1, only changed without any change in the sectoral composition there could be only a proportional change in the size of the basket 2 and basket 3. Between 1961-79, the change in the composition of the export basket has given rise to slightly greater increase in the total size of basket consistently. But the growth pattern of the total size of the basket 3 is rather different. The basket 3 has grown in size by 21.07 per cent between 1961-62 and 1967-68, which is less than the growth size of basket 1 and basket 2 in the same period; between 1967-68 and 1973-74. it has also grown by less than that of basket 1 and basket 2, but between 1973-74 and 1978-79, the index of size of basket 3 (1961-62=100) has grown to 303.09, whereas the index is 224.00 for basket 1 and 244. 27 for basket 2. Between 1973-74 and 1978-79 the composition of the

basket 1 has changed in such a fashion that consequent impact on output requirement via income generation and induced consumption is much more than of the impact in the previous periods.

Now let us have a look into the pattern of change in the composition of the basket 2 and basket 3 through 1961-79. We observed that in the basket 1, though the sector 'Textile' was slowly losing share consistently since mid sixties, it remains the leading contributor upto the terminal points of our analysis (1978-79). When the basket 2 and the basket 3 are considered, we find that the sector 'Agriculture' continues to be the leading contributor in both the baskets. In the basket 1 the share of Agriculture decreases from 12.92 per cent in 1961-62 to 5.84 per cent in 1967-68, then rises to 10.20 per cent in 1973-74 and then rises by 2.3 per cent in the year 1977-78. In the basket 2 (incorporating only the direct and intermediate output requirements), 'Agriculture' happens to be the leading contributor throughout the period of our analysis, the share decreases from 53.37 per cent in 1961-62 to 49.20 per cent in 1965-66, then it further decreases to 37.39 per cent in 1973-74. In 1978-79 the share of Agriculture further declines to 30.41 per cent. In the basket 3 (incorporating the intermediate output requirement as well as the feedback effect of induced consumption), Agriculture has a share of 42.39 per cent in 1967-68, the share declines to 39.73 per cent, in 1973-74 and a further marginal decline of .68 per cent occurs. In 1978-79, the share further declines to 37.44 per cent. Inspite of the decline in the share in both the baskets the absolute size of contribution in the basket 2 and the basket 3 consistently increases. This indicates that though Agriculture has not much of contribution in the direct export basket, indirectly the sector 'Agriculture' has a still now the leading role to play in our export earnings. The big share of 'Agriculture' in the basket 3 simply implies that whatever the change in the composition of the export basket that has occurred during 1961-79, the feedback effect of induced consumption generating pressure on output requirement in the sector 'Agriculture' continues to be substantial. As we are considering only physical export, obviously the sectors 'Transport' and 'Trade & Services', although we have zero contribution in the basket 1. When we consider the basket 2, we find that the size of contribution of the share in the basket is 1.23 per cent, in 1967-68, the absolute size of contribution increases to Rs. 20.08 crores and the share in the basket increases to 1.60 per cent. In 1973-74, the size increases to Rs. 27.53 crores, but the share decreases to 1.65%. In 1978-79, the size increases to Rs. 45.28 crores and the share increases to 1.84%. Now, if we consider the basket 3, we observe that in 1961-62 the size and share of contribution of the sector 'Transport' are increasing overtime. In 1961-62 the absolute size and share of contribution of the sector are Rs 68.78 crores and 2.06 per cent, respectively. In 1967-68, they are Rs. 37.36 crores and 2.17 per cent, respectively. In 1973-74, it is Rs. 118.28 and 2.18 per cent, respectively. So we infer that though the export basket as such has no direct implications in terms of contribution of transport, indirectly it has some impact on transport, though not so significant. The changes in the composition of the export basket also has not much significance in terms of impact on the requirement of transport.

The sector 'Trade and Services' has no direct contribution in the export basket (we have excluded invisibles), but the size and composition of the export basket of India (the basket 1) has significance in terms of the impact on Trade and Services through intermediate output requirement and it is still more significant when the feedback effect of induced consumption is considered. Of course, the variation itself in the composition of export through 1961-62—78-79 has not any remarkable significance in terms of indirect output requirement. From the tables it can be easily understood that in 1961-62, if we consider the basket 2, we find that the size and share of contribution of the sector 'Trade and Services' has been of size of Rs. 71.87 crores and share 7.29 per cent, respectively; in 1967-68, size being of Rs. 100.67 crores and share being 8.05 per cent, in 1973-74, Rs. 148.58 crores and 8.90 per cent, respectively, in 1978-79, Rs. 238.06 crores and 9.67 per cent, respectively. So we find that there has been consistent increase both in size and share of 'Trade and Services' in the basket 2. But more interesting thing is revealed by the composition of basket 3. In the basket 3 the sector 'trade and services' has a sizeable share although. This share increases from 18.40 per cent in 1961-62 to 18.50 per cent in 1967-68, to 18.87 per

cent in 1973-74 and to 19.13 per cent in 1978-79. So, it becomes clear that when feedback effect of induced consumption is taken into consideration, the composition of our export basket seems to have interesting implication in terms of the requirement of 'Trade and Serviees'. Of course, the changes in the composition of the basket 1 have no sizeable impact on basket 2 and basket 3.

Obviously, the sector 'Electricity generation' has no direct share in the export basket. But in the basket 2, the shares are 1.29 per cent (1961-62), 1.49 per cent (1967-68), 1.66 per cent (1973-74) and 1.69 per cent (1978-79). This means that changing pattern of composition of export has some impact in terms of increase in the requirement of electricity generation, though the increase in requirement is marginal. In the basket 3, we find that, though the size of power requirement is quite substantial, the shares are like 1.00 per cent (1961-62), 1.07 per cent (1967-68), 1.13 per cent (1973-74) and 1.14 per cent (1978-79). Though marginally, it seems that our export baskets are growing indirectly more and more power intensive over years.

For the sector 'Textile' in the basket 2, the absolute size increased from Rs. 208.03 crores in 1961-62 to Rs. 268.42 crores in 1967-68, then to Rs. 294.71 crores in 1973-74 and then to Rs. 336.66 crores in 1978-79. The share of 'Textile' in the basket 2 (i.e. in the intermediate output requirement) remained almost to 17.66 per cent in 1973-74 and a further decline in the share to 13.68 per cent occurred in 1978-79. The decrease in share inspite of increase in size simply means that increase in sizes in other non-traditional sectors were more pronounced. Now, if we consider the basket 3, we find that the size of the sector increased from Rs. 356.63 crores in 1961-62 to Rs. 446.25 crores in 1967-68 and then to Rs. 533.41 crores in 1973-74 and then Rs. 679.51 crores in 1978-79.

It is interesting to note that the shares of the sector 'Textile' in the basket in all the years of our study are comparatively smaller than those in the basket 1 and basket 2. In the basket 3 also, the share marginally increases from 10.73 per cent in 1961-62 to 211.09 per cent in 1967-68, then it declined to 9.86 per cent in 1973-74 and a further decline took place in 1978-79.

The share of 'Food Industry' sector in the basket 2 decreased from 34 per cent in 1961-62 to 23 per cent in 1967-68 and then to 15 per cent in 1973-74. A further decline in share in the basket 2 occurred in 1978-79 when it came to 12 per cent. In absolute size also the contributions of the sector decreased. It may be noted that multiplier effect is comparatively smaller for this sector. In the basket 3, the share decreased from 13.51 per cent in 1961-62 to 11.56 per cent in 1967-68 and then to 10 per cent in 1973-74. It further declined to 9.54 per cent in 1978-79. We observe consistent decline in the share of the sector in the basket 3.

In the basket 2 the share of the sector 'Electrical Equipment' increased from .16 per cent in 1961-62 to .44 per cent in 1967-68, then to 1.08 per cent in 1973-74 and then to 1.42 per cent in 1978-79. So, there was a consistent increase in the share of the sector in the processing of indirect output requirement. In the basket 3 also the increase in the share was from .24 per cent to .32 per cent, then to .52 per cent and then to .64 per cent. So, it may be said that though there is an increasing trend in the share, still now resulting feedback effect of induced consumption originating from the increased share of the sector in the export basket is not significant. For the sector 'Transport Equipment' the shares in the basket 2 were like .18 per cent (1961-62), .49 per cent (1967-68), 2.03 per cent (1973-74), 2.35 per cent (1978-79). In the basket 3, the shares were like .28 per cent (1973-74), .37 per cent (1967-78), .85 per cent (1973-74), .96 per cent (1978-79). So, almost same inference may be drawn for this sector. For the 'Non-Electrical equipment' sector there was significant increase in the share in the basket 2. From .50 per cent in 1961-62 to .85 per cent in 1967-68, then to 5.82 per cent in 1973-74. In 1978-79, the sector has 10.68 per cent share. In the basket 2, the shares were like .86 per cent (1961-62), .97 per cent in 1967-68, 2.51 per cent in 1973-74, 4.08 per cent in 1978-79. So, among the non-traditional items, we find that the sector 'Non-Electrical equipment' accounted for remarkable increase in the share in all the baskets. The growing prominence of this sector in the export basket partly explains the growing relative decline in the share of the sector 'Textile'. The sector 'Iron & Steel' had insignificant contribution in all the baskets in

1961-62. But in 1978-79 we find that in the basket 1 it has a share of 5.55 per cent, in the basket 2 the share is 6.67 per cent and in the basket 3 it takes the share of 2.31 per cent. The reason for higher share in the basket 2 is that 'Iron & Steel' has significant roles in the processing of intermediate output requirement of most of the sectors.

Need for Careful Export Planning

Often, when export planning is in the process, the basic objective becomes the earning of foreign exchange and to pay for import. But if the structural implication is not looked into, sometimes the damage to the economy through the shortage of resources in certain sector or any other bottleneck being created may be harmfully overlooked. Any conclusion based on a mere observation of direct participation in trade of the various sectors of the economy can at best be partial. The secondary requirements of such deliveries to trade sector are, in fact, absolutely essential to draw any meaningful conclusions not only regarding the relative significance of the various sectors in exports but also the total sacrifice in terms of domestic output which a given level of exports of a specified composition implies to the economy. The assumption of fixed input coefficients and consumption coefficients in the model obviously, limits the accuracy of the results obtained with regard to contribution of the sectors in the basket 2 and basket 3, but the interpretative value of the results in terms of multiplier effect on the economy is hardly affected.

Note: The baskets could not be incorporated here for non-availability of space. The readers are requested to make querries, if any, to the author directly.

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PLANNING FOR PRODUCTIVITY

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As a careful planning system facilitates coordination of efforts and improves efficiency within the organisation, it forms a crucial determinant of productivity

Planning is a major management function that must be performed for any organization to have long-run success. The topic discussed in this article assumes once managers have developed organizational objectives and they are ready to start planning. Planning requires not only generalization of information for making decisions, but decision making itself. The kinds of decision and types of data should dictate the choice of who is involved in what aspects of planning within an organizational structure.

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Basically, planning is the process of determining how an organization can arrive where it wants to go. Planning is the process of determining exactly what the organization will do to accomplish its objectives. Another formal way to define planning is, "a systematic program directed at reaching agreed objectives by the process of analyzing, evaluating, and selecting, among the opportunities which are predictable."

Over the years management has developed several different planning techniques which are protective and affirmative. The protective approach to planning is to minimize risk by reducing the uncertainties surrounding business conditions and clarifying the consequences of related management action. The basic purpose of planning is to increase the degree of organizational success ! In addition to this, a second reason for planning is to coordinate an effort within the organization. The absence of planning is usually accompanied by an absence of coordination and us ually contributes to organizational inefficiency.

A vigorous planning program helps managers to be future-oriented. They are forced to look beyond daily problems and project what may face the manager and organization in the future. Managers who look only at the *present* and neglect the future seem headed toward certain failure. The planning function assists managers in their efforts to coordinate their decisions. Another major advantage of planning is that it emphasizes organizational objectives. Since organizational objectives are the starting points for planning, managers are constantly reminded of exactly what their organization is trying to accomplish.

If the planning function *is not* well executed within the organization, planning as an activity may have several disadvantages. For example, an overemphasized planning program could consume too much managerial time. A good manager must strike a balance between time spent on planning and time spent on their other functions of organizing, influencing, and controlling. Many managers openly voice the opinion that sound planning can increase productivity and profits.

Planning is the primary management function. It is the function which precedes and is the foundation for the organizing, influencing, and controlling functions of managers. Only after managers have developed their plans can they determine how they want to structure their organization, place their people, and establish organizational controls. Organizing, influence and controlling are interrelated and based upon the results of planning.

Tactical Vs. Strategic Planning

When one reviews the literature on planning activities, this literature review can be divided into two types of planning: tactical planning and strategic planning.

Tactical planning is short-range planning that emphasizes current operations of various components of the organization. This short-range planning can be defined as a period of time extending only about one year or less into the future.

Strategic planning is long-range planning that focuses on the organization as a whole. Management considers the organization as a total unit and ask themselves what must be accomplished in the long run to attain organizational goals. The

long-range planning time period can extend from three to five years into the future. Managers are trying to determine what the organization should do to be successful during the specified time period.

It is important to remember, managers need both tactical and strategic planning programs, but these programs must be highly related to be successful. Tactical planning will focus on what to do in the short-run and strategic planning will help the organization to achieve its goal in the long-run. Although all levels of management typically are involved in the planning process, upper-level managers usually spend more time in planning than lower-level managers. Lower-level managers should be highly involved with the everyday operations of the organization and have less time to contribute to planning. The type of planning managers do also changes as managers move up the organization.

The Planning Process

The planning process contains six major steps: (1) Stating organizational objectives (2) listing alternative ways of accomplishing organizational objectives, (3) developing premises upon which each alternative is based, (4) selecting best alternative for accomplishing objectives, (5) develop a *plan* to pursue chosen alternative, and (6) putting the plan into action. Again, a good statement of organizational objectives is necessary before planning begins, since planning focuses on how the management system will accomplish its objectives. After an alternative has been chosen, managers begin to actually develop their plan.

There are three basic approaches or philosophies to performing the planning function: (1) the high probability approach, (2) the maximizing approach, and (3) the adapting approach.

The *High probability* approach to planning is based on the philosophy that there should be a high probability that the organization will be successful. Emphasis *is not* on being as successful as possible but on reaching some acceptable level of success. The high probability approach to planning has both advantages and disadvantages. The advantage is that this approach usually generates an extremely feasible plan. Planners aim on a practical way of attaining the desired success level. A disadvantage of high probability approach is that it usually does not encourage creative planning. A planner will not deviate from his plan program making the planning process a conservative way of reaching the desired level of success.

The *Maximizing Approach* is based on the philosophy that 'the organization should be as successful as possible'. Generally, planners are not satisfied with the acceptable level of success characteristic of the high probability approach, but instead emphasize maximizing success, planners using the maximizing approach make constant use of quantitative techniques and other mathematical models. The maximizing approach to planning, like the high probability approach, has advantages and disadvantages. An advantage is that this approach continually emphasizes reaching the full profit potential of an organization and uses sophisticated quantitative techniques to develop plans. The disadvantage, generally treats components of oranizations quantifiable, although some aspects of organizations, such as human behavior, are not.

The *Adapting Approach* emphasizes that effective planning concentrates on helping the organization to change or adapt to internal and/or external variables. This approach is based on the philosophy that an *inability* to adapt is the major obstacle to oranization successs. Planners who use this approach (1) see organizational change as inevitable; (2) concentrate on future changes, and (3) determine how to best modify the organization as the time for changes approaches. The disadvantage of the adapting approach includes a lesser emphasis on organizational objectives than either high probability or the maximizing approaches. The adapting approach has the advantage of focusing on both the internal and external environments of the organization to predict organizational changes. Regardless of the planning approach used, this environmental analysis is necessary if an organization is to remain viable.

A Concluding Note

As shown in Fig. 1, the planning approach most managers should use is probably some mixture of the high probability, maximizing, and adapting approaches. This combination

approach emphasizes the advantages and deemphasizes the disadvantages of each of the other approaches. As with most managers the following points are stressed: (1) planning is the process of determining how the organization can get where it wants to go. (2) Planning is the primary management function. (3) Both strategic and tactical planning must be interrelated for a planning program to be successful. (4) As managers move from lower to upper levels of management positions, they can expect to spend more time planning. They will also find that the emphasis of their planning activities will change from tactical to strategic planning as depicted in Fig. 2.

MANAGEMENT LEVELS	PERCENT TIME IN PLANNING ACTIVITY							
President	1%	2%	5%	17%	15%	25%	30%	5%
Vice-President	2%	4%	10%	29%	20%	20%	13%	2%
Manager	4%	8%	15%	38%	20%	10%	5%	-
Superintendent	6%	10%	20%	43%	10%	9%	20%	-
Dept. Mgt.	10%	10%	25%	39%	10%	5%	1%	-
Sect. Supervisor	15%	20%	25%	37%	3%	-	-	-
Group Supervisor	38%	40%	15%	5%	2%	-	-	-
TIME PERIOD	Today	1 Week	1 Month	3 to 6 Months	1 Year	2 Years	3 Years	5 Years
	SHORT RANGE PLANNING ←							→ LONG RANGE PLANNING

Figure 2 Movement of planning activities from a short range to long range as management level changes.

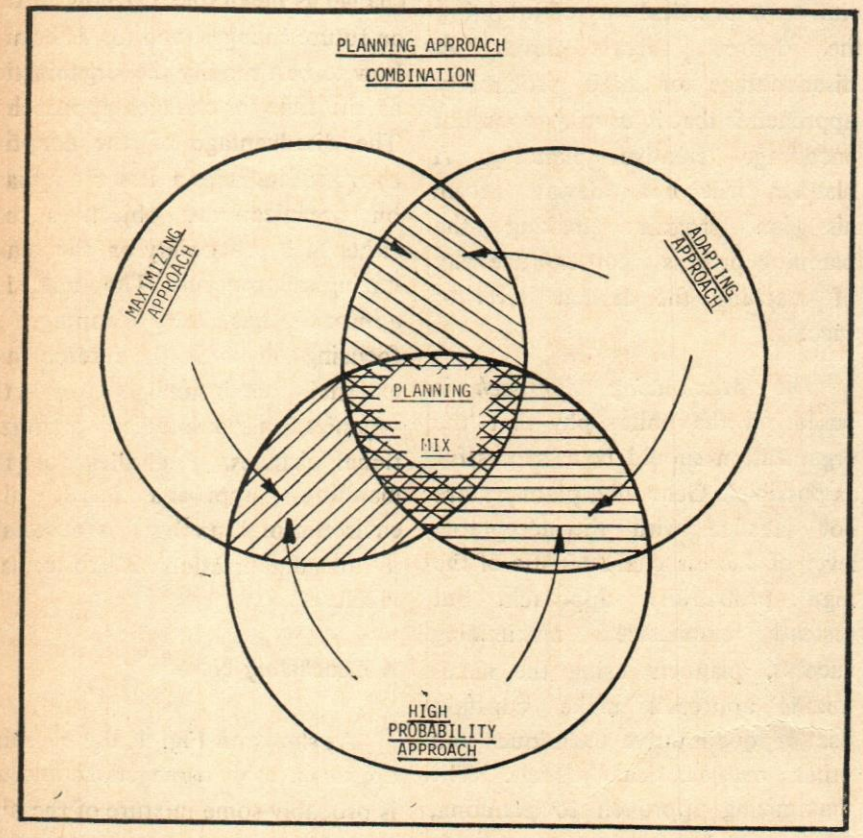

Figure 1 The planning manager generally will use some mixture of various planning approaches.

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Improving Capacity Utilisation

Kedia, Y.P.

Even if profitable organisations cannot afford under utilisation of their capacity, why concerted efforts are not made by all to diagnose the causes for inadequate capacity utilisation and accordingly use corrective measures

A case study of a machinery manufacturing plant has been described to demonstrate the relevance of improving capacity utilisation, identifying handicaps and using corrective measures. Despite growing demands for its product, the performance of the industry as a whole was not satisfactory for varied reasons. Stress is laid on the need for increased production and profitability in the plant under study indicating its available capacity, load, and workmen's efficiency at different centres. This follows an analysis of capacity utilisation using the six stage model and various options available to management and their impact on capacity utilisation. There prevailed incentive for labour efficiency which, however, was adversely affected by over-time payment and other issues. The author describes several corrective measures to be used currently and at a later stage for improving capacity utilisation in the plant.

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Most of the times, under utilization of capacity is either not evident or is overlooked particularly when the enterprise is making profits despite the under-utilization. However, it is not difficult to see that such a situation cannot last very long. Moreover, the factors affecting utilization of capacity are some times difficult to identify and, at other times, are difficult to tackle with, even when identified.

Growing Demand for Product

The industry concerned with manufacturing this type of machinery is well established and can successfully manufacture, install and commission plants of the capacity required. The industry is also in a position to export. According to the Handbook of Statistics, 1979 [1], published by the Association of Indian Engineering Industry, there are 24 units engaged in manufacturing, erecting and commissioning this equipment. The number of units, as indicated in the annual survey of industries, are much more since ancillary units are also included.

It is, thus, seen that there is a fairly wide manufacturing base in this industry and the equipment can be considered to be enjoying a competitive market. Production figures for the entire industry are indicated in Table 1.

Guidelines for Industries (1976-77) [2] has indicated this: "There is substantial scope for expansion and diversification of existing units". The firm under consideration had sufficient orders. Various manufacturing load centres revealed orders pending for a period ranging from 6 months to 2 years. The firm was also accept-

Table 1

Year	*Capacity Target in Rs. worth*	*Production in Rs. worth*	*Capacity Utilization*
1972	—	17.90 crores	—
1973	—	19.20 crores	—
1974	—	20.00 crores	—
1975	28.15 crores	27.40 crores	97%
1976	—	31.00 crores	—
1977	36.00 crores	39.83 crores	110%
1978	50.00 crores	33.00 crores	60%

Note : 1. Based on *Handbook of Statistics* (1,3,4)
2. These figures are not modified for the price rise. The output in money value has been steadily rising till 1977. 1978 saw a slight decline in the output.

ing orders other than the main items of machinery and plant.

Why Inadequate Capacity Utilisation in the Industry

It can be seen from Table 1 that the performance of the industry as a whole has already declined during 1978. Even during the earlier years, the performance, in terms of capacity utilization, was only apparently satisfactory, as the capacity utilization, as measured, is not satisfactory due to the following reasons:

1. Capacity indicated by Industry was only a target based primarily on marketing potential.

2. Money value, in any case, is not a satisfactory measure of the capacity of different units, since capacity to produce is independent of prices prevailing in the market.

3. Production figures include value of purchased components and hence do not, in fact, show the value added by the firms. Most of the firms resort to vertical integration and add capacity for producing components also after the operations of assembly, testing and commissioning are fully established.

Why the Plant Needs Increased Production

The firm under consideration was working in two shifts. Order book was full and there was a need to increase production to meet the promised delivery dates. The repercussions of not arranging for increased production would be:

- ☐ Extension of delivery dates and consequent loss of goodwill of customers.
- ☐ Loss of credibility and erosion in the capacity of the firm to get more orders.
- ☐ Reduced share of market which would be difficult to revive in the face of ever-increasing competition.

Why it Needs Improved Profitability

After checking the firm's records in some detail, it was found that:

- ☐ the company buys its requirement of castings and forgings, but has satisfactory welding facilities;
- ☐ weldments, castings and forgings are machined within the plant for which adequate facilities are available;
- ☐ these finished components as such or as assemblies are sent to the site where components ordered on other sub-contractors and manufacturers of special equipment are also received;
- ☐ erection and commissioning of the equipment is also undertaken by the firm.

A discussion with the authorities revealed that the approximate sales and profits of the manufactured components, purchased components and of the erection and commissioning operations are as indicated in Table 2.

Table 2

Item	*% of sale value*	*% of profiits on sale value of the component*
Purchased components	40	15
Manufactured components	40	Nil
Erection and commissioning	20	15

It is thus, clear that the manufacturing division is not contributing to any profits.

It was further clear that, while profits on purchased components can partly be justified as a reward of co-ordination effort spent by the firm in selecting the right vendor, placing the purchase order and monitoring the purchase, the same can also be looked down upon as Middleman's profit, being inflationary in character and hardly productive in nature. As a result, two public sector companies have started quoting for such plants and after obtaining the orders, are re-ordering the components and erection and commissioning on established manufacturers, the expectation being that the Middleman's profit can be reduced. In future, therefore, the firm would find it increasingly difficult to enjoy a comfortable market.

Moreover, with many suppliers eager to swallow the profits on purchased components attributed to

middlemen, there was an urgent need to have a close look at the manufacturing activities, as earning profits on your own manufacturing activities appears to have become vital for future profitability.

Assessing Cost Centres

The shop was divided into a number of cost centres. Each cost centre had a number of load centres. Tables 3,4 and 5 indicate the relevant parameters of analysis: available capacity, load and workmen's efficiency.

Table 4: Cost Centre No. 2

(Details for December)

Item	*Load Centres*			
	Lathe	*Vertical Boring*	*Horizontal Boring*	*Shaper*
Monthly available capacity in Man-M/c Hours	7809	7846	3482	5479
Load in Actual Man Hours/month	7127	10557	6291	70
Surplus/(Deficit)	681	(2611)	(2809)	5400
% of Surplus/Deficit to available capacity	+8.0	−33.0	−80.0	+98.1
Average efficiency of working in %	62.0	51.0	67.5	54.8

Table 3 : Cost Centre No. 1

(Details for December)

Item	*Load Centres*			
	Lathe	*Horizontal Boring*	*Vertical Boring*	*Slotting*
Monthly available capacity in Man-M/c Hours	15574	10996	3866	4035
Load in actual Hours/month	21251	11409	5024	4876
Surplus/(Deficit)	(5677)	(413)	(1155)	(841)
% of Surplus/Deficit to available capacity	36.5	—3.7	—30	—20.8
Average efficiency of working in %	57.9	60.3	52.0	48.5

Alternatives

The machine shop is working in two shifts. To meet the pending load at a number of load centres, the following alternatives were available to the firm:

- ☐ Start third shift working on these load centres.
- ☐ Put workers on over time.
- ☐ Off-load these items to other firms.
- ☐ Improve workers' efficiency.
- ☐ Improve availability %, i.e. of equipment by reducing break-down, absenteeism, etc.

Table 5: Cost Centre No. 3

(Details for December)

Item	*Load Centres*						
	Lathe	*Vertical Boring*	*Horizontal Boring*	*Planer*	*Shaper*	*Slotter*	*Horizontal Milling*
Monthly available capacity in Man-M/C Hours	51537	1698	3445	7125	1703	1869	20758
Load in actual Man Hours/month	41091	2064	3158	7455	2691	3180	35935
Surplus/(Deficit)	10445	(366)	287	(330)	(938)	(1311)	(15177)
% of surplus/deficit to available capacity		−21.6		−4.6	−55.0	−70.0	−73.0
Average efficiency of working in %	54.0	32.5	41.0	41.5	47.0	55.0	53.6

Definitions and Nomenclature

Monthly available capacity in Man-M/c Hours	= Total Man-M/c Hours available/ month less (−)
	− Hours lost through absenteeism and through genuine idleness, on account of breakdown of machines etc. (1)
Total Man-M/c Hours available/ month	= Total No. of staff employed on a load centre × 8 (No. of hours per shift) × No. of working days per month. (2)
Availability %	= $\frac{(1)}{(2)} \times 100$ (3)
Total production in standard hours	= Total production of one component as certified by inspection through that load centre × No. of standard hours allowed for that job on that load centre. (4)
Average efficiency of workers	= $\frac{(4)}{(1)} \times 100$ (5)
Capacity utilization	= Average worker's efficiency × monthly availabile capacity
	= Average worker × $\frac{\text{Availability}\%}{100}$
	= (5) × (3) (6)

Analysing Capacity Utilization

Capacity utilization analysis is more appropriately undertaken by employing the six stage model [5]. The six stages to be considered are as follows :

1. Total investment in creating capacity.
2. Theoretical installed capacity.
3. Theoretical rated capacity.
4. Planned capacity.
5. Budgeted capacity.
6. Actual Production.

Both 2 and 3 assume 8760 hours of working of each equipment per year, but operational time in 2 is based on collaborator's time, or established through appropriate techniques, whereas in 3 these operational times are considered after being downrated due to poor method applications, faulty work measurement or under labour pressure, etc. Planned capacity (4) is less than the theoretical rated capacity, if labour is employed to work less number of shifts or less than 8760 hours. Budgeted capacity (5) is established after taking care of the demand trends, availability of power and other inputs. Difference between planned capacity/budgeted capacity and actual production is due to excessive (more than the norms adopted) breakdown, absenteeism, power failure etc.

Management Options

Various options available to management and their impact on capacity utilization are indicated in Table 6.

Table 6 : Impact on CU of various Management Options

Management Option	*Impact on CU*
1. Employ additional workers in third shift.	Improve planned capacity vis-a-vis theoretically rated capacity, i.e., bridging the gap between 3 and 4.
2. Permit over time to workers.	Improve budgeted production vis-a-vis the planned production, i.e., bridging the gap between 4 and 5.
3. Off-load some items to trade.	Improve budgeted production vis-a-vis the planned capacity, i.e., bridging the gap between 4 and 5.
4. Improve labour efficiency.	Improve theoretical rated capacity to bring it nearer to the installed capacity, i.e., bridging the gap between 2 and 3.
5. Improve availability percentage.	Bridging the gap between 5 and 6.

The management of the plant under consideration showed adoption of the solution options in the following order :

5, 4, 2, 3, 1.

Additional employment was the last priority, in view of the following:

- ☐ Expectation of labour efficiency improving in the near future and the possibility of extra staff becoming redundant.
- ☐ Uncertainty of getting orders at the present rate in view of the growing competition from the public sector firms.
- ☐ Third shift working not being in vogue in the region.
- ☐ Third shift working considered costly, inefficient and a headache.
- ☐ Perceived additional labour problems due to extra labour force.

Off-loading or sub-contracting was next to the last priority, due to:

- ☐ Dearth of reliable sub-contracting firms.
- ☐ Expectation of labour efficiency improving in the near future.
- ☐ Possibility of profit margins being eroded in future.

Availability % was found to be reasonable and did not provide much scope for improvement. On the face of it, labour efficiency was considered fairly low and could be improved.

Incentive for Labour Efficiency

(a) Monthly payments to workers, on an average, were examined and are given in Table 7.

Table 7

(Rupees)

	Shops			*Total*
	HMS	*LMS*	*Fitting*	
Direct wages	24408	20030	6097	79502
Over time	22768	8610	4601	84040
Incentive payment	2370	1200	713	1=390

HMS : Heavy Machine Shop
LMS : Light Machine Shop

(b) Under the incentive scheme prevalent in the plant,

If Standard Hours of all jobs done during the month by an operator $= K$

and

Actual Hours taken by him $= K'$

Then, efficiency of operator $= \frac{K}{K'}$

There was a point system in operation and incentive payments were made to staff if the efficiency was beyond 50%

Overtime Payment — A Damper on Efficiency

It can be seen that incentive earning was very low compared to overtime payment and there was hardly any motivation to improve efficiency.

More efficiency means more production during the same time period and, hence, need for overtime. Since this might lead to less payment, due to reduced overtime, to the same worker who is improving efficiency, the workers are inclined to continue working at a lower efficiency so that overtime can be continued. Overtime payment, as per factory act regulations, is twice that of normal pay and OT payments are, therefore, more lucrative than increased payments earned through better working efficiency.

In case of OT working, total number of hours for which machines are operated are more than the normal working hours and to that extent, utilization of equipment is better even though the productivity is lower due to lower labour efficiency. Two options open to the management, therefore, are:

More hours worked at less efficiency with extra hours paid at OT rate and less efficiency naturally not rewarded by incentive payment.

OR

Operation of plant according to planned hours worked at high efficiency with more efficiency rewarded by more incentive pay-

ment and no need to pay at OT rate.

Second alternative is obviously a better option. Firstly, when efficiency is uniformly low and overtime is paid to a few, over-all result is low production. Secondly, in course of time, a dysfunctional view is likely to prevail and even at load centres, where workload is not in arrears, efforts will be made by workers to bring about a situation where OT can be demanded and would have to be sanctioned, if the authorities are pursuing a policy of overtime working to meet extra load.

According to the management, it was impossible to curtail OT unless the labour efficiency improved due to a very serious backlog of orders.

It was, therefore, a situation where management could not afford to curtail OT unless workers' efficiency increased and workers were unlikely to be motivated to increase efficiency unless OT was reduced and the need for additional income was perceived. The situation prevailing is depicted in Fig. 1.

If the labour efficiency could be improved through a concerted action of management, the model could be modified to appear as given in Fig. 1.

More the orders, more the desire of management to have better labour efficiency and better efficiency results if action by management is effective.

Better efficiency of workers leads to less demand and less actual booking of OT, which, in turn, prompts still better efficiency on the part of worker to compensate for the loss of earning due to less overtime.

It is obvious that management's action can either make the circle a vicious one or an extremely profitable one.

Analysing other Issues

To further analyse the reasons of low labour efficiency, the following features needed examination :

1. *Quality of Standard Times Fixed* :

In almost all the load centres, while average efficiency was low, efficiency of individual workers was more than 100 also. This proved the attainability of the standard times.

It was also found that the standard times were borrowed from the collaborators and modified to suit local conditions of M/c and plant and also tested through independent time studies and synthetic time data.

2. *Operation Parameters* :

(i) The basis of standard time fixation was recorded in Industrial Engineering Departments. Number of cuts to be taken, depths of cut, speeds, feeds, cutting tools to be used for each and every operation on each machine were available.

(ii) However, it was seen that the actual practice differed widely from the planned one. It was not evident that this was done deliberately. Most of the workers were not aware of the correct speeds, feeds, etc.

(ii.a) Industrial Engineering Departments had prepared charts indicating proper speeds and feeds for various types of jobs, but these were not available with the workers now.

(ii.b) Because the information was not readily available on the spot, the difference between planned and actual parameters of cutting and working do not become evident to workers, supervisors or even officers and corrective action is, therefore, either not taken or delayed.

3. *Setting Time* :

(i) Setting procedures were found to be very crude. No standard components and devices were available with workers. T-bolts, packing pieces, nuts, etc., were also not available in adequate quantities. Setting took lot more time because of this.

(ii) Setting times, on the other hand, have been kept as indicated by collaborators and according to memories of those who had been to the collaborators' works, and the setting fixtures for various operations which were in use there. It was, therefore, a clear anamoly

in as much as, under the given conditions, a worker was bound to take more time for setting.

(iii) The setting time was more significant because of jobbing character of the shop and difficulty of standardising the setting procedure, setting fixtures, etc.

4. *Cutting Tools and Accessories* :

(i) Cutting tool design was not carried out for all operations. Standard tools and accessories were used and some of these were found to be inadequate for job. Thin and long boring bars were used to cut small bores at very reduced depth of cut and speed.

5. *Availability of Crane and other Facilities* :

In a number of cases, operations were found to be waiting for crane. But this was not reflected under that heading because, while the operator waited for the crane, he did not care to punch his job card off and punch in the idle time card. Similarly, idle time cards were not punched for many other situations, like waiting for machine (under maintenance), orders (jobs not available), etc. Supervisors, being directly responsible for this component, discouraged workers to book idle time on such grounds.

It was, therefore, apparent that low worker efficiency could be due to any one of the following :

- ☐ Excessive setting time on machine due to non-availability of proper fixtures and standard accessories.
- ☐ Sub-optimal cutting speeds; feeds and depths of cut, reasons being lack of knowledge on the part of the worker and non-availability of adequate information to the workers from the Industrial Engineering Department.
- ☐ Excessive idleness on many counts beyond the control of the operator, even though these were not always recorded and a number of discrepancies were noticed between actual and recorded idle time.
- ☐ Worker malingering and wasting time.
- ☐ OT rate being more attractive than the incentive rate.
- ☐ Some workers being untrained and really slow.

Though a thorough work sampling was ordered, enough evidence was available to prove the existence of the above factors.

Identifying Corrective Measures

Following corrective measures were proposed and accepted after discussion :

(i) *Workers' Education* : It was decided that for each operation on each job on each machine, a blue-print will be prepared indicating :

- ☐ the outline of the concerned portion of the job;
- ☐ tolerances required;
- ☐ details of speeds, feeds and number of cuts;
- ☐ cutting tool requirement;
- ☐ setting time permitted; and
- ☐ availability of jigs and fixtures.

Every worker was duty bound to use these parameters and a surprise check could enable comparison of actual with blue-print. Each worker was to be given a booklet containing information for all the jobs with which he was concerned.

(ii) *Better Loading & Unloading of Jobs and Reduced Time Setting* : The workers were to be provided with standard clamps. bolts, spacers, supports and where necessary, fixtures. Setting times were to be standardised and fixtures improved.

(iii) *New Boring Bars, Cutting Tools* : Better cutting tools and accessories were to be designed for critical operations.

(iv) *New Incentive Scheme* :

(a) Even though new fixtures, setting arrangements were to be provided, standard time was not proposed to be revised. Workers were to be encouraged to improve their efficiency and earn more money as incentive payment.

(b) After a certain level of efficiency, the rate of incentive payment per point was to be given a sudden raise, as follows :

50% to 75% efficiency – 2 P. per point per hour – maximum being 200 hrs/month, i.e., Rs. 100/- p.m.

75% to 90% efficiency – 100 + 3 P. per point per hour – maximum being equal to Rs. 190/-.

90% and above ,, – 5 P. per unit/hour.

(v) Overtime was to be progressively brought down.

The Porter-Lawler Model

The above corrective action is based on the application of the Porter-Lawler model, [7] which considers the labour efficiency to be a function of the following :

(i) knowledge of the operation;

(ii) fairness of the effort-reward relationship;

(iii) perceived equitableness of the reward.

Techniques for Further Application

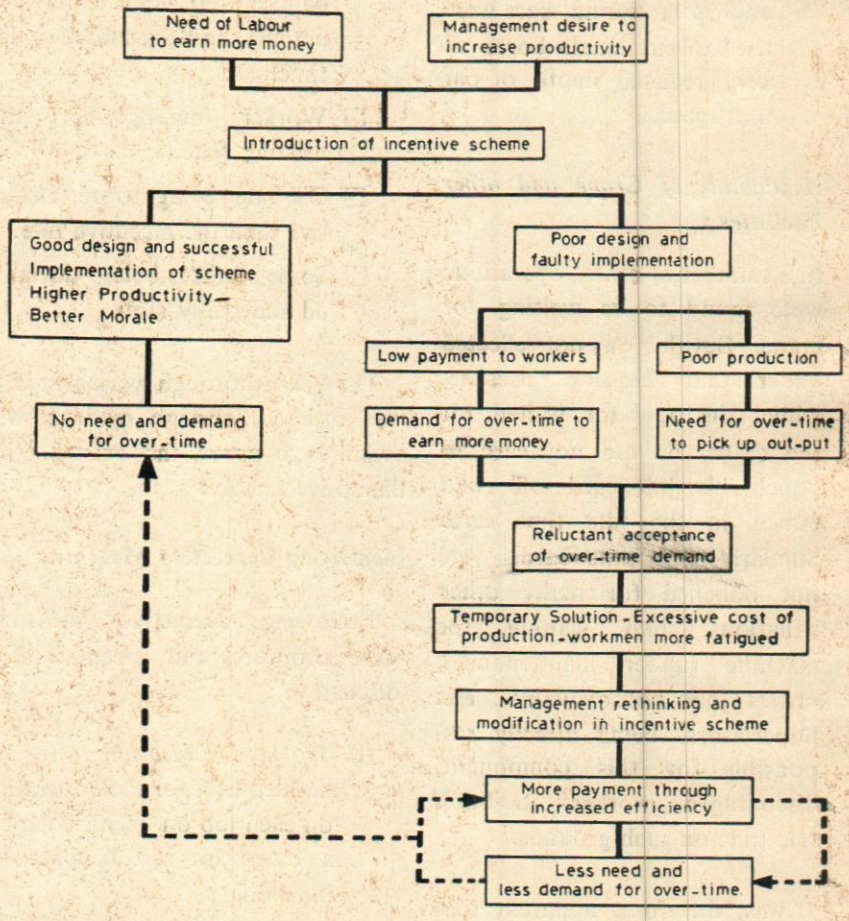
The following techniques were recommended to be tried after attaining a satisfactory level of workers' efficiency :

(i) *Group Technology* :

The cost centres were designed a long time ago and the relevance of grouping certain machines in one particular cost centre was at best based on Product Layout principle, i.e., one component should be completed with one cost centre as far as possible. This principle has long since been recognised as leading to better production control. However, since the jobs keep on changing and the number to be produced is not large, it is necessary to allow considerable and cost set-up times between successive jobs. It is, therefore, necessary to study the jobs according to processes and details of working and group jobs on a set of machines so as to enable the same set-up to be used for various jobs with either no change or minimum change.

(ii) *Identifying the Marginal Operator* :

Even with the action taken as specified in the first part of the project, some workers will be found to be slow in picking up or deliberately trying to appear slow for many reasons which include laziness, union pressure, lack of confidence, wrong habits and other personal reasons etc. This will be a right time to keep a careful watch on these persons and study the underlying



REDUCING OVER-TIME THROUGH BETTER INCENTIVE SCHEME

Fig. 1

causes for this behaviour [6]. There should be very few such staff.

(iii) *Operations Research Techniques* :

Better scheduling and sequencing of jobs through well laid out programmes and principles will form the next step. When defects can be noticed without trouble, the same must be rectified first and sophisticated analysis done later. However, optimization for the entire system is only possible through system analysis and that requires increased use of OR techniques. In this case, linear programming and network analysis (from raw material to the erection and commissioning) and many other techniques can be usefully applied.

A Concluding Note

This was a factory with a well laid out system of working based on time standards, cost standards and efficiency conciousness.

It was only because of this base that a study could be made quickly and shortcomings pinpointed.

Scope of improvement is naturally tremendous. The direction of effort for the best results has to be determined after due analysis of facts. Choice of technique had to be determined carefully.

In Indian conditions, technological constrains, lack of attention to working details can form a very important cause of under-utilization of capacity and low productivity.

Expansion through more shift working is not preferred as long as the efficiency of working is poor and, in case this is ignored, the expansion will drift the enterprise towards sickness.

Overtime working, so usually resorted to in India, is suicidal for the plant, particularly in times of slight recession with its adverse impact on labour efficiency and clear production control.

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RESURRECTING A RAILWAY CORPORATION

Emergence of Organisational crisis and breakdown can be checked and effectiveness restored through timely action research measures

Acharya, R.C.

Nigerian Railway Corporation utilised the consultancy services of the Rail India Technical and Economical Services (RITES) to overcome a crisis it suffered since 1963-64 and improve its managerial and organisational effectiveness. Based on a careful diagnosis of the problem, attempts were made to build a task force for effective transfer of technology and evolve development plans to revitalise the system. Propelled by effective results accomplished through reorganisation and innovations, a guideline for future action was evolved as a follow-up and reinforcement measure.

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The Deteriorating System

Nigerian Railway Corporation, (N.R.C.) the largest govt. undertaking of Nigeria, had been very effective and viable until about 1960. The system from then onwards gradually started deteriorating. The physical performance indicators, viz. its freight traffic and the number of passengers carried came down by 32% and 51% respectively over a period of 13 years from 1963-64. The deterioration of the performance was due to various reasons, major amongst which were:

- ☐ Lack of involvement of top echelons and no clear cut policy being laid in regard to long term developments.
- ☐ Lack of confidence displayed by successive governments leading to gradual reduction in funds for maintenance and development.
- ☐ Multifold increase in revenue from oil and greater emphasis being placed on development of Road Transport.
- ☐ Flight of talent and trained hands from the organisation.

Approaching for Consultancy Services

The Nigeria Federal Government felt the need for revitalising the system as an alternative to the Road system. They invited a number of organisations viz, 'SOFER RAIL' of France, 'CANAC' of Canada, 'Trans-Mark' of UK and 'Rail India Technical and Economical Services' (RITES) of India to submit proposals for revitalising the system. A survey was carried out by each organisation and reports submitted in August 1977. After the visit of a high level delegation to India in October, 1977 and after detailed discussions, the contract was awarded in October 1978 to RITES for the Management support.

Diagnosing the Crisis

The total route track of the N.R.C. is over 3600 kms with 274 stations. Main traffic routes are Lagos to Nguru via Kano, and Port Harcourt to Maiduguri via Enugu and Banchi. The two routes are joined at Kaduna and Kafanchan, respectively forming an inclined H. For administrative convenience the Railway with Main Headquarters at Lagos, is divided into 6 Districts with their respective Headquarters at Ebute Metta, Ibadan, Zaria, Bauchi, Enugu and Kafanchan.

When the new management took position in early 1979, the general health of the Railway system was in a run-down condition. As a result of serious neglect in maintenance, out of reported fleet of around 7,000 wagons and 800 coaches only 2,500 and 500, respectively were available for movement of traffic. Similarly out of a total fleet of 219 line locomotives, only

97 locomotives were in working order.

A variety of spare parts for repairing the various assests, including the rolling stock, were lying unutilised in the stores. Notable among these are loco spare parts valuing (Naira) 2.5 million, and miscellaneous stores items for 12 million. In addition, 7 wheel lathes of value 2.5 million and track materials worth 13 million were also available, unutilised.

Due to lack of enough technical staff in the system, there was a virtual breakdown of the maintenance infra-structure, communication systems and control-systems. Similarly, workshops, and locomotive running sheds were working at low capacity for a variety of reasons like shortage of trained staff, shortage of electric power, congestion caused by damaged stock and improper organisation in the sheds. On account of the low availability of rolling stock the number of passenger train services got reduced and even those which ran were constantly out of schedule. The wagon loading was also drastically affected due to poor availability of wagons and locomotives. Also there were no printed passenger tickets available at most of the stations because of non-availability of blank cards for printing. The passenger earnings, therefore, were not coming into the coffers of the Railway fully.

Building a Task Force

For the first time, perhaps in the history of the RITES as well as NRC, the concept of a Management Task Force was developed. This involved replacement of the entire top level management including the General Manager and 5 Asstt. General Managers in charge of Finance, Operations, Mechanical/ Electrical, Civil Engineering and Administration. Middle and other levels of management were given suitable support at key positions. Additional posts to assist the existing 5 Regional District Managers were created. Similarly four major sheds were made to come under new District Mechanical/Electrical Engineers (Diesel). The rest of the task force comprised of Diesel Maintenance personnel and also Electrical, carriage and wagon maintenance, signal, telecommunication and operating technicians. The entire NRC has a total work force of about 39,000 men and the induction of about 420 RITES staff as task force in the organisation was aimed mainly to effect strong coordination and training of the Nigerian staff. Certain key areas required manning adequately at the higher management levels in addition to the existing NRC managers. It enabled intensive supervision and effective transfer of technology.

Making Innovations

The task force took about a month to identify problems in key areas in each discipline which had to be tackled on priority. Both long and short term plans were drawn up and actions initiated with full involvement of the local staff. In the entire exercise, the key word was 'innovation' and making maximum use of the existing assets and facilities. Over a period of 25 years, NRC has phased out steam locos. However, the four loco maintenance workshops were not completely re-planned and laid out to cope up with the increasing number of diesel locos. It was decided to modify and convert the existing facilities to take care of diesel locos instead of going in for entirely new facilities which might have been 4 to 5 times more expensive. Marginal increase in covered area, changes in track, lay out, additional work platforms, lifting facilities, new sections for Battery Charging and Maintenance, Laboratory testing, Switch-gear repairs and Fuel injection equipment were all accomodated. Simultaneously, work study of all activities in the Maintenance Depots were undertaken thus improving the productivity.

As the idea was to use the existing assets and facilities effectively, innovation had helped in the conversion of existing old covered wagons with wasted bodies, uneconomical cattle wagons, open lowsided wagons, etc. into container carrying flats. Similarly over 100 overaged wagons which were otherwise condemned due to wreck under frames were reconditioned to carry motor cars. About 400 hopper type surplus wagons of civil engg. were converted to move wheat. The track capacity being fully saturated, the passenger trains were being detained heavily for crossing or precedence. Most of the way-side stations of NRC are provided with 2 lines only and in case of a damaged rolling stock or a failed locomotives occupying one of the lines, it becomes a single line station. This is the major cause for detainment of trains for several hours.

A novel solution was found out through using locos in 'Multiple' to pull a single train. In this process, there was a considerable reduction in total number of trains being run and reduced delays for crossing and precedence, etc. This reduced the possibility of a section getting blocked if a locomotive failed, even with one loco working, the load could be cleared in two portions at a reduced speed. Another innovation was the conversion of the obsolete petroleum oil tank wagons into that for vegetable oils and HPFO.

It was decided that the latest sophisticated type of systems and equipment be transferred to the N.R.C. The two key areas in which maximum inputs were organised were Diesel locomotives, maintenance and the communication centres known as 'Control offices'. Not only new technical facilities in these two areas were developed, but also the transfer of the technical-knowhow was effectively carried out. This was achieved through a number of well planned and developed extensive training programmes. These programmes were organised by the major training centres and management institutions in India. The training programmes numbered to high figure of 261.

Evolving Development Plans

The Fourth National Development plan of the Nigerian Federal Government envisages greater demands and preference for rail transport. The plan provides for two approaches to satisfy these rising demands: (i) the rehabilitation and reactivation of the existing Railway network and (ii) surveying, mapping and designing of a Broad Gauge system for construction in future. As the second proposal is likely to take considerable amout of time and resources, a dominant role is expected to be played by the existing metric gauge system for the next 20 to 25 years as major carrier of goods & passenger traffic.

The main inputs in the plan period to cope up the expected 300% increase in freight and 330% increase in passenger traffic, are the following.

- ☐ Acquisition of 180 mainline Diesel locos, 20 Diesel shunters, 4400 wagons and 832 passenger coaches
- ☐ Construction of new locomotive shed and satellite sheds
- ☐ New carriage and wagon workshop
- ☐ Training facilities
- ☐ Track Reconditioning
- ☐ Increased line capacity through creation of additional block stations, improved signalling, and third looplines for crossing facilities
- ☐ Creation of micro-wave Repeater Stations
- ☐ Building of bridges and culverts
- ☐ Infrastructure development like facilities at stations, staff quarters, training centres etc.

The Results Accomplished

With the inputs organised for repair and maintenance, training staff, re-structuring of the organisation etc., the deteriorating trend of N.R.C. has not only been arrested but effectively reversed. In effect, N.R.C. has reached what is known as the take-off stage and the next few years will be vital for the organisation.

Lines For Future Action

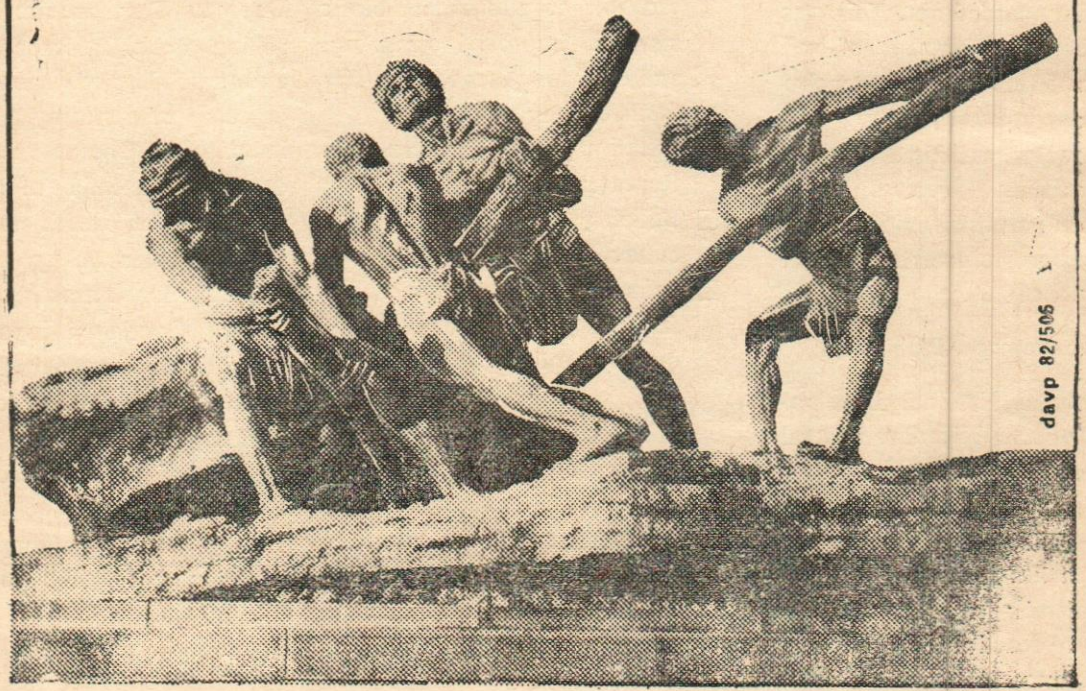
During the plan period, a collosal amount of activity is envisaged in all spheres of the Railway. The rehabilitation process whatever were executed have to continue at the same pace. This plan period is a very critical period for the N.R.C. as during the next few years both the rehabilitation and rapid growth are closely inter-woven. All the Railway projects envisaged for the IV plan period would have to be necessarily implemented without any throw forwards.

In certain areas such as Maintenance of Rolling Stock, the requirements of the preventive maintenance system are very rigid. There can be no scope for any failure in meeting the production targets laid down in the repair facilities such as Shops and Sheds. Day to Day monitoring of the rolling stock, locomotives, loading and unloading of wagons and other aspects of railway working is inescapable. The next few years will determine the extent of improvement in N.R.C. An overall strategy has to be carefully drawn up and a drive initiated for attracting additional traffic. Continued inputs in operational facilities are necessary in the form of additional/new crossing stations, additional loops and renewal of tracks. Each Manager has to clearly follow all his objectives amongst which the attempt to achieve results must be given high priority. A growing system is a healthy system and adequate attention is to be paid to this aspect at the highest possible levels. ☐

"There is only one magic which can remove poverty—and that is hard work helped by a clear sense of purpose and discipline."

—Indira Gandhi

Satyameva Jayate—Shramaeva Jayate



TOWARDS PROFITABILITY OF MANUFACTURING INDUSTRIES

If the majority of manufacturing industries enjoy a rising trend in their rates of profit, why the core industries including iron and steel and cement suffer a decline in their earning capacity

Rede, L.A.

The paper aims at exploring the long term trends in the profitability of twenty-one Indian Manufacturing Industries over the period of 28 years. A simple Linear Bivariate Regression of Time on Profitability reveals that out of 21 industries, nearly 15 enjoyed a rising profitability, 3 suffered declining profitability while no trend could be traced for the remaining industries.

Majority of the industries which experienced increase in their earnings were of recent origin and therefore, could be termed as modern industries while Iron and Steel and Cement suffered a set back to their earning capacity.

A number of factors were found responsible for the trends observed above. Important among them are government policies (pricing, distribution, etc.) regarding the industries, growth of output, capital-output ratio, rising or falling demand for the products, turnover assets ratio, availability of raw material, power fuel, labour unrest, modernization of plant, etc. The paper is concluded with the observation that an encouragement to profitable industries would help speed up the industrial progress in India.

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Profit rate, which is a yardstick for measuring the financial performance of any concern, plays a pivotal role in the growth process of the industry, as well as of the economy.

In this imperfect world, where a great deal of changes influence the whole economy, and where no change would be expected, the first impact of change gets reflected in two basic data of the industry, viz., rate of profit (rate of return) and capital. Hence G.J. Stigler comments, "And in the opposite world, where no change would ever be expected, the first impact of every change would be on rates of return; every surge of demand would find the industry unprepared and its prices and profit rates would rise; every cessation of demand would find the industry over expanded and its output selling at distress prices."[1] In short, in this dynamic world, an industry has to cope with a number of forces such as : changing consumers incomes; population changes; competition with foreign producers; discovery of new resources, production techniques or new products, etc. All these changes and the adjustments made to them are portrayed in two basic data of each industry : its capital stock and rate of return on this stock of capital. Hence the need to examine the profitability trend of different industries.

The Classical Perspective

Classical theory of economic development which visualizes a stationary state at the end of the process of capital accumulation is mainly based on their celebrated proposition of falling tendency of rate of profits in the long run. As the society progresses, the competition among the businessmen for higher profits, and their craze for increasing capital accumulation, coupled with rising wages and rising population, lead to a fall in the rate of profit which in the long run tends to zero.

According to Adam Smith, as the society progresses, production increases, which leads to an increase in demand for labourers. This is followed by a rise in wages which results in population growth and expansion of markets. Consequently, large scale production, and division of labour are adopted which let the cumulative growth process set in. Since production process requires longer time, there arises the need for the capitalist class to stock capital and to provide it to productive labourers, who, further add to the total production. Thus, capital accumulation sets into the process. The economy works under the conditions of perfect competition along with the mechanism of invisible hand (i.e. price profit mechanism). Competition among businessmen for investing into

1. Stigler, G-J. : *Capital and Rates of Return in Manufacturing Industries* : A study by National Bureau of Economic Research, Princeton University Press, New York, 1963, p.4.

higher profitable industries results into levelling down of the profit rates over time. Growth of population, too, pushes down the wages. The process of growth through perfect competition, thus continues, till profit rates lower down to a minimum, and the wage rates to a subsistence level. In short, according to Adam Smith, as the society progresses, capital accumulation sets in and the rates of profits tend to fall over time.

David Ricardo, another famous classical economist also proposed a theory according to which rate of profit for each industry, has a tendency to fall over time. He argues that, as the society progresses, population expands fast as the wages are above the subsistance level, while food production increases slowly because of the application of the law of diminishing returns. Capitalists accumulate capital for supporting or for giving advances to the labourers during the production process and earn a sufficient rate of profit on their capital. The society works under the conditions of perfect competition. In the beginning, high profits attract more capital, resulting in more capital accumulation. This, in turn, leads to increase in demand for labourers. Consequently, wages are pushed up above the subsistence level, as a result of which population expands, causing an increase in demand for food and resort to lower and inferior quality land (with the law of diminishing returns in operation). Hence, the rents on land are pushed up very high. The whole produce is divided between wages and profits after rents are paid. As the rents rise, the amount left for profits and wages is reduced. Secondly, due to capital accumulation (expressed through increased demand for labour), population expands so much that wages are pushed down at subsistence level. Rents are so high and profits so low that they leave no incentive for further capital accumulation. The society reaches the stationary state, with very high rents, subsistence wages, and, very low or zero rates of profit. Thus the rate of profit for the industry falls over a long period of time.

Karl Marx, the most famous critic of the classical writers, also assumed a falling tendency of rates of profit over time. He explained the growth process through the "class struggle". According to Marx, labour is the only source of value and is paid in wages its own value, socially neccessary for rearing, training and maintaining its life. Capitalists, who employ labourers, exploit them (by lengthening numbers of hours of work, etc.) by securing surplus value in the form of profits. Capitalist's main aim is to extract as much surplus value from labourers as possible (labour being the only source of value). This is attained through accumulation of capital in two basic forms, variable capital (the labour) and constant capital (raw material, tools, machines etc.) Consequently, on one hand, production increases greatly through employment of machinery but, on the other hand, technological unemployment in the form of industrial reserve army, is created. Thirdly, the constant capital produces just equal to its own value, while, labour, the only source of 'surplus value, is replaced by constant capital. Thus constant capital acts as a two edged sword for the capitalist. On one side, it causes unemployment, resulting into low wages and continuous exploitation of labour, and, on the other side, it fails to fulfill the ultimate purpose of the capitalist, i.e. creation of surplus value. Marx further argues that there is a long run tendency under capitalism to employ constant capital in relatively increased amounts than variable capital. Capitalists' passion for profit through capital accumulation leads to continuous increase in the organic composition of capital.[2] As organic composition of capital increases, the amount of surplus value created goes on falling. This leads to a fall in the rate of profit[3] overtime. Thus, capitalists' passion for capital accumulation, for extracting more and more surplus value itself, results into fall in the rate of profit.

Alfred Marshall, while discussing the longrun analysis, argues, that the principle of factor substitution through the competitive forces, compels the rates of return to move towards a central value. In other words, competition, and, substitution among the factors of production assuming high elasticity of supply of undertakers, (i.e. entrepreneurs), results in wiping out of abnormal profits and levelling of rates of

2. Organic Composition Capital $= \frac{C}{c+v}$, where c = Constant capital, V = variable capital.
3. Rate of Profit is defined by Marx as surplus value as a proportion of total capital. It is measured as follows: $P = \frac{S}{C+V}$ where S = surplus value, C = Constant Capital, V = Variable Capital, P = Rate of Profit.

profits among different industries towards the central value.

The Need for an Empirical Analysis

The classicals, their critic Karl Marx, and Marshall, all have assumed that rates of profit have a tendency to fall in the long run. Considering this, there arises a need to answer a query regarding the tendency of profit rates of different Indian Industries. What trends are observed in profitability ratios of different Indian Industries? Do the profit rates of different Indian Industries show a tendency towards rise, or, fall? Does the empirical evidence regarding the profitability of different Indian Industries accept the classical by hypothesis or does it reject it and why?

An attempt has been made to seek answers to these questions with the help of an empirical evidence of twenty one Indian Manufacturing Industries.

The Industries Covered

The data for these twenty one industries are derived from Reserve Bank of India publication[4] for the years 1950-51 to 1977-78. The profitability ratios are estimated from these published series of combined accounts of different industries. Only large and medium public limited companies are covered. The study is confined to Manufacturing Industries only.

The number of companies covered under the study rose from 419 in 1950-51 to 1068 in 1970-71. Most of the companies covered in earlier series have been covered in latter series also. Attempts were made to include in latter series as many companies as possible which went into production during the five year period preceding the commencement of latter series.

Notwithstanding the differences in the numbers of public limited companies covered, the coverage has been kept around 80% in terms of paid-up capital of all the non-governmental, non-financial public limited companies at the commencement of each of the series companies with paid-up capital of Rs. 5 lakhs [Rs. 0.5 Million] each or above are classified as medium or large companies.

The twenty-one industries covered in this study controlled around 68.5% (i.e. Rs. 42099 lakhs out of Rs. 61453 lakhs of Productive capital) and 34.7% (i.e. Rs. 385012 lakhs out of Rs. 1110580 lakhs of productive capital) of productive capital employed in the whole manufacturing sector in the years 1950-51 and 1970-71, respectively. A considerable decline in the share of total productive capital controlled by these twenty-one industries in 1970-71 is due to considerably great expansion of industries other than these twenty-one in the manufacturing sector. However, even in 1970-71, the share of these twenty-one industries still remained one-third of the whole sector. Similarly, the contribution of these industries to net value added of the whole manufacturing sector, was 61.3% in 1950-51 and 49% in 1970-71. If we consider the share of these industries in National Income, it would be around 3.4% and 6.7%.

The Methodology Followed

The study is based on financial concept of profit rate. The profit rate is measured by dividing the gross profits (consisting of profits, interest, dividend, rents and retained profits) by total capital employed (i.e. total net assets of the industry). This implies that the study is subject to following limitations.

Firstly, the statements on basic data i.e. balance sheets or profit or loss account, show, only the combined position, and not the consolidated position, for the group of companies for which the data are presented, as intercorporate transactions are not eliminated while combining the data.

Secondly, the published accounts of a company cover all its industrial activities of the company. Thus, the combined data for particular industry will include figures relating to the subsidiary activities included in that industrial group. However, this sort of limitation is bound to be present in the studies pertaining to industries whatever may be the source of data. However, inspite of these limitations, RBI data forms a big and reliable source of information on company finances, and, hence has been relied upon for the study.

Considering above mentioned limitations, the study is carried on

4. *Financial Statistics of Joint Stock Companies in India*, 1950-51 to 1962-63, 1960-61 to 1970-71, 1970-71 to 1974-75, Reserve Bank of India, published in the years Feb. 1967, August 1977 respectively. The data for the years 1975-76 to 1977-78 are collected from *RBI Bulletin* of May, 1980.

by applying the time trend analysis to the profitability ratios of each of the twenty-one manufacturing industries. Following linear regression model of time trend is applied.

The linear model fitted is

$$P=\alpha+\beta t+E$$

where, P is gross-profit rate[5], α and β are the parameters (intercept and trend coefficients respectively), t is time and E is the error term. The results are briefed in Table I. Following conclusions are drawn :

The Empirical Analysis

Table I reveals that the Linear Model of "Time Trend of Profitability" has proved to be a "good fit" in 15 out of 21 fitted relations.[6] This is obvious from the values of R^2 i.e. the coefficient of determination.

Whether the profitability ratios have a strong tendency to rise or fall is indicated by the sign and value of "β", i.e. the trend coefficient. Table I indicates that there is a strong tendency for the profit rates of twelve industries to rise over time. Not only has the trend coefficient 'β', for these industries, positive sign, but, the estimates of β are also statistically significant, The industries indicating rising trend of profit rate are : Edible Vegetable & Hydrogenated Oils, Silk-Rayon & Woollen Textiles, Medicines & Pharmaceutical Preparation, Matches,[7] Pottery, China Earthenware & Structural Clay Products (Consumers goods industries), Aluminium, Basic Industrial Chemicals (Basic goods industries), Transport Equipment,

Table-I : Regression of Gross Profit Rates on Time : 1950-51 to 1977-78

Industry	α	β	R^2
1. Grains and pulses	17.421† (3.323)	—.429* (.200)	.215*
2. Edible Vegetable and Hydrogented Oils	1.722 (1.265)	0.433† (0.076)	.554†
3. Sugar	8.249† (0.830)	0.038 (0.050)	0.021
4. Tobacco	11.411† (1.203)	.082 (0.072)	0.047
5. Cotton Textiles	6.830† (1.117)	(0.065 (0.067)	0.35
6. Silk-Rayon and Woollen Textiles	4.562† (1.527)	0.513† (0.092)	0.544†
7. Medicines and Pharmaceutical Preparations	4.663† (1.375)	0.706† (0.083)	0.737†
8. Matches@	11.000† (1.417)	0.325† (0.116)	0.305†
9. Pottry, China Earthenware and Structural Clay Products.	7.197† (0.948)	0.214† (0.057)	0.351†
10. Paper & Paper product	9.084† (1.336)	0.077 (0.080)	0.034
Consumer Goods Sector	6.861† (0.673)	0.182† (0.041)	0.437‡
11. Iron and Steel@	13.238† (1.152)	—.326† (0.078)	0.435†
12. Aluminium	5.300† (1.328)	0.269† (0.080)	0.304†
13. Basic Industrial Chemicals	3.304† (0.785)	0.448† (0.048)	0.775†
14. Cement	11.797† (0.961)	—.186† (0.058)	0.285†
Basic Goods Sector	10.247† (0.749)	—0.017 (0.045)	.006
15. Transport Equipment	3.881† (0.795)	0.291† (0.048)	0.586†
16. Electrical Machinery Apparatus & Appliances	8.426† (1.433)	0.212† (0.086)	0.189†
17. Machinery (other than Transport & Equipment etc.)	7.140† (0.802)	0.149† (0.048)	0.268†

5. Gross Profit Rate = Gross Profits as percentage of total Capital employed.

(*Contd. on next page*)

18.	Ferrous/Non-ferrous Metal Products	4.488* (1.632)	0.325† (0.098)	0.296†
	Capital Goods Sector	6.686 (0.680)	0.201† (0.041)	0.480†
19.	Jute Textiles	8.228† (1.820)	—.195 (0.110)	0.108
20.	Other Chemical Products	1.942 (1.269)	0.604† (0.076)	0.706†
21.	Rabber & Rabber Products	13.362† (0.949)	—0.087 (0.057)	0.081
	Intermediary Goods Sector	8.754† (1.031)	0.148* (0.062)	0.180*
	Whole Manufacturing Sector	7.512† (0.493)	0.144† (0.030)	0.477†

Source : *Financial Statistics of Joint Stock Companies in India*, op. cit., p.5.

Notes : 1. Figures in brackets indicate standard errors.

2. * and † indicate level of significance at 5% and 1% respectivley.

3. @Data for Matches and Iron & Steel Industry are Available for 20 and 25 years respectively.

Electrical Machinery, Apparatus and Appliances, Machinery (Other than Transport Equipment etc.) Ferrous/Non-ferrous Metal Products (Capital goods sector), Other Chemical Products (Intermediary goods sector).

Three industries viz., Grains & Pulses, Iron & Steel[8] and Cement experienced a declining trend in profitability over time. This is obvious from the fact that trend coefficient 'β', assumes negative sign for these in industries and is statistically significant too.

It is further observed from Table I that R^2, the coefficient of determination, assumes different values for the industries having rising trend, (varying in value from .189 for Electrical Machinery, Apparatus and Appliances to .775 for Basic Industrial Chemicals) as well as falling trend in profit rates (R^2 varying in value from .215 for Grains & Pulses to .435 for Iron & Steel). This implies that time explains variations in profit rates of different industries in different degrees over time.

Similarly, β, the trend coefficient assumes different values for different industries and thus ranges in value from .149 for Machinery (Other than Transport Equipment etc.) to .604 for other Chemical Products, in case of industries having rising trend, and, ranges in value from $-.186$ for Cement to $-.429$ for Grains and Pulses in case of industries having falling trend in profit rates.

In addition to industry-wise time trends, the table also provides information on sectoral trends in profit rates. The Nineteen[9] industries are divided into four groups, viz., Consumers Goods Sector, Basic Goods Sector, Capital Goods Sector and Intermediary Goods Sector, each group comprising of 9, 3, 4 and 3 industries respectively. All the Nineteen industries together form the whole manufacturing sector. The profit rates for the individual sectors are worked out as follows :

Profits Rate for consumers Goods sector

$$= \frac{\sum_{i-1}^{q} \text{Profits}}{\sum_{i=1}^{q} \text{Total Capital Employed.}}$$

where i=1, ... 9 indicates the industries of which the sector comprises. Linear Time Trend model is then fitted, and following results are drawn.

It is seen from the Table that the fitted relations are good in case of consumers', Capital and, Intermediary goods sector, all these sectors show that profitability ratios have rising tendency over time. R^2, the coefficient of determination varies in value from .180 for Intermediary Goods Sector, to .480 for Capital Goods sector. Similarly, 'β',

6. When similar type of Models are fitted to Profit to Profitability Ratios in Net terms (i.e. Net profits as percentage of Net Worth, where Net Profits Comprise of dividends and retained earnings and Net worth is defined as paid-up capital plus surplus, plus reserves) Similar trends are observed for different industries.

7. Data for Matches Industry are available for twenty years only i.e., from 1950-51 to 1969-70.

8. Data for Iron & Steel Industry are available for twenty-five years only i.e. from 1950-51 to 1974-75 only.

9. Matches & Iron & Steel Industry are dropped out as data for these are available for less than twenty-eight years.

'the time trend not only assumes positive sign, but is statistically significant for these sectors, and varies in value from .148 for Intermediary Goods Sector to .201 for Capital Goods sector.

As far as the Basic Goods Sector is concerned, it can be seen from Table I, that neither R^2 nor, β is statistically significant. This may be due to the reason that some industries in this sector, indicate rising trend while some have declining trend in profit rate over time.

In case of Whole Manufacturing Sector, it is observed that both the R^2 and β are statistically significant, latter having positive sign and thereby indicating that profit rate for the whole manufacturing sector, taken as a whole, has a rising tendency over the period 1950-51 to 1977-78, i. e. 28 years.

While summing up it can be said that as far as Indian Manufacturing Industries are concerned, majority of them have been experiencing rising trend in profit rates over the period 1950-51 to 1977-78 i.e. 28 years. Does this imply that the classical hypothesis of falling tendency of rate of profit over time is false in case of Indian Industries? Can we therefore reject the hypothesis of falling tendency of profit rate over time? The answer is 'No.' This is for several reasons. Firstly, the concept of profit rate considered by classical writers is entirely different (Economic Concept) from the one considered for this study (which is financial concept). The classical economists talked in real terms whereas this paper deals with financial ratios. Secondly, the industries during classical writings were considered to be of almost similar age structure, whereas the ones studied here have great variations in their inception periods (e.g. Cotton Textiles and jute Textiles are almost 125 years old industries while Chemical & Engineering industries are just 40-45 years old.)

Thirdly, the long run is not known to any one. Moreover, majority of the Indian Manufacturing industries are of recent origin. Industrialization in India is a recent phenomenon. Hence, there is no strong reason for the profit rates of these industries to all over this period. This reminds us of the fact that the classicals, mainly Adam Smith, also argued that during the initial stages of industrial growth, profits would be high, hence, would be the rates of profit too.

Lastly, the business entities, as well as the surrounding economic conditions of two hundred years ago, i.e. at the time of classicals, were entirely different from what they are to-day. Hence, it is felt that the results based on the empirical data of entirely different type and conditions than considered by classicals should not be used either to refute or to accept their hypothesis. One must, therefore, try to interpret the results of such analyses against the prevailing economic conditions.

The Major Finding

1. It is observed that 12 out of 15 industries experienced a rising trend in profit rate over the period 1950-51 to 1977-78, and three suffered from a declining rate in profit rate during the same period.

2. Nine Industries like Silk-Rayon & Woollen Textiles; Medicines & Pharmaceutical Preparations, Aluminium, Basic Industrial Chemicals; Transport Equipment, Electrical Machinery, Apparatus and Appliances; Machinery (other than Transport Equipment etc.); Ferrous/ Non-ferrous Metal Products. Other Chemical Products enjoyed rising profitability and can be attributed to Modern Industrial sector because of their recent inception while Edible Vegetable and Hydrogenated Oils; Matches, and Pottery, China Earthenware and Structural Clay Products also enjoyed increase in Profit rates, and can be classified as Traditional ones, as being old industries.

3. Three industries viz., Grains & Pulses, (Consumers Goods Sector), Iron & Steel and Cement (Basic Goods Sectors) experienced a fall in profit rate over time.

4. The sectoral trends in profit rates indicate a rising value over time for whole Manufacturing sector. Consumers' Capital and Intermediary Goods Sectors while no definite trend is observed for Basic Goods Sector. The reason may be that the 50% industries in Basic Goods Sector enjoyed rising profit rate (Aluminium, Basic Industrial Chemicals) while 50% suffered from a decline (Iron & Steel and Cement), thus leaving no definite trend for the sector as a whole.

5. Finally, Differences in the nature of industries (whether agro based or chemical based, procuring necessities

or luxuries, key or basic industries old or new industries) have no influence on the time trend analysis as it affects majority of them irrespective of their nature.

What Hinders or Helps Profitability

What could be the possible factors influencing profit rates of different industries over this period? Why have some industries enjoyed rise in profit rates while some suffered a set back 9. Following factors may be accounted for the trends in profit rates of these industries.

Majority of the industries experiencing rising trend in profit rates belong to Chemical and Engineering Group of Industries. These occupy a very important place in the development of the economy. The goods produced by these industries are used for consumption as well as capital formation and the latter used for forming the infra-structure of the country. The progress of the economy and the priority given to these industries through Industrial Policy Resolution of 1956, and Five year Plans, have been responsible for increasing pressure of demand for their products resulting into expansion of these industries and raising their profitability throughout the plan era. These industries being newly developed are well modernized, better equipped and well diversified. Hence, these industries could cope up with rising demand, (though not fully), and in the process strengthened their earning capacity. If we examine the Index of Production[10] for these industries it can be seen that it rose from 100 in 1950-51 to 12306 and 35927 in 1974-75 for Aluminium and Basic Industrial Chemical Industries, respectively, while it rose from 100 to 21227, 42221, 6795 and 50194 for Transport Equipment; Electrical Machinery, Apparatus and Appliances; Machinery (Other than Transport Equipment etc.); and Ferrous/Non-ferrous Metal Products industries respectively in 1974-75.

The Index of Production also rose in case of those Chemical industries which either produced essential consumer goods or produced intermediate goods. In case of Silk-Rayon and Woollen Textiles and Medicine and Pharmaceutical Preparations and Other Chemical Products it rose from 100 in 1950-51 to 16669 and 12306 and 55984 respectively in 1974-75. The Index of production for Edible Vegetables and Hydrogenated Oils, Matches and Pottery etc. rose from 1000 in 1950-51 to 5201, 190 (in 1969-70) and 4093 respectively in 1974-75. The first two industries produce essential consumer goods. The demand for which has been rising with rise in population, leading there by a rise in profit rates earned. As regards Pottery, the products require frequent replacement and hence are highly demanded Matches have very few substitutes (electric and non-electric lighters). All these have resulted into larger demand and higher sales, consequently raising their profit rates over time.

How do we relate Index of Production with Profitability? The answer is straight and simple. Firms working under competitive conditions are assumed to be involved in maximizing profits. Maximizing profits requires that sales be increased and costs be reduced. Thus, larger sales can be held responsible for larger revenue and profits (assuming constant costs or costs rising less than revenue), and hence for higher profits rates. If this is true for a firm, it would also be true for the industry as a whole as it comprises of many such firms. Hence, Index of Production can be taken as a factor that not only reflects rising physical output (if worked at constant prices) and sales revenue (even at constant prices if output increases, sales revenue would increase), but also reflects rising demand for the products of these industries. It can, therefore, be said that rising outputs of these industries have helped these industries to expand, and grow and to raise their earning power.

A further probe into the structure of capital and output data of these industries enables us to detect another important factor responsible for rising trend of profit rates of these industries. The Capital-output ratio at disaggregative level i.e. industry-wise or commodity-wise, occupies a central place while choosing the techniques of production or while allocating the investment in industries.

In short, the capital-output ratio, being indicative of capital requirement per unit of output is one of the determinant factors of investment decisions and choice of techniques

10. Derived by the author, for Ph. D. thesis and is worked out as value of production at constant prices, and is taken as a proxy for Index of Physical Output.

used. The private industries being mainly profit motivated, would consider this factor to be of great importance, because its trend over time would indicate whether it is profitable to undertake more investment or not. The inverse of capital output ratio (i.e. output-capital ratio) reveals the productivity of capital. It indicates how much output does one unit of capital produce. The higher the productivity of capital the higher would be the profitability of that industry and vice-versa. In short, from amongst the large number of industries, an investor would be interested in selecting that industry for which the productivity of capital is relatively high, thereby leading to reap high profits also. Hence, it is necessary to examine the capital-output ratio (i.e. inverse of capital-productivity) for different industries.

An industry with a high capital-output ratio in the initial period may improve its capital productivity over time. Such an industry would be capable of increasing its profitability over time through improving the productivity of capital. A fall in capital-output ratio, for a particular industry over time would thus be indicative of an increasing capital productivity and hence, it can be argued that it would raise the profitability of such industry. An examination of the capital-output ratios[11] for these industries reveals that capital-output ratios for Edible Vegetable and Hydrogenated Oils; Silk-Rayon & Woollen Textiles, Medicine and Pharmaceutical Industries, were 10.7, 9.6 and 3.9, respectively which declined to values around 6.1, 4.6 and 3.1, respectively in 1974-75. In case of Other Chemical Products the ratio declined from 6.2 in 1950-51 to 3.5 in 1974-75.

The capital-output ratio assumed values around 8.5, 7.9, 5.1, 4.7 and 4.8 in 1950-51 for Basic Industrial Chemicals; Transport Equipment; Electrical Machinery, Apparatus and Appliances; Machinery (Other than Transport Equipment etc.) and Ferrous/Non-Ferrous Metal Products respectively, which dropped to 5.5, 5.6, 3.6, 4.1, and 3.9 in 1974-75.

As far as Matches and Pottery industries are concerned, they are less capital intensive and therefore, would not be affected much by capital-output ratio. It has been observed that capital-output ratio for these two industries has shown a slight rise over this period.

An examination of the Turnover Assets Ratio,[12] gives us another clue for the rising tendency of profit rates of these industries. Since Profit Rate is defined as gross profits as percentage of total net assets and Turnover Assets Ratio is defined as Sales divided by total net assets, it is obvious that there would be some relationship between the two. In fact Return on Investment (ROI or Rate of Profit here) can be worked out (with the help of Du Pont Control Chart) as the product between Profit Margin $(\frac{\text{Profits}}{\text{Sales}})$ and Turnover Assets Ratio $(\frac{\text{Sales}}{\text{Assets}})$.

Thus it can be seen that

$$\text{ROI (Return on Investment or Rate of Profit)} = \frac{\text{Profits}}{\text{Sales}} \times \frac{\text{Sales}}{\text{Assets}} \times 100$$

It is thus obvious from the above given formulae that ROI can be influenced by both the ratios, profit margin and turnover assets ratio. Assuming profit margin to be constant, rising, or falling less rapidly than the rise in turnover asset ratio, the result of rise in the latter would raise the ROI and vice-versa. Hence, a rising turnover asset ratio for these industries may be considered as an important factor influencing the rate of profits of the industries. Normally, firms would attempt to have a constant profit margin. Hence, a rise in profit rate can be attributed to a rise in turnover assets ratio.

A closer look into the turnover assets ratios for these industries confirms to our conclusion. The ratio in 1950 assumed values around 1.56, 0.39, 0.82, 0.61, 0.40, 0.51, 0.76, 0.56, 0.72, 1.04 and 0.71 for Edible Vegetable and Hydrogenated Industries; Silk-Rayon and woollen Textiles; Medicines and Pharmaceutical Preparation: Pottery-China, Earthenware and Structural Clay Products; Aluminium; Basic Industrial Chemicals; Transport Equipment; Electrical Machinery, Apparatus and Appliances; Machi-

11. Capital-Output ratios are defined as an average concept and measured as a ratio between Gross Stock of Capital (Physical Assets valued at current prices) and Gross Value Added (at Current prices).

12. Derived by author in her Pn.D. Thesis and is worked out as follows: Turnover Assets Ratio – Net Sales/ Total Net Assets where sales are taken net of excise duties, cess, etc. and Net Assets are defined as Net Fixed Assets plus Current Assets of the Industry.

nery (Other than Transport Equipment etc.). Ferrous/non-ferrous Metal Products and Other Chemical Products respectively and increase in value for each of these Industries in 1974-75 and had values around 3.67, 1.09, 1.34, 0.86, 0.55, 0.89, 1.10, 1.14, 0.97, 1.21, and 1.55 respectively. In short, sales per unit of capital invested in each of these industries increased during the period 1950-51 to 1974-75, which can be taken as a factor leading to rise in profit rates of these industries.

If we probe into the causes of decline in profitability of industries, mentioned below, following factors can be held responsible :

As far as Iron & Steel and Cement Industries are concerned, these produce goods required for infra-structral development of country. These provide raw material to other groups of industries, also at the same time, cement, provides for the basic necessity of life i.e. Shelter, Inspite of the great role played by these two industries, their profitability has been observed to be falling over a long period of time. Due to the progress of the economy in industrial as well as the agricultural sectors, the demand for the products of these industries is continuously rising. However, these being key and basic industries the government exerts lots of controls on their prices, production and distribution. Iron & Steel industry is classified in schedule 'A' of Industrial Policy Resolution of 1956, hence, private sector can not open any new units in this industry, though existing units could continue to work under it. Hence, there had been a control over the entry of new firms into this industry.

Both these industries suffered from price control from 1940 (Iron & Steel) and 1945 (cement) onwards till end of 1960's. The prices fixed are uneconomical and thus, result into low profit rates. There were controls on distribution of cement as well as high excise duties on the products of these industries which aggravated their earning position still further. Moreover, these industries also suffered from shortages of raw materials, which resulted into under-utilization of capacities, affecting the output and profitability adversely.

Moreover, both these industries require heavy capital investment which bears fruits after a long gestation period. Hence, private capital is not attracted towards these and prohibited particularly in case of Iron & Steel industry. Since profitability of these industries is low, internal provision of finance is also very weak. This implies that both external and internal sources of finance for these industries are meagre. Hence, modernization of the industries with up-to-date machinery and technology becomes a problem. This hinders the expansion of these industries and thus affects the growth of the industry and lowers its profitability.

The government took steps to improve the conditions of these industries through decontrols in 1964 (Iron & Steel) and 1968 (Cement) which came very late. Problems of power shortages and labour unrest added fuel to the fire. The two industries thus suffered a setback to their earning positions.

If we consider the figures for the Index of Production for these two industries' products we see that it rose from 100 in 1950-51 to 2492 and 3636 from Iron & Steel and Cement respectively in 1974-75. This implies that the industries did not face any problem from demand side. However, the demand for the products of these industries, mainly for Iron & Steel came from the public sector, and remained highly fluctuating which in turn adversely affected their profitability.

As far as capital-output ratio for these two industries is concerned it was 4.4 and 6.2 for Iron and Steel and Cement, respectively in 1950-51 and rose to 11.1 and 13.7, respectively in 1974-75. This implies that the industries being capital intensive, expanded in terms of capital, while output did not rise in the same proportion. In other words, productivity of capital declined in these two industries over this period which contributed to fall in the rate of profits of these industries.

As regards the turnover assets ratio, its value in 1950-51 was 0.76 and 0.57 for Iron & Steel and Cement Industry respectively which dropped to 0.69 for Iron & Steel and rose slightly to 0.82 for Cement Industry in 1974-75. Thus, in case of Iron & Steel, the decline in turnover asset ratio might be taken as responsible for fall in profit rate, while in case of cement profit margin, might have fallen more sharply than a slight rise in turnover asset ratio, leading to a fall in rate of profit over this period. In other words, it can be argued that though industries were highly pressed for larger outputs, which they produced, within their limitations of raw materials shortages, power shortages, labour unrest, etc., they suffered from a decline in profit rates mainly due to

wrong pricing policy adopted by the governmet which left behind very low profit margin. A decline in capital productivity or a rise in capital output ratio for these industries reveals the inefficiency of the firms working under these industries, which requires to be taken care of immediately.

A declining rate in profitability of Grains and Pulses industry can be attributed to great fluctuations in the raw materials for the industry. The industry depends upon food-grains and pulses for its final production, which depend upon the vagaries of nature. The industry produces a commodity classified as a necessity, hence, suffers from a number of government controls (price, distribution etc.). It has been observed that overall supplies of the products of this industry are less than the overall demand for them. This has given rise to the problem of proper distribution of the products at reasonable prices, and, thus has invited government intervention and a number of controls.

The continuously rising population has resulted into increasing demand for the products of this industry. This is reflected in the data for Index of Production for this industry which rose from 100 in 1950-51 to 1930 in 1974-75. However, the rise in Index of Production has not been adequate and the exertion of government controls on the product has led to fall in profit rate of this industry over this period.

The capital-output ratio for this industry rose from 6.2 in 1950-51 to 8.2 in 1974-75. A rise in capital output ratio for this industry indicates that productivity of capital declined over time which resulted into decline in profit per unit of capital invested over time also.

As regards the turnover asset ratio, it increased from 2.49 in 1950-51 to 5.49 in 1974-75. This implies that sales revenue as percentage of net assets increased, however, profitability declined. This may be due to the fact that profit margin for the industry dropped more sharply than the rise in the turnover asset ratio. The reason for drop in profit margin being the price control exerted by the government throughout the study period.

In short, it can be concluded that factors like Index of Production, Capital-Output Ratio, and Turnover Assets Ratio along with the government Policy, rising demand for the product modernization of industries availability of raw materials, fuel etc. were the factors responsible for the rising or falling trends in profitability in the above studied Indian Manufacturing industries.

A Concluding Note

Since India is a fast developing country, it is advisable to encourage those industries which are indicating rising tendency in their profit rates. This is so because the increase in profitability of these industries would enable these industries to reinvest the capital in the same or in other industries. Moreover, rising profitability would increase their capacity to raise equity capital also. Consequently, these industries will be able to expand fast and speed up industrial growth in the economy.

However, in case of industries like Iron & Steel and Cement, a declining Trend of profitability is a cause of concern. On one side, falling profit rate would repel the private investment from these industries, and, on the other, industries using the products manufactured by these industries as raw materials will also be affected adversely by their poor performance. These industries are under heavy controls of the government, too. Hence, while determining the price and distribution policies of the products of these industries, the Government should pay attention to the cost structure of these industries, so that the industries improve upon their earnings and utilize them for further reinvestment and expansion of their own industries, thereby helping and encouraging speedy industrialization in the country.

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THE ERGONOMICS HAS PROVED ITSELF

Banerjee, J.

Ergonomics has emerged as a significant managerial device to resolve several baffling problems at work by providing an insight into the complexity of psycho-physiological bases of human behaviour to enhance its effectiveness

The human aspect of management has come to lime light as the present day guiding tool for setting the objectives. The physiological and psychological characteristics have been studied in great detail by the different research workers which have now emerged as a special field on 'Ergonomics'. The paper details the progress and development in this field and presents the problems that are imminent for proper understanding to arrive at a rational solution.

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With the decreasing environmental space for a man to work or live, he is now conscious of his surroundings. He tries to adjust himself to his own comfort and safety within his boundaries. Science has helped in studying the effects of work system and the attendant-operating and living environment on a human being and evolved a more pleasant and productive technique to suit different conditions to which a human being is exposed, from space craft to industrial surroundings or from hospital to sweet homes. Such a science is commonly termed as 'ergonomics' or, human engineering or, Bio Engineering.

Defining Ergonomics

'Ergonomics' is derived from two Greek words 'ergon' meaning work and 'nomos' meaning laws. In short, it may be said as 'laws of work'. BS 3138: 1959 defines thus:

'Study of the relation of a worker and the environment in which he works, particularly to the anatomical, physiological and psychological knowledge of the problems arising therefrom'.

The concept has emerged from the principles of motion economy and in the study of the fatigue phenomenon of an operator in 'Work Study'. At present, it forms a link between Engineering sciences and human sciences as shown in Fig. 1. Taylor and Gilbreth were

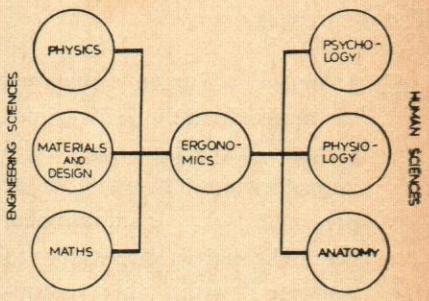


Fig : 1
Elements of Ergonomics

the first who attempted to improve man-machine relationships, through increase in machine productivity by improving the work habits of the operator, i.e., man was taken as a variable to adjust to the machine. In ergonomics, machine has become the variable. This reversal was sprawned by World war II when equipment (or weapon systems) became more complicated and difficult to operate. The question arose, 'why not design equipment (weapon systems) to secure optimum operation in terms of human capabilities, limitations, and variability?'

In ergonomics a behavioural model is generally developed concerning how man fits into a given environment, what tools he uses for control, and how he controls it for his safety and comfort. Based on the techniques, the products are designed and the services streamlined for better living. At present ergonomists are conversant with the human capacities and limitations and they apply the same to a particular environment for the best use of human effort.

Ergonomics had its full concern over the man machine systems when the capabilities of man were compared with those of a computer. The differences are:

- *Memory* : Human memory has approximately 10^4 times greater capacity than the largest computer available at present. A technological break-through is necessary to compete with this mini-computer within the skull. However, human memory is highly selective, it rejects repetitive data and forgets easily. (Franchois Paycha's experiment). It requires association between the elements that are to be stored away for future recall. It can easily distort information without realising that this transgression has taken place.
- *Perseverence* : Man is not so stead-fast as the computer. Whereas the computer can be asked to repeat its operation or iterate indefinitely, human brain gets fatigued rapidly when asked to do routine operations. A machine is unemotional and tireless; its diagnosis is wholly unbiased.
- *Thinking and creativity* : Computer is literally incapable of handling situations where no prior pattern has been discovered or objectified. It can scan a set of symptoms and pick up the relevant ones.
- *Logic formulation*: Computer behaves only the way an algorithm is taught. Man, however, can devise intricate rules of logic but is unable to apply consistently the logical rules devised by himself. He has a tendency to digress.
- *Speed of computation*: A computer can bring out results in nano-seconds or even less, but the lead time may be high for preparation and for extraction of information from permanent store.
- *Variability in output rate*: Man cannot work at the same efficiency all the time. He requires frequent refreshment through coffee break or through conversation.
- *Cross talk monitoring*: Cross-talk occurs when several sensory perceptors (hear, see touch, taste and smell) are simultaneously called upon to receive a varied set of input data. Man is incapable of perceiving the same unless the related informations reinforce each other, as in a Cinema. In fact, he cannot monitor the behaviour of a system unless data are fed one at a time, as in a sample data system.

What Ergonomics Embraces

The fields which encompass the ergonomics are: fatigue, safety, illumination, noise, ecology, learning anatomy of structure or bio-mechanics, display or sensory devices and control.

The variables that affect a human system can be classified into three categories: physiological changes, psychological changes and concommitant variables.

- Physiological changes: Continuous physical work affects the following mechanisms either separately or collectively:

  (a) the circulatory system (b) digestive system (c) muscular system (d) nervous system and (e) the respiratory system.

The changes include heart rate, blood pressure, cardiac output, pulmonary ventilation, oxygen consumption, chemical composition of blood and urine, lactic acid concentration, oxygen debt in blood and 17-ketosteroid excretion in urine, body temperature, rate of sweating, and galvanic skin response (G.S.R.)

- Phychological changes : Through monotony, motivation and morale.
- Concomitant variables: Such as room temperature, relative humidity, time of the day and the subject's (man's) height, age, weight, weight to height ratio and physical fitness.

Anatomy of Fatigue

The word is used rather loosely to define at least four of the commulative and reversible effects of work:

- a diminished capacity to perform the task at hand, both in rate and in quantity;
- a diminished capacity to perform other tasks as well as the one being performed;

- ☐ physiological changes in the blood chemistry, nervous system, and glandular sections;
- ☐ feeling of tiredness—an experienced and perceived state of the organism.

It deals with an aggregate of a number of different and only moderately correlated commulative effects of work, and hence, it is difficult to measure. It is thought that fatigue is the result of accumulated waste in the muscles and in the blood stream. Muscular movements are accompanied by chemical reactions which require food for their activities. The food is supplied by the glycogen in the blood stream that is convertible to sugar readily. During continued activity of the muscles glycogen is changed to lactic acid but reconverted to glycogen by oxygen present. For less strenuous work the muscle is able to maintain a satisfactory balance. Excess of lactic acid as waste product affects the fibre terminals, and the central nervous system to slow up when tired.

A host of methods of measurement of fatigue are now in practice. The simplest one is the 'output decrement method'. The extent of which a worker (normally termed as subject) reduces his rate of work after working for a prolonged period of time, say a day, is taken as measure of the amount of fatigue generated by the task. The above method assumes primarily the following conditions:—

- ☐ Worker does not significantly alter his effort level over the period measured nor in fact allow any of the many possible factors other than fatigue to affect his output rate over the day.
- ☐ Worker (or subject) varies his actual production rate according to change in his work rate capacity, to physiological changes in the body, and to feeling of tiredness.

However, in practice, the worker is unaware of the changes while performing a task.

Interpreting the Effort

Effort cannot be communicated to a person by mere words. It is an experience, the feeling as to how hard he is working, or, the degree to which he feels that he is exerting himself. According to Ryan, it is 'the relation between actual rate of performance and the capacity of the individual at a given time'.

The feeling or sensation of effort depends upon the actual rate of work, capacity to perform the task involved, the amount of physical work involved, person's attitude towards the job, and working conditions, such as temperature, humidity, noise level and others. Regarding 'attitude', it may be said that two tasks remaining the same, one seems to be more pleasant than the other to an individual, as in case of playing ball game with a child as against lawn-mowing under the directions of wife. Each can offer two very different feeling of exertion to the individual. The reaction to an effort should reflect the amount of physical effort required by the method, pleasantness, intrinsic intereset associated with it, conditions surrounding it, and other characteristics.

Some of the earliest systematic observations on effort and human body were made by Leonadrdo Da Vinci in the fifteenth century. In his notes on human body, methods of accomplishing specific task were presented which minimised or optimized the human effort involved.

Due to a large number of determinants affecting the effort, its measurement by a single criterion is difficult. 'Objective measures' are used at present for its measurement, the simplest one is the time to perform a given task. However, it is observed in many cases that the reduction in the total effort due to decreased time is offset by a greater increase in effort, because of other factors. Another approach is to combine all tangible physical components of a job and relate the same to the energy requirement as an objective method of measurement of work in the form of algebraic formulae. The tangible components may be the weight lifted, distance carried or the number of occurances per day. Although some nonlinear relationships are being used in practice, the simple mechanical work formula for measurement of energy is not suitable because, holding a weight by hand at rest requires effort. The other indirect methods of measurement of effort are:

- ☐ Degree of tension in the muscles with passage of time (Hartee and Hill);
- ☐ Integral of mass times acceleration with respect to

time and expressing static work and dynamic work on similar terms (xg) for effort rating (Starr);

- ☐ Change in acceleration pattern due to changes in specific factors contributing to effort (Franz and Nadler);
- ☐ Change in the resistance (actually, conductance) of skin to an electrical current Galvanic skin response (GSR) by exosomatic mcthod;
- ☐ Systolic and diastolic blood pressures ;
- ☐ Pulse rate. It not only measures the amount of effort but includes a host of other commulative or non-commulative aspects of work like, rate of energy expended, fatigue, monotony, emotional state, and others.

Measuring Energy Expenditure

The amount of energy expended by a subject in performing a task in calories per minute is a measure of both effort and fatigue. Some of the standard methods of measurement are as follows: (a) The Max-Plank respiration Gasometer (or the input Co_2 method).

The procedure is to fit a mask over nose and mouth of the subject, clip over nose and insert a tube in the mouth, ask the subject to perform a specific job and collect the Co_2 gas exhaled by him in a special apparatus, during the experiment and beyond, for some time. From charts, the recorded figure is converted into the total calories expended.

(b) The mechanical work method (or the 'output' method):

The 'subject' is asked to lift a 50 lbs. wt. through a vertical distance of 3 ft under the gasometer mentioned above and his mechanical efficiency is calculated as follows:

By Co_2 method, the energy recorded is 0.34 calories, say,

$$\text{Output} = 3 \times 50 = 150 \text{ lbs}$$

$$\text{Input} = 0.34 \times 3085 = 1049 \text{ ft/lb}$$

$$\text{Hence, } \mu = 150/1059 = 0.14$$

The method has its obvious limitations mentioned above.

(c) The 'Larau' force platform method:

The method measures the output in terms of forces exerted by the subject's muscular system in the three directions while the subject is asked to perform the task on a triangular platform. The vertical (P_z) frontal (P_y) and transverse (P_x) components of forces are transduced through sensitive peizo-electric quartz crystals and recorded on a three channel recorder.

The method has the advantage that the platform is extremely sensitive and can record the movement of a rat. Further, it recognizes the static work which is a failure in the computational methods. The criticism against this method is that it neither measures the energy expended nor the effort (absence of distance component), and that it is expensive.

Larau's concept was first improved by Green through the introduction of linear variable differential transformer and further modified by Barany for study of the dynamic characteristic of the subject.

(d) The Brouha's pulse rate method (Harvard fatigue laboratory):

The physiological stress for a particular job can be determined from the recovery pulse rate measurements. The heavier the physiological load, the higher is the heart rate and the more slowly it returns to its resting level. The method consists of counting the pulse rate for 30 seconds at three, one-minute intervals during the first three minutes of recovery period after termination of work, and while the subject is sitting quietly.

A more recent method is to correlate the heart rate with the oxygen consumption and effectively measure the physiological effect of task. According to Weir, oxygen consumption can be converted to metabolic rate and expressed in kilogram calories (kcal) of energy expenditure per unit of time. This can be taken as a primary index for the energy demands of a task. Based on the study of rural postmen and infantry men, a walk of 3 miles an hour is taken as the standard. Meuller has stated that the maximum endurance limit of work is 4 kcal above basal metabolism (which he takes as about 1 kcal). The physiological level of work is measured in kcal (NSR) which is the not seated rest-level. It is equal to total kcal minus seated rest kcal.

The seated rest kcal seated is usually taken as 1. 51 kcal.

For the heart rate measurement, ECG electrodes are coupled telemetrically by an F. M. transmitter, which the 'subject' wears on a head band, to a Gilford model 120 cardiotachometer.

(e) The Oxygen input method:

The subject wears a respiratory face mask and breathing valve. The oxygen content of the expired air is measured by a Beckman model E_2 oxygen analyzer. The rate of energy expenditure, for correlation, is determined by the Weir calorametric equation, which eliminates consideration of Co_2 with negligible error.

Oxygen input under relaxed sitting, relaxed standing and experimental tasks, which normally are expected to be performed under aerobic conditions apart from the initial adaptation period are measured by the steady state method. Expired air is collected in relaxed sitting or standing positions only after the heart rate has attained a steady state. It is continued for six minutes. During the time the subject is performing the task, expired air is collected only after 4 minutes of exercise and continued for two to four minutes depending upon the level of pulmonary ventilation. If the task involves anaerobic processes, namely, static work or dynamic work above 5 gross kcal/min, the total oxygen intake during exercise and recovery is measured.

Towards A Biomechanical Analysis

The above investigations are made in 'repetitive physical task' where primary importance is laid on the magnitude of man's physiological endurance with respect to the amount and type of muscular exertion.

Another type of physical task concerning ergonomists is the type of activity where 'occasional high levels of physical exertion' are required such as, in lifting. Under such circumstances, it is necessary to assess the maximum strength of man's skeletal muscle system in comparison to the forces and torques created within the body by the task. The research of this type in Kinesiology, is generally termed as Biomechanics because of the inter-relationships of the concepts of mechanics with the functional anatomy. Basing on the concept of Williams and Lissner the reaction of muscles or external forces on the various bone articulations is a pure torque, it may be assumed that the specific strength limits of a particular body member would be assessed in terms of the subject's maximum torque producing capability at each of the major articulations under consideration. Chaffin considers the body to be composed of a series of seven solid links namely, feet, lower legs, upper legs, trunk including neck and head, upper arms, lower arms and hands. The movements of body links while performing a given task are referred from a common reference axis, called the symmetric, saggital body plane. The maximum voluntary articulations torque for the elbow extension shoulder flexion, shoulder extension, hip extension, knee extension and ankle plantar flexion can be measured by force transducers as shown in Figs. 2.1 and 2.2. It is thus observed that the maximum load that an average male can lift by bending his knees without excessive strain in articulation muscles is 100 Ibs.

The mechanical variables that affect the bio-mechanical characteristics of the subject performing the experimental task are:

(a) The total mechanical energy (P.E. + K.E.) expended in doing one complete cycle of work task, newton-metres;

(b) Average shoulder force, which is the magnitude of the average resultant force occuring at the glenohumeral joint, newtons;

(c) Average shoulder torques, as above, but for torque, newton-metres;

(d) Shoulder linear impulse for successive 25 times increments during the work cycle, newtons—second

$$I_e = \Sigma F_{sl} \times \tau ;$$

where, F_{sl} = instantaneous shoulder force, newtons, and

τ = time interval of the force acting, sec.

(e) shoulder annular inpulse, determined at each joint as in (c);

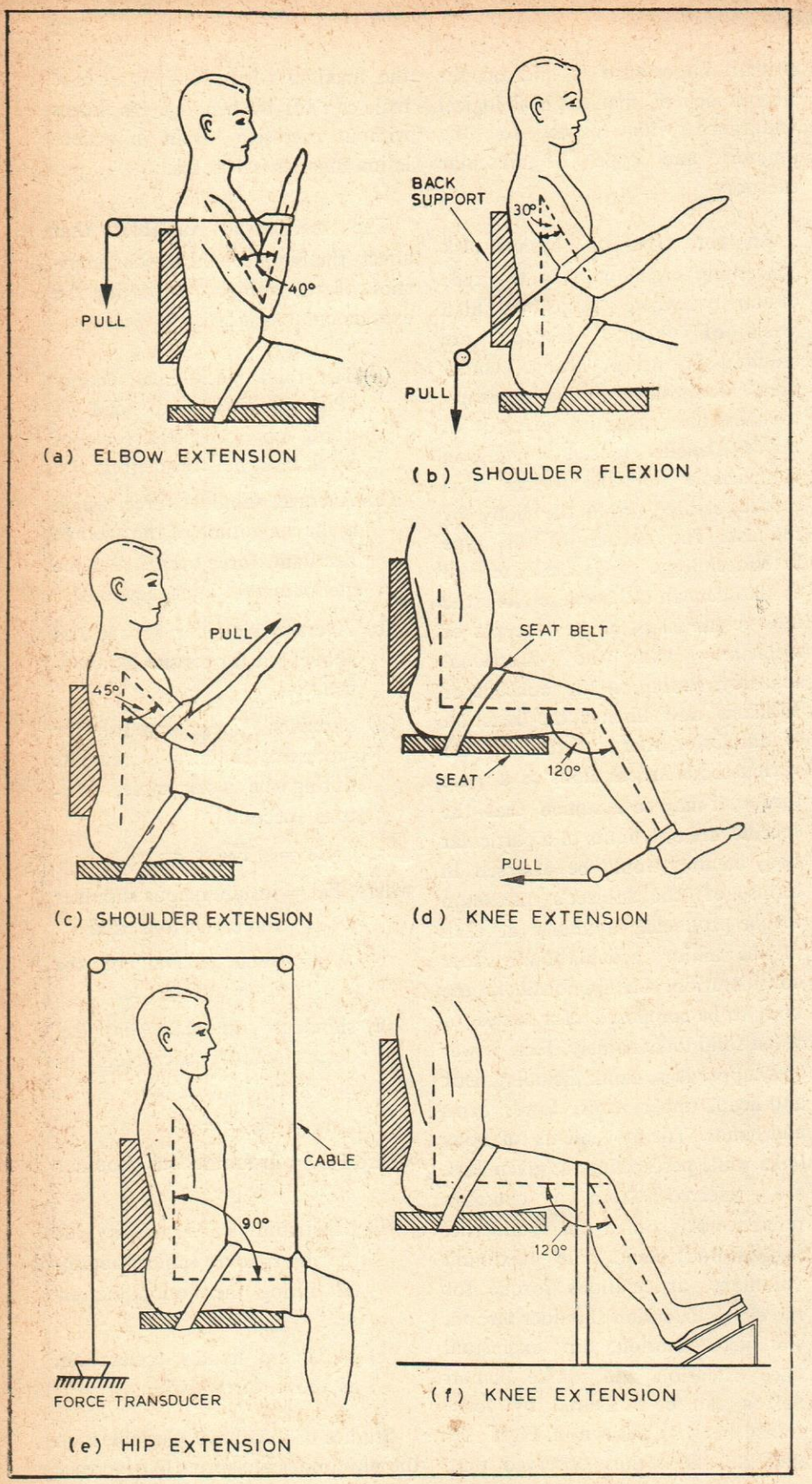
$$I_a = F_{st} \times \tau ;$$

where F_{st} = instantaneous shoulder torque

(f) Maximum hand velocity, at the mass centre (point) obtained during the motion, metres/sec;

(g) Maximum hand acceleration, as above, metres/sec^2.

Studies of the above variables on the physiological aspects like increase



(CHAFFIN & BAKER)

Fig. : 2.1 Methods of Measurement of Maximum Voulantary Articulation Torques

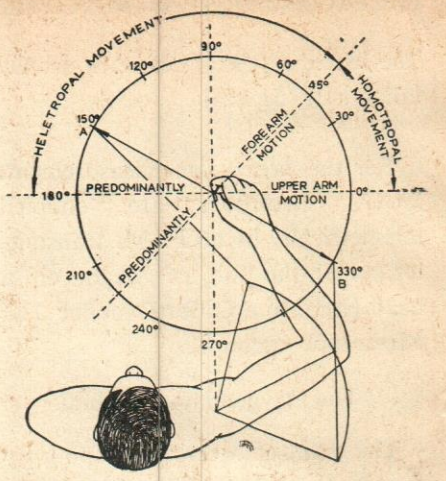


Fig : 2.2 Angular Turning of Upper And Lower Arm (5 TIER)

in ventilation rate per BSA (body surface area) at standard temperature, pressure and dry conditions (STPD); increased heart rate; increased oxygen consumption per BSA, etc., can be obtained by using the Ramsay's 'exoskeletal kinemometer'. Daydruff has provided the Anthropometric data of skeleton dimensions of Joe, Josephine and Joe Junior.

A Look at the Test Results

Some of the characteristic test results are shown in Figs. 3.1 through 3.6.

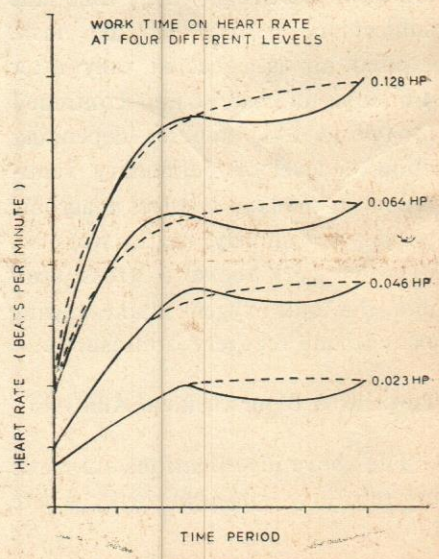


Fig : 3.1

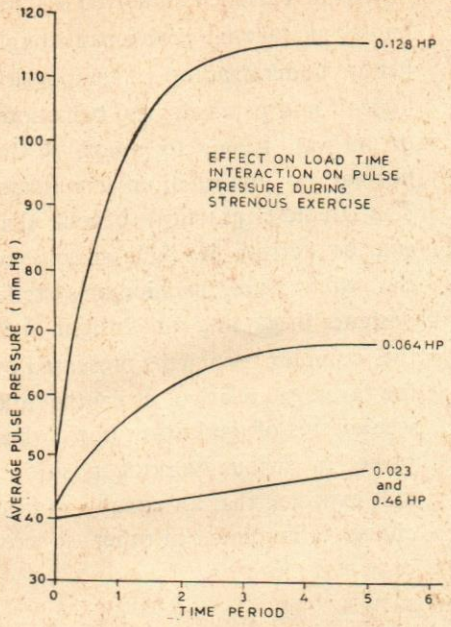


Fig : 3.2

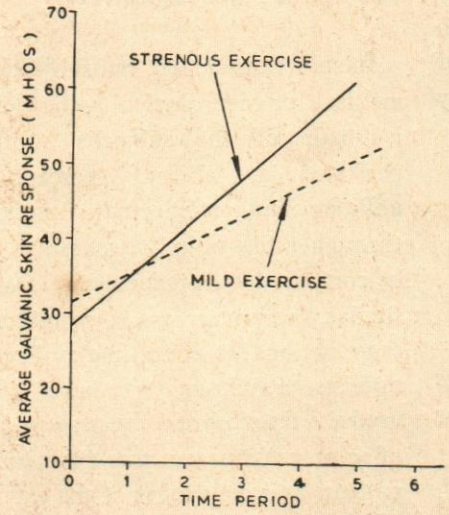


Fig : 3.3

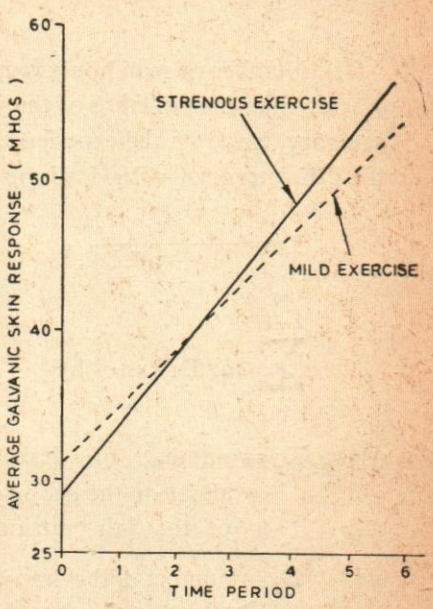


Fig : 3.4

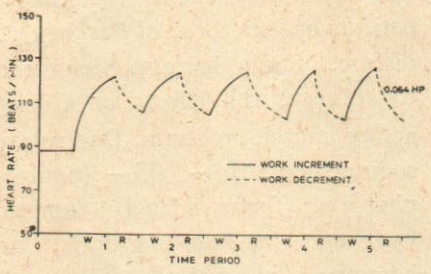


Fig : 3.5

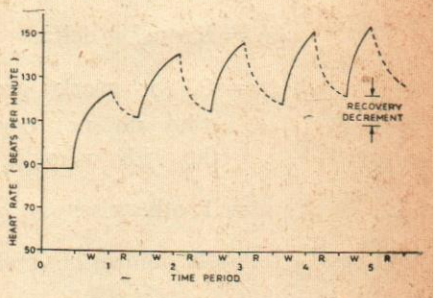


Fig : 3.6

The Learning Process

During World War II a remarkable phenomenon was consistently observed in aircraft industry; the direct labour input per airplane declined with considerable regularity as the cumulative number of planes produced, went up. It was obvious that the operators learnt as they performed the operations, acquiring more and more skill through better eye hand co-ordination: muscular control became more and more habitated and automatic; and better understanding and coordination amongst fellow workers. This phenomena was termed as 'learning', being different from 'Productivity'. In order to correctly assess the progressive decline in the unit cost of production Stanford Research Institute made a statistical study and prepared standards on log paper of different slopes for different catagories of planes. Wright (1936) developed a formula of the type:

$$\bar{Y} = a.\, x^n ; \qquad (1)$$

where, $\bar{Y}$ = estimated average direct man hours per unit for the first x units;

a = parametric constant $= \bar{Y}_1$, for the first unit;

n = index of reduction in cost ($n < 0$).

The above formula was modified by Stanford Institute as "Stanford–b– formula" as follows:

$$Y = a(x + b)^n ; \qquad (2)$$

where, b = equivalent units of experience available at the start of the manufacturing programme

$$\approx 4 \; (1 < b < 10)$$

The programme may be still more complicated by the different versions of planes, say in Boeing 707 family (B-17, B-47, B-52, etc.) being done by a set of work groups either engaged fully in one version or partly in two or three continued versions. If 'N' is the total number of versions of different catagories of planes in a family, the total number

of experience groups in a family is $\neq (2^N - 1)$.

The Number of man hours required for the manufacture of the j th category, based on the experience of the i th category (= Y_f) is given by

$$Y_j = \frac{Y_f}{(1 + b)^n . D_j} \sum_{i=1}^{2^N - 1} \delta_{ij} . D_i (x_i + b)^n \quad (3)$$

where, D_j = number of drawings afloat on the shop floor of the j-th version;

D_i = number of the drawings afloat on the shop floor of the i-th version (past experience);

δ_{ij} = Kronekar delta;

= 0, for work groups who do not contain the jth version, or

= 1, otherwise;

= N number of versions;

n,b = parameters, as mentioned earlier.

The above formula has been effectively utilized in further design changes of the family.

The Concept of Monotony

It is viewed as opposite of interest, distaste for task that accumulates as a lack in the variety and mental challenge while performing an activity. Its effect is an increased effort required to continue working. It is severe in highly specialized and highly repetitive work. It is usually an experience, that defies satisfactory quantification and prediction.

The Use of Psychological Tests

In such tests skilled, but subjective medical or neurological assessment is made of the subject's motor performance, ability, perceptual abilities and intellectual function through a few objective measures to be compared with judgements from similar, but not neccessarily duplicate examinations (at other time). Ergonomists (Psychologists) have not used the tests beyond the assessment of some gross parameters on mental patients and judgement of the extent of deficit, the degree of recovery and the effect of treatment to drug efficiency. The experimentation is also conducted with hemiplegic patients or with those of Parkinson's disease. Study has also been made to observe the effects of a long acting muscle relaxant, Dantrolene sodium, i.e., {1 − ([5 − (p-nitrophenyl) furfurylidene] amino} hydantoin sodium hydrate, on hemiplegic patients. It reduces or eliminates spasticity (spasmodic, uncontrolled muscular contractions and increased resistance to motion) and as such is expected to enhance motor performance on patients suffering from Hyper metria. An attempt has been made to evaluate the change caused by the administration of the drug L-Dopa to patients suffering from Parkinson's disease, a form of brain damage.

The Epilogue

Ergonomists have pioneered a revolution in the industrial base, scratched deep into the engineer-physician barrier, and solved several knotty managerial problems through better understanding of the physiological and psychological behaviour of human beings to adapt to the normal or abnormal environments. The greatest practical benefit that can be derived is the assistance to the work place, machine or systems designer in gaining an insight into the complex problems presented by the average relative strengths and weaknesses of the human body when placed in various working positions. It is expected that an equally radical change is imminent in other spheres of activity as well.

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TAPPING THREE-PRODUCT HEURISTIC SOLUTION PROCEDURE

Mohanty, R. P.
and
R. Natarajan

Managers engaged in production planning and control activities may go to multiple-product solution procedure for effectively resolving their problems of lot sizing and sequencing on one common facility

The problems of determining lot sizes and taking decisions about sequencing of multiple products on one common facility with deterministic demand have been attempted by several authors. It has been observed that the procedures developed by them are really difficult to apply in production planning and control activities in an industrial organisation where the managerial talents are not sufficiently exposed to such sophisticated techniques and procedures. It is felt therefore, to suggest a heuristic method of solution, which can be practised by those managers who are not exposed to rigorous mathematical or operational research techniques. The objective of this paper is to suggest a simple computional procedure which can handle multiple-praduct from one common facility. For demonstrating the procedure, a three-product example is solved and the salient steps have been mentioned.

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The Problem Scenario

The problem to be addressed here deals with the problem of scheduling annual production for a shop manufacturing products (i.e, electronic devices or alcohol products, etc.); and describes an approach to the resolution of such a problem in a near-optimal manner. The shop under consideration is, in the real life, a collection of smaller units or transfer lines which interact on different levels. The levels may be at raw-material stage, or at labour requirement and allocation stage. Some of the input raw material is utilised in more than one line of production. A certain degree of exchange of labour among lines is possible, because to some extent, labour skill is common to more than one line. Furthermore, at management level, there is a distinction among the lines and the products also, and hence some interaction can be observed at this level.

By the very nature of the products, they are manufactured on the basis of batch-size. Production is always meant in the shop for stocking and ultimately the products are shipped to warehouses whenever there is a demand. Of course, different products are not in equal demand. However, the problem is that some products are small runners while others are large runners. The major elements and parameters of problem confronting the management of this particular type of production shop are very common. They are customer demand which is variable from month to month, inventory which is used as a decoupler between the market and the production lines, and in-process inventories which in certain lines, cannot be ignored nor can their fluctuations be ignored.

The capability of the shop is considered here as the aggregate of the individual capabilities of the production transfer lines, with each line handling several products in any given period. For the purpose of our demonstration we can consider each line as a unit. Sometimes, it is observed in such industries that the same product is secured from another shop at a different geographical location. We omit the effect of such dual-sourcing in our analysis. It has also been observed that traditionally, there is always a conflict between the inventory manager and production manager. It is an immediate and inevitable consequence of the adoption of different criteria by upper management: minimum inventory for the inventory manager and minimum cost for the Production Manager. It is in fact very complex to make a compromise between these two criteria. However we make an attempt here to minimise the cost of the total system composed of inventory and production. To this end certain cost parameters are to be recognised which require closer scrutiny for the cost estimation.

It is not our intention here to present a novel approach to the above mentioned problem. Several approaches are available in the literature (1,2,3,4,5), and we do not wish to review the status and the contributions of those approaches here. A distinguishing aspect of our treatment is that our emphasis is on the development of an operational system as a managerial aid to the problem of multi-product scheduling for a single facility. The solution procedure can be established as a basis for n-product heuristic problem analysis.

Developing The Heuristics

Notations:

T : the number of production days in the year

N : the number of products

R_i : the annual demand for production

C_i : the fixed cost of a run of product i (set-up cost)

H_i : the cost of holding one unit of product i in inventory for one year

P_i : the daily production rate for product i

n_i : the number of equal sized runs of product i in one year, —not necessarily integral

r_i : R_i/T_i : the daily demand rate for product i

$\left(1-\frac{r_i}{p_i}\right)$: the fraction of a day's production which goes into inventory

$R_i/(n_i p_i)$: the number of production days in a production depletion cycle (p–d cycle) for product i

$R_i[1-(r_i/p_i)]/n_i r_i$: the number of depletion days in a p-d cycle for product i.

For convenience, we define

$$W_i = H_i R_i [1-(r_i/p_i)]c_i.$$

Feasible solution will only exist if $P_i \geqslant r_i$, for all i and if

$$\sum_{i=1}^{n} (r_i/p_i) \leqslant 1,$$

the latter stating that there is sufficient time available on the machine to produce all of the requirements for each product.

Assumptions:

The following assumptions are made to develop the solution procedure :

(a) Only one product may be produced at a time,

(b) A batch must be started and be completed before that particular product model runs out,

(c) A re-order point on each individual product is available and the stock is replenished at intervals by a quantity equal to optimum batch size,

(d) There is a constant set up cost and often a constant set-up time associated with each product,

(e) The demand rate for each product is known and constant over an infinite planning period, and all demand must be met,

(f) The production rate for each product is known and constant, and

(g) An inventory charge is made based on the value of stock held and the time for which the stock is held. These assumptions are not too restrictive assumptions but they have been accepted in inventory management literature (6) as axiomatic.

Three-Product Heuristic Model

Let the products be so numbered that

$$w_1 \leqslant w_2 \leqslant w_3 \qquad \ldots (1)$$

Let n_i ($i=1,2,3$) denote the runs of products i in one year. Assume that, $n_1 \leqslant n_2 \leqslant n_3$. For schedule feasibility it is necessary that

$n_2 = k_1 n_1$ and

$n_3 = k n_2$ where k, $k_1 = 1, 2\ldots$ (discrete integer value) ..... (2)

Violation of (2) means there will be times when both products will simultaneously require time from the same machine. For schedule feasibility, it is necessary that depletion time in p-d cycle of products 3 and of product 2 be at least as large as the production time in a p-d cycle of product 1. That is, mathematically, we can write them as :

$$R_3(1-r_3/p_3)/n_3 r_3 \geqslant R_2/n_2 p_2,$$

$$R_2(1-r_2/p_2)/n_2 r_2 \geqslant R_1/n_1 p_1,$$

and, $R_3(1-r_3/p_3)/n_3 r_3 \geqslant R_1/n_1 p_1$

Using (2) we obtain,

$$R_3(1-r_3/p_3)/k n_2 r_3 \geqslant R_2/n_2 p_2$$

or $$\frac{R_3\left(1-\frac{r_3}{p_3}\right)}{k r_3} \geqslant \frac{R_2}{P_2}$$

or $$\frac{R_3 P_2\left(1-\frac{r_3}{P_3}\right)}{R_2 r_3} \geqslant k$$

or $$k \leqslant \frac{R_3 P_2\left(1-\frac{r_3}{P_3}\right)}{R_2 r_3} \qquad \ldots (3)$$

and $$\frac{R_2(1-r_2/p_2)}{n_2 r_2} \geqslant \frac{R_1}{n_1 p_1},$$

becomes

$$\frac{R_2(1-r_2/p_2)}{k n_1 r_2} \geqslant \frac{R_1}{n_1 p_1},$$

or $\frac{R_2P_1\ (1 - r_2/p_2)}{R_1r_2} \geqslant k_1$,

or $k_1 \leqslant \frac{R_2P_1\ (1 - r_2/p_2)}{R_1r_2}$ ... (3.1)

and $\frac{R_3\ (1 - r_3/p_3)}{n_3r_3} \geqslant \frac{R_1}{n_1p_1}$,

becomes

$$\frac{R_3\ (1-r_3/p_3)}{k\ n_2r_3} \geqslant \frac{R_1}{n_1p_1},$$

or $\frac{R_3\ (-\ r_3/p_3)}{k\ k_1n_1\ r_3} \geqslant \frac{R_1}{n_1p_1}$,

or $\frac{R_3P_1\ (1 - r_3/p_3)}{R_1\ r_3} \geqslant k\ k_1$,

or $k\ k_1 \leqslant \frac{R_3P_1\ (1 - r_3/p_3)}{R_1\ r_3}$ ...(3.2)

(2) and (3) (3.1) & (3.2) together are necessary and sufficient conditions for schedule feasibility. Let the annual cost of the general production plan be represented by $f(n_1, n_2, n_3)$. The three product problem is embodied in the following optimisation problem :

$$\min f(n_1, n_2, n_3) = n_1c_1 + n_2c_2 + n_3c_3 + \frac{c_1\ w_1}{3\ n_1} + \frac{c_2\ w_2}{3\ n_2} + \frac{c_3\ w_3}{3\ n_3}$$

n_1, n_2, n_3

such that $n_2 = k_1n_1$

and $n_3 = k\ n_2$

where

$$k \leqslant \frac{R_3P_2\ (1 - r_3/p_3)}{R_2r_3}$$

and $k_1 \leqslant \frac{R_2P_1\ (1 - r_2/p_2)}{R_1r_2}$

and $n_1, n_2, n_3 > 0$ and $k, k_1 = 1.2.$ ... (4)

To solve, substitute (2) into $f(n_1, n_2, n_3)$ producing $\min g(n_1, k, k_1) =$

$$f(n_1, k_1n_1\ kn_2) = n_1\ (c_1+k_1c_2) + k\ k_1n_1c_3 = \frac{1}{3n_1}\left(c_1w_1 + \frac{c_2w_2}{k_1} = \frac{c_3w_3}{k\ k_1}\right)$$

such that

$$k \leqslant \frac{R_3P_2\ (1 - r_3/p_2)}{R_2r_3}$$

and $k_1 \leqslant \frac{R_2P_1\ (1 - r_2/p_2)}{R_1r_2}$

and $n_1 > 0$, $k, k_1 = 1, 2, \ldots$

Optimising over n_1, we get

$$\partial \frac{[g(n_1, k, k_1)]}{\partial\ (n_1)} = (c_1+k_1c_2) + k\ k_1c_3 - \left(\frac{1}{n_1}\right)^2 \left[\frac{1}{3}\ (c_1w_1 + \frac{c_2w_2}{k_1} + \frac{c_3w_3}{kk_1})\right] = 0$$

$$\text{or } n_1^*\ (k, k_1) = \left[\frac{\frac{1}{3}c_1\ w_1 + \frac{c_2\ w_2}{k_1} + \frac{c_3\ w_3}{k\ k_1}}{(c_1 + k_1\ c_2) + k\ k_1\ c_3}\right]^{\frac{1}{2}} \quad \ldots (5)$$

Hence,

$$g(n_1^*, k, k_1) = \left[\frac{1}{3}\left(c_1\ w_1 + \frac{c_2\ w_2}{k_1} + \frac{c_3\ w_3}{k\ k_1}\right)\left(c_1+k_1\ c_2+k\ k_1\ c_3\right)\right]^{\frac{1}{2}} + \left[\frac{1}{3}\left(c_1+k_1\ c_2+k\ k_1\ c_3\right)\left(c_1\ w_1 + \frac{c_2\ w_2}{k_1} + \frac{c_3\ w_3}{k\ k_1}\right)\right]^{\frac{1}{2}}$$

$$= \left[\frac{2}{3}\left(c_1+k_1\ c_2+k\ k_1\ c_3\right)\left(c_1\ w_1 + \frac{c_2\ w_2}{k_1} + \frac{c_3\ w_3}{k\ k_1}\right)\right]^{\frac{1}{2}} \ldots (6)$$

the problem thus reduces to $\min_{k, k_1} g\ (n_1^*, k, k_1)$ such that

$$k \leqslant \frac{R_3P_2(1 - r_3/P_3)}{R_2r_3}$$

$$k_1 \leqslant \frac{R_2P_1\ (1 - r_2/p_2)}{R_1r_2} \ \&\ k, k_1 = 1, 2, \ldots (7)$$

The unconstrained minimisation of $g(n_1^*, k, k_1)$ over k, k_1, may be readily accomplished by observing that $g(n_1^*, k, k_1)$ may be rewritten in the form:

$$g(n_1^*, k, k_1) = \left[\frac{2}{3}\left(c_1^2w_1 + \frac{c_1c_2w_1}{k_1} + \frac{c_1c_3w_3}{k\ k_1} + c_1c_2k_1w_1 + c_2^2w_2 + \frac{c_2c_3w_3}{k} + k\ k_1c_1c_3w_1 + k\ c_2c_3w_2 + c_3^2w_3\right)\right]^{\frac{1}{2}}$$

$$= \left[\frac{2}{3}\left\{c_1^2w_1 + c_1c_2\left(\frac{w_2}{k_1} + k_1w_1\right) + c_1c_3\left(\frac{w_3}{k\ k_1} + k\ k_1w_1\right) + c_2c_3\left(\frac{w_3}{k} + kw_2\right) + c_2^2w_2 + c_2^3w_3\right\}\right]^{\frac{1}{2}}$$

To minimise $g(n_1^*, k, k_1)$ it is sufficient to minimise $h(k)$, $h(k, k_1)$ and $h(k_1)$ where

$$h(k) = \frac{w_3}{k} + k\ w_2$$

$$h(k_1) = \frac{w_2}{k_1} + k_1 w_1$$

$$h(k\,k_1) = \frac{w_3}{k\,k_1} + k\,k_1 w_2$$

Since

(i) $h(k) - h(k-1) = w_2 - \frac{w_3}{k(k-1)}$

thus k^* is the largest integer such that $k(k-1) < \frac{w_3}{w_2}$

(ii) $h(k-1) - h(k_1 - 1)$

$= w_3 - \frac{w_2}{k_1(k_1-1)}$ thus k_1^* is the largest integer such tnat

$k_1(k_1 - 1) < \frac{w_2}{w_1}$

and

(iii) $h(kk_1) = h(kk_1 - 1) = w_1$

$- \frac{w_3}{k\,k_1(k\,k_1 - 1)}$ thus $(kk_1)^*$ is the largest integer such that,

$k\,k_1(k\,k_1 - 1) < \frac{w_3}{w_1}$

The solution to minimum $g(n_1^*, k, k_1)$ is thus given by (i), (ii) and (iii) and

$$k \leqslant \frac{R_3 P_2 (1 - r_3/p_3)}{R_2 r_3}$$

and $k_1 \leqslant \frac{R_2 P_1 (1 - r_2/p_2)}{R_1 r_2}$ ...(8)

A Numerical Example

We consider here a three-product problem to illustrate the applicability of the above model. For various products the different data required are mentioned in Table 1. It has been observed that for each product change in a particular line the following time and costs have to be incurred :

Table 1

Product type (i)	Consumption per year (Ri)	Production rate per day (Pi)	Holding cost per item/year (Hi)	Set-up cost per batch (Ci)
1	488800	44625	0.494	811.50
2	2581000	51000	0.377	811.50
3	214286	51000	0.221	811.50

- ☐ 7½ hours for the preparation of the line.
- ☐ 50 minutes for picking up the production to the working capacity of the line.
- ☐ 30 minutes for breaking up the line at the end of the run.
- ☐ 2 hours for maintenance of the line during start up and break up.
- ☐ 6 persons are engaged for starting of the line and breaking of the line.
- ☐ One maintenance mechanic is engaged during the working of the line.

The following types of costs are considered here :

(a) the stocking costs which are the costs directly resulting from the holding of stocks. These costs increase as the batch size increases and conversely.

(b) Set-up costs which are the costs associated with initiating the manufacture of a batch. For each product type these costs are having the following components :

- ☐ costs of administration for product changes
- ☐ costs of maintenance for product changes
- ☐ costs of preparation for product changes
- ☐ costs of breaking up for product changes
- ☐ costs of losses resulting from the system (for example, in case of an alcohol industry system losses may include liquid losses, packing material losses, breakages etc.).

We take T=250 working days/year, with 7 hours (working time) per day. The interest rate has been taken to be 13%.

Using Equation 8, we get

$k^* = 4.8559$, and $k_1^* = 18.2035$.

Using Equation 5, we obtain also $n_1^* = 1.0228$ and hence,

$n_2^* = 18.6190$

and $n_3^* = 90.4136$

The minimum cost of this solution = Rs. 73392.126. We therefore, find that the production days in the p-d cycle for different products are 10.709 days, 2.7180 days and 0.0464 days, respectively.

We conclude here by saying that the model and numerical examples

presented in this paper are merely an illustration of a simplified operational procedure which we believe can be successfully implemented in any similar industrial situations. It is our experience that such a procedure has worked well in some industry for production planning and has gained managerial acceptance as a simple technique. It is our contention that the success of any operational system is crucially dependent upon the correct balance between the various components, and is less dependent on the degree of sophistication.

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HOW TO SELECT TRAINEE PILOTS

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If objective tests and techniques have emerged to be effective predictors of the training performance, why the airlines should not use them as a selection device

The objective of the study was to develop a selection test battery for recruitment of trainee pilots for an airlines and to evaluate the predicative efficiency of the selection procedure through follow-up study and thus, to throw light on how to select trainee pilots.

349 candidates appeared in the selection tests and 50 were finally selected on the basis of detailed assessments of their attitudes, personality and knowledge through tests, 'group task' and interview.

Some of the selection variables were found to have significant positive correlation with the training period performance, while for the rest ihis was not true. When the present group of trainees was compared with previous groups selected through traditional method (i.e., interview) with reference to the training period performance, marked superiority of those who scored high in the written test and 'group task, was observed.

The results so far obtained appeared to be promising but further improvement in the test battery was felt possible.

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The Need for a Careful Selection

Importance of any recruitment depends upon the level of the job and the responsibilities involved. The higher the level and the responsibility, the larger will be the number of dimensions both cognitive and non-cognitive, called for achieving success. Therefore, it is essential to identify these variables through observation and job analysis, before one takes up any recruitment programme.

Recruitment of pilots is of prime importance to any airline as it means a large investment; the performance of the pilot has a direct bearing on the efficiency and reputation of the company, its business prospects and expansion potential. Now a days, airlines spend crores of rupees in procuring expensive and sophisticated aircrafts and ground installations but ultimately it is the human element that is put up in the air to manoeuvre the machine, determines the safety and smooth running of the fleet. An airline may have well managed departments, may have staff with pleasing personality to serve the customers but unless the flight appears to be reasonably safe as per past records, the passengers will not be attracted and hence the future of that company cannot be bright.

The job of a pilot does not call for any super-human quality during its normal course of functioning, because with ever increasing sophistication almost everything is getting relegated to the realm of automation, but emergency does occur, the automatic systems do fail and then the human element on board is to take over the control at this crucial moment and is required to do the needful under a highly stress situation. Failure to react to such rare incident which may come up suddenly with alertness, precision and speed of reaction or failure to take the right decision at the right moment may bring total disaster for all on board. So, the pilot has to maintain constant vigil inspite of the boredom usually associated with the job. He has to have the capacity to observe and interpret minute details, to be logical to a point that the decisions are instantaneous and their correctness acquires an instinctive flavour for him.

During the last forty years of the history of aircrafts' industry, it is observed that the progress rate is unbelievable. But one cannot claim that the human being who controls the aircraft is getting changed with the progress of technology. Perhaps technology has outstripped man's span of control and attention. As a result, the human element occasionally becomes overloaded to such an extent that he himself becomes the primary cause of an accident. When weather is bad, runways are short, equipments start malfunctioning, the human mind has to deal with so many variables at a time under great stress, that the situation goes beyond his limit; he misinterprets the basic information and makes mistakes which may cause total disaster.

What Qualities are Needed

A number of studies were undertaken by organizations like-United States Air Force Human Resources Laboratory (4, 6, 8, 9, 11, 12, 15), U.S. Naval Aerospace Medical Laboratory (11), Aeromedical Laboratory, Japan (7, 13, 16) and Medical Centre of the Aeronautics Laboratory of Psychology, Rumania (2), etc., analysing the job situation of pilots, the effect of unusual set up within the cockpit during flying hours upon the physical and mental stability of the pilots, the abilities, personality traits and family background required for success as a pilot. These reports reveal that so far as the functions of a pilot are concerned, they mainly comprise of reception, perception and processing of information, decision making and final action (17). Co-ordination with the crew members, ability to work efficiently under stress situation, high degree of self-confidence, emotional stability, anxiety-freeness etc., are proved to be contributing towards success. Intelligence, clear communication, space orientation, basic attention, capabilites, quick reaction are found to be correlated with success. Some of these studies analysed the eliminated and drop out cases of a training course and found that poor division of attention i.e., inability to pay attention to diverse details simultaneously, inadequate visual perception of distance, emotional tension etc., are the main causes of failure.

When the management of a particular airline requested the authors to work out suitable selection procedure for the trainee pilots holding basic commercial pilot's license, the first step was to analyse the job of a pilot through study of the relevant literature, discussion with senior pilots employed in the organisation and teachers at their pilot training centre, observation of on-the-job activities in the cockpit over a period of time. On the basis of the information thus gleaned it was decided that the following variables were to be assessed for the purposes of the selection, keeping in view the time and opportunity available for testing the candidates.

Cognitive Variables	*Non-cognitive Variables*
General Intelligence.	Sense of responsibility.
Ability to handle large number of variables simultaneously.	Emotional stability—cool & strong nerve.
Accuracy of judgement of the situation.	Co-operativeness.
Ability to follow direction.	Involvement in work.
Ability to master new assignment quickly.	Clear communication.
Co-ordination and judging distance.	Leadership—Captainship.
Attention to details.	Careful—not dare-devil type.
Quick reaction in response to instruction.	Well disciplined.

In addition to these basic qualities, sound technical knowledge about aviation was a must for those to be recruited as pilot trainees. Moreover, originally it was planned to use simulator for testing the candidates after initial screening prior to interview as it duplicates more or less the actual job situation. But as adequate facilities could not be made available, this idea was dropped out.

Objective Tests Used

A test battery was developed to measure the cognitive aspects mentioned earlier. There were three parts viz., Speed, Aptitude and Technical Knowledge. The tests were objective in nature i.e., either a short answer type or the multiple choice type. Duration of the entire test was 4 hours. A brief description of the tests is presented here.

Speed test : Different colours (those used in modern aircrafts for signal purpose) were presented to the candidates in different combinations and they were required to give simple and repetitive responses to the colour sequences with sudden change in direction.

Aptitude test : There were four parts —two connected with space relation and attention to details like identification of hidden figures or identifi-

cation of similar figures etc., and the third and fourth part were related with intelligence, abitity to follow direction and comprehension of information provided.

Technical Knowledge test : It was a multiple-choice type test and the duration was two hours. It covered areas like navigation, magnetism, meteorology. radio aids, instrumentation, aerodynamics etc.,

Assessment of Personality Qualities

The higher the complexity and level of the job, the more will be the importance of non-cognitive variables in determining the success. The cognitive aspects mentioned above would help the pilot trainee in acquiring further knowledge in modern aviation technology and in learning the operation of sophisticated aircrafts quickly but whether he will apply his intelligence to acquire that knowledge or whether he would be able to face danger with stability and maturity will be determined by his personality aspects. Actually, personality acts as guarantee towards utilisation of his potential ability for ultimate success.

It has been observed that during flight training, candidates well qualified from the technical point of view fail to complete the training successfully though the real cause of failure is not exactly known. In such situation the personality pattern which often remains unknown, may be identified to be responsible for the failure.

Identification of the required personality traits and their assessment, more or less objectively especially under selection situation where probability of faking is high, are rather challenging tasks. It was, however, planned to use Group Task and Group Discussion for this purpose.

In Group Task, the participants are asked to solve a problem using paper and pencil. Problems are so designed that they have some relevance to the job in question. Successful completion of the task calls for interaction among the members of the group. The participants, desirably eight in number, seated around a table, are to solve the problem within one hour. Each participant is evaluated by three or four or five raters independently on the basis of their observation during this period with respect to the relevant personality traits. The method was proved to be useful and reliable in a study conducted by the authors (3).

Group Task was followed by Group Discussion for half an hour and the participants were rated as done in Group Task. The personality traits independently assessed by the raters through this process were as followes :

Mental Alertness

Involvement in group activity and co-operativeness

Application and Initiative

Judgement

Emotional Stability

Leadership

Address or Manners

Articulation—ability to communicate efficiently

Participation

Logical presentation of points

Depth of knowledge about common themes

Ability to co-ordinate

All eligible candidates took the written test. Those who were above the cutting point were called for Group Task, Group Discussion and Interview. Interview was conducted by subject matter experts and Directors of the airlines who rated the candidates on the basis of their Professional Knowledge and Personality. Combining all these measures and also the Educational and Professional qualifications of the applicants, a merit list was drawn up for final selection.

The Trainees Selected

349 candidates appeared in the written test. They were all Commercial Pilot's Licence holders and belonged to the age group 22 to 30 years. 111 candidates who qualified in the written test were called for Group Task, Group Discussion and Interview. Ultimately 52 candidates were selected for the training.

The Findings

As the training facility available was limited, the successful candidates were admitted in batches for the training on the basis of the merit list. Altogether three batches took

the training in succession. Mean scores, etc., of the selection variables for three batches along with those for all the applicants, are presented in Table 1.

made through various examinations and trainers' observation. The duration of the training course was 14 weeks. At the end of the training, examinations were held on ten diffe-

tion variables and the training period assessments are presented in Table 2. These correlations were separately calculated for each batch and as the number of trainees per batch was

Table 1 : Means of the Selection Variable for selected batches and for different groups of applicants

Variable	Batch I N=16	Batch II N=16	Batch III N=20	Applicants called for Group Task & Interview N=111	All Applicants N=349	Maximum possible score
Speed	334	317	323	322	276	360
Aptitude : I	25.42	24.46	25.10	23.01	23.04	30
II	19.29	17.08	18.73	17.79	16.02	24
III	27.46	23.77	23.83	24.47	21.39	42
IV	12.60	11.56	10.21	10.61	8.63	18
Technical Knowledge	96.38	77.51	80.31	78.36	66.68	120
Group Task & Group Discussion	5.10	4.87	4.36	4.31	*	9
Interview :						
Prof. Knowledge	22.42	20.83	17.05	12.99	*	30
Personality	7.83	7.50	6.80	5.92	*	10
Educational Qualification	6.59	6.33	5.40	5.69	*	10
Professional Qualification	6.75	6.17	5.40	5.73	*	10
Final Composite	96.38	77.51	59.55	57.44	*	100

*Data not available.

The figures presented in Table 1 reveal that the performance of Batch I was best, followed by Batch II and Batch III, respectively. The tests were, however, found to be quite suitable to the level of the applicants.

Predicting Training Performance

The criterion used in this study was the training period assessment

rent subjects like Magnetism, Instrumentation, Navigation, Flight Planning, Plotting, Radio & Radar, Metallurgy, etc. Beside these theoretical subjects, there were simulator and flight training and the data available indicated the time required to master the technique. Here, the less the required time the better was the performance of the candidate.

The correlation between the selec-

quite small, rank order correlations were calculated. For some trainees the performance record was incomplete and these cases were excluded.

Of the 45 correlations, five were found to be significant at the 5% level and four at the 10% level. Speed part of the test had maximum validity whereas other parts were found to be not so much related

Table 2 : Rank Correlations between Selection Variables and Training period Assessment

Selection Variables	Percentage marks in Theoretical Subjects			Simulator Hours			Flying Hours		
	Batch *I*	Batch *II*	Batch *III*	Batch *I*	Batch *II*	Batch *III*	Batch *I*	Batch *II*	Batch *III*
Speed	.70*	.37	−.15	.00	.74*	.09	.61*	.59+	.10
Aptitude	.71*	.20	.18	.45	.22	−.18	.46	−.29	.01
Technical Knowledge	.05	—.32	.51+	.49	—.60*	.02	.18	—.27	—.37
Group Task & Group Discussion	.50	.25	—.06	.28	.13	.05	.54+	.08	.10
Composite Selection Variables	.48	.15†	.31	.46	—.44	—47	.56+	.40	—.19
Number of cases	12	12	20	12	12	20	12	12	20

* Significant at the 5% level.
† Significant at the 1% level,
+ Significant at the 10% level.

with training performance. The same was also true with personality ratings but this variable was not expected to be much related with the criterion as performance during training period mainly depended upon the potential ability of the trainees to learn the subjects in question. The personality traits will have its effect on actual job performance when not only the technical skill but a number of other factors would be required for successful performance of the duties assigned. Hence, the relevant criterion for Group Task and Group Discussion would be available after some more time when job performance record of the pilots could be obtained. However, the validity coefficients presented here are based on the selected group of candidates only and hence the restriction of range has its effect on them.

The New vs. Old Systems

In order to assess how far the newly introduced procedure of selection helped to select better candidates, the performance of these three batches of trainees was compared with those of the other three batches selected earlier through interview only. Comparable training period examination marks, flying and simulator hours etc., were available for two of the three old batches and for the remaining one, however, marks for only four theoretical subjects were available without any record for flying and simulator hours.

The training period assessments were divided into two categories viz., theoretical subjects and simulator and flying hours as the nature of the two sets of data was different. The means of different trainees for the six batches are presented in Table 3. The results show that the training performance of batches selected by the new procedure was in general better than that of the previous three batches with respect to theoretical subjects as well as simulator and flying training, except in one particular occasion.

It is also apparent from the result that the training period performance varied directly with the composite of the selection variables. So far as the performance in flying and simulator was concerned Batches I, II & III were markedly superior to Batches B and C. Significance of the difference between the mean for Batch A and those for Batches I, II and III was tested by t-test and the results are presented in Table 4.

Table 4 shows that the performance of Batches I, II and III in the theoretical subjects was significantly better than Batch A.

Significance of the difference in performance of other batches was tested by analysis of variance. For each pair of batches two sets of

Table 3 : Means of Training period Assessments and those of Selection Composite score for six batches of trainees

Batches	Number of cases	Percentage marks in Theoretical subjects	Simulator Hours	Flying Hours	Percentage marks in Selection Composite
Selected through Interview					
A	27	78.99	*	*	*
B	12	86.26	18.77	16.50	*
C	11	95.63	17.54	16.20	*
Selected through Objective Method.					
I	11	94.37	12.02	14.78	96.38
II	12	89.55	12.53	15.33	77.51
III	20	86.79	13.23	15.35	59.55

* Data not available.

analysis of variance were computed—one for ten theoretical subjects and another for simulator and flying. The nature of the data suggested the use of 'mixed design' (10) in which some of the treatment comparisons are inter-subject and some are intra-subject. If treatment A indicates the subjects taught during training and treatment B indicates the method of selection, then each of A treatments in combination with any one of B treatments, was adinistered to the same individuals but each B treatment was administered on different groups of individuals. Hence, the comparison of 'effect of selection methods' became between subject comparison whereas the comparison between 'the training subjects' and that of 'interaction between training subjects and selection methods' became within group comparison.

Table 4 : t-values indicating the significance of differences between means of Batch A and Batches I, II & III

Pair of Batches	*t-value*	*d.f*
A×I	12.71†	36
A×II	8.35†	37
A×III	6.42†	45

† Significant at the 1% level.

The results of the analysis are presented in Tables 5 and 6.

The following conclusions may be drawn from the results.

- ☐ So far as simulator and flying training were concerned, Batches I, II and III were significantly better than Batches B and C. They mastered the technique in much less time than the older batches. It speaks for the efficiency of the new method of selection.
- ☐ With respect to other training subjects, Batch I was significantly better than Batch B though not so with reference to Batch C. So far as Batch II is concerned, its performance in theoretical subjects was not significantly different from that of Batch B; Batch C did significantly better than Batch II. The same is also true for Batch III.

A Promising Note

The objective of the present investigation was to find out the efficiency of the particular selection procedure undertaken by an airline for recruiting their trainee pilots. The results on the whole appear to be promising though further improvement in the procedure was felt necessary. So far as Batch I was concerned, not only the examination marks demonstrated their superiority but also as per the opinion of the teachers this batch had no parallel in the record of the training centre. By lowering cutting points of the selection variables, Batch II and III were admitted and consequently low level of performance in the training was observed. This speaks for the positive relation between the selection composite and the training performance. It also indicates that a high level cutting point should be maintained in order to admit really efficient trainees. As speed part was proved to have maximum contribution some improvement and extensi on of this

Table 5 : F-values obtained through Analysis of Variance

(Flying & Simulator)

Source of Variation	*Batches* $B \times I$		*Batches* $B \times II$		*Batches* $B \times III$		*Batches* $C \times I$		*Batches* $C \times II$		*Batches* $C \times III$	
	F	*d.f*	*F*	*d.f*	*F*	*d.f*	*F*	*d.f*	*F*	*d.f*	*F*	*d.f*
Method of Selection	45.61†	1,22	23.41†	1,22	24.25†	1,26	36.31†	1,20	20.97†	1,20	14,80†	1,25
Training Subjects (Flying & Simulator)	0.17	1,22	0.22	1,22	0.17	1,26	1.31	1,20	1.32	1,20	0.12	1,25
Training Subjects × Method of Selection	17.89†	1,22	16.93†	1,22	1.30	1,26	12.26†	1,20	11.91†	1,20	5.60	1,25

†Indicates significant at the 1% level.

Table 6 : F-values obtained through Analysis of Variance

(Ten theoretical subjects)

Source of Variation	*Batches* $B \times I$		*Batches* $B \times II$		*Batches* $B \times III$		*Batches* $C \times I$		*Batches* $C \times II$		*Batches* $C \times III$	
	F	*d.f*	*F*	*d.f*	*F*	*d.f*	*F*	*d.f*	*F*	*d.f*	*F*	*d.f*
Method of Selection	17.48†	1,22	2.65	1,22	0.13	1,30	2.20	1,20	40.04†	1,20	70.87†	1,29
Training Subjects (Theoretical Subjects)	7.99†	9,198	6.06†	9,198	12.92†	9,270	16.23†	9,180	21.07†	9,180	26.76†	9,261
Method of Selection × Training Subjects	6.03†	9,198	10.42†	9,198	11.20†	9,270	20.11†	9,180	12.37†	9,180	10.48†	9,261

† Indicates significant at the 1% level.

part of the battery was felt desirable. The change was incorporated in the succeeding selection battery and the improvement in the result is yet to be established through follow up study.

It is a matter of research interest to follow the selected pilots and collect their performance record continuously and establish the long term validity of the entire selection procedure. Work in this direction is in progress.

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WHERE DO OUR WASTE MANAGEMENT PRACTICES STAND?

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and
P. Vrat

If substantial amount of wastes are generated in different sectors of our economy and there exist immense possibilities for waste reduction and recycling process, why not managers pay attention to this critical issue

This paper is in continuation of part 'I' in which broad outline, encompassing sources of data, design of questionnaire, major inferences etc. of a national survey on waste management was discussed. The data obtained from the responses of questionnaire survey, published literature, and personal interviews is compiled, synthesized and analysed to determine the critical stages of waste generation, resources, sectors, and functional elements deserving immediate attention from waste management point of view. Certain quantitative estimates are tabulated and crucial problem areas are highlighted.

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Quantitative estimates regarding the type and quantum of waste (1) generated, collected, recycled and disposed off in various sectors provide a sound basis for the design and planning of future Waste Management systems and indicate the potential of work in this field. Some survey reports on pollution, material conservation etc. are available in Indian context, while no macro level survey has been conducted covering various facets of Waste Management. The problems in obtaining the information on this aspect are complex and involve following factors'

- ☐ Various organisations differ widely in their waste generating practices.
- ☐ Lack of understanding, few records, and non-availability of data on this aspect.
- ☐ Reluctance of the firms due to treatment of waste data as confidential.
- ☐ Lack of interest taken by the participants.
- ☐ Some industrial activities are subject to seasonal variations.

With the limited response of the survey due to above factors, some information regarding the waste of various resources have been derived.

The Methodology for Data Analysis

The data from the responses of the questionnaire survey was compiled under separate heads, i.e. Generation, Reduction, Collection, Recycling and Disposal, and synthesized with that obtained through the personal interviews and the published literature. Due to the limited number of responses it was not possible to do comprehensive statistical analysis. Hence, the subjective analysis using the numerical evaluation techniques has been done in order to get a comparative picture of the various aspects of Waste Management. Some quantitative estimates have also been derived but on degree of confidence has been associated with them. Some information is also derived from secondary sources. While assessing generation of waste due consideration has been given to:

- ☐ measures of quantities,
- ☐ Statistical analysis of generation rates, and
- ☐ factors that affect generation rates.

As the data were diversified in nature, a variety of methods were adopted for analysis. The general methods adopted for the purpose of analysis are as follows:

(i) Paired Comparison method

(ii) Frequency distribution method

(iii) Estimation method.

The data has been analysed separately for resources, stages, sectors, functional elements, etc.

The Pattern of Resource Waste:

Resource wise analysis has been done in order to determine the relative weightage of different resources that are wasted. The factors considered in determining the relative weightage are:

(i) Percentage contribution of resources to GNP.

(ii) Criticality of the resource on the basis of availability.

(iii) Social importance of the resource.

(iv) Secondary effects of the resource wasted.

The paired comparison method was used, and the results of the analysis are shown graphically in the Fig. 1. The analysis shows that materials constitute the most important resource in Indian context; followed by energy, capital and manpower resources.

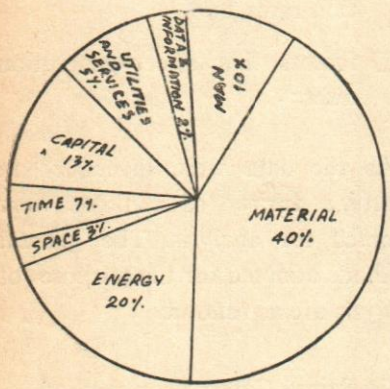


Fig. 1: Resource Wise Analysis of Relative Weightage of Basic Resources from Waste Management point of view

Material waste may be in any of the three forms, viz, solid, liquid, or gaseous. Solid wastes may potentially contain any of the solid materials found in nature and in addition many of the synthetic materials. They constitute most heterogeneous collection of substances possible and may be hazardous or non-hazardous.

The liquid waste mainly constitutes the water. The quantity and composition of water from a given industry vary widely, depending on the manufacturing process employed and the methods of their control in different plants. An in plant survey carried out in a textile mill shows that the quantity of water used in these mills is about 12.0 to 13.5 cu.m/1000 m. of cloth produced and the water let out is about 10.0 to 11.5 cum/1000 m. of cloth (1)

The waste gases which do not take part in any chemical process and are let out to atmosphere are generated in various industries, and creating pollution e.g.,

- ☐ exhaust gases from power plants,
- ☐ gases leaving L.D. convertor, and open hearth furances in steel industry,
- ☐ gases leaving, rotary kiln in cement plant, coke calcination plant, glass melting furnaces, roasting furnaces of copper and Zinc industry,
- ☐ Waste gases from fertilizer plants etc.

The results of survery conducted has shown that the generation rate of various waste gases from a fertilizer plant with installed capacity of 750 MT/day NH_3, 880 tons/day urea and 1650 tons/day NPK fertilizer are as follows:

(a) flue gases from auxilliary boilers	3.7×10^6 NM^3/Day
(b) Co_2 from NH_3 plant	428 MT/Day
(c) Waste air from urea plant	16.8×10^6 NM^3/Day
(d) Waste air from NPK plants	13.5×10^6 NM^3/Day

Identifying the Critical Stages

By using the frequency distribution method the relative frequency of various stages of waste generation have been found and rationalized to find the critical stages. The results of the analysis are shown graphically in the Fig. 2, which indicates that the critical stages that need immediate attention for waste control are Design, Planning, Production and Control.

Locating the Critical Sectors

A subjective analysis by applying paired comparison method has been done to find out the rank of various sectors in respect of the various types of wastes and contribution to pollution. The higher the waste/pollution caused, higher the rank. Following factors were considered for the purpose of comparison:

(i) The sectoral outlays for various types of resources; the data was taken for Fifth five year plan (21)

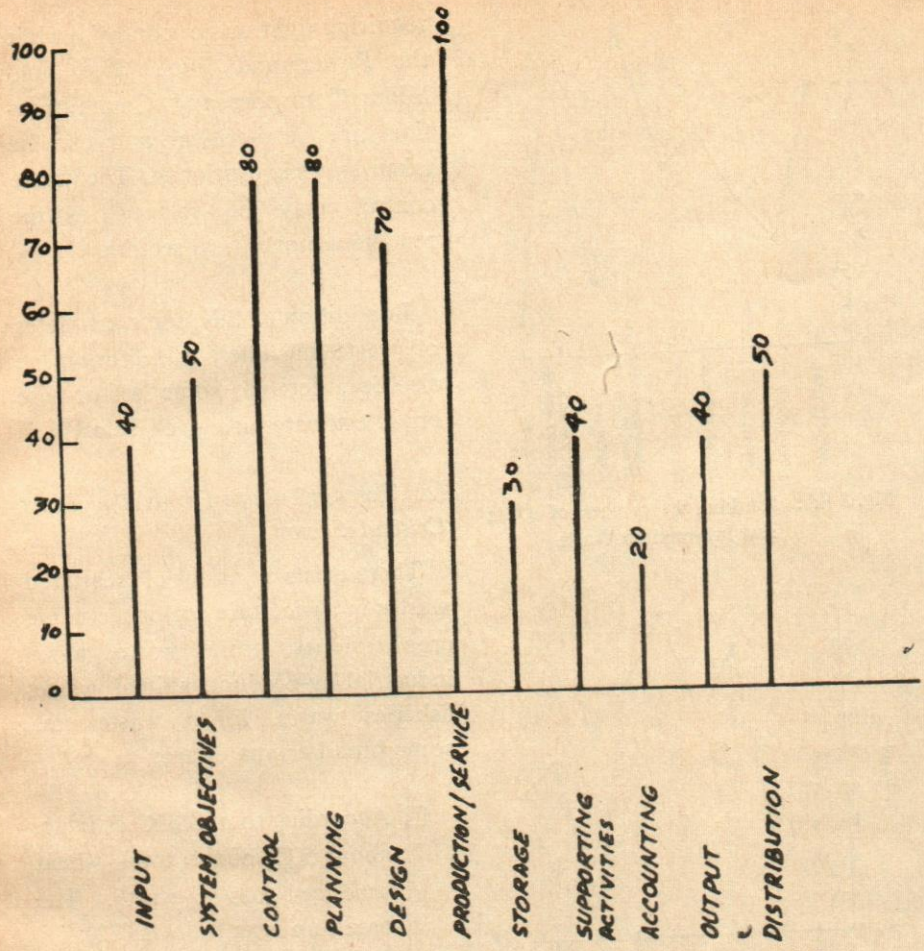


Fig. 2: Stage wise analysis of Criticality of various stages in the light of Waste Management

(ii) The data obtained from survey on waste/pollution caused in various sectors.

The results are represented graphically in the Fig. 3 (a to i). The curves so obtained only give a rough comparative picture of various sectors as regards waste of resources, while they do not represent the actual percentage contribution to total waste by various sectors.

In order to rank the various sectors in respect of the total aggregated waste, the weighted sum of the ranks of each sector for different types of resources has been computed, and a curve is drawn as shown in Fig. 3 (j) which represents the criticality of the sector in view of the waste generated. The results of the survey show that Agricultural and Industrial sectors are critical

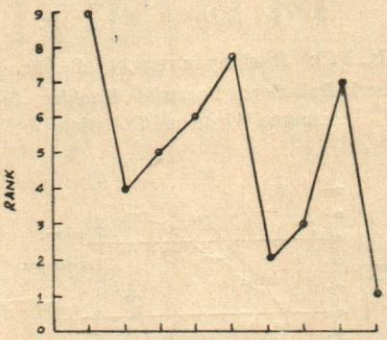


Fig. 3 (a): Ranking in respect of Man-power Waste

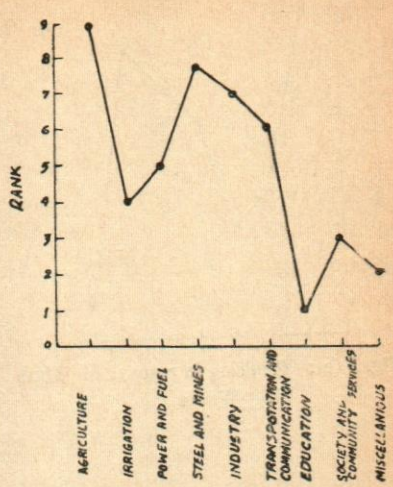


Fig. 3 (b): Ranking in respect of Material Waste

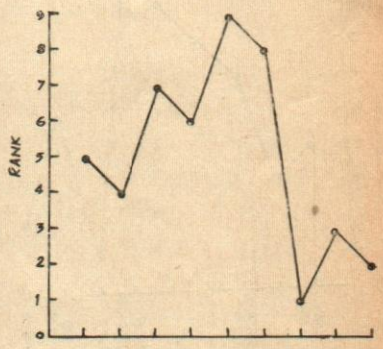


Fig. 3 (c): Ranking in respect of Energy Waste

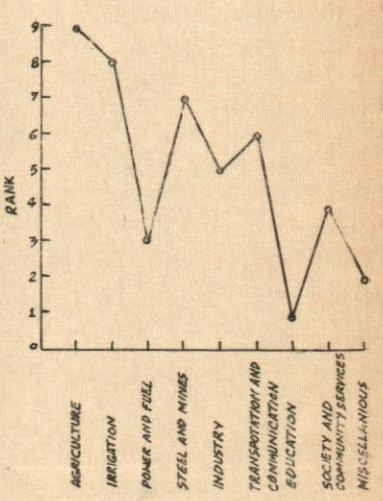


Fig. 3 (d): Ranking in respect of Space Waste

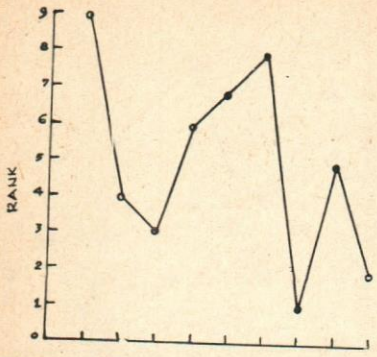


Fig. 3 (e); Ranking in respect of Time Waste

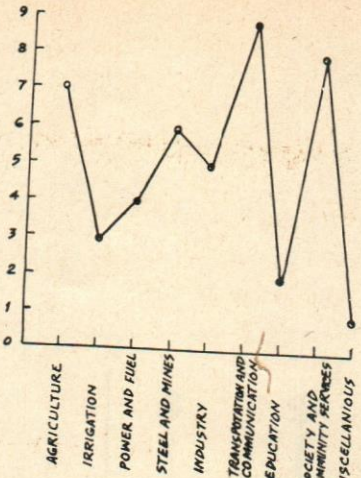


Fig. 3 (h): Ranking in respect of Data and Information Waste

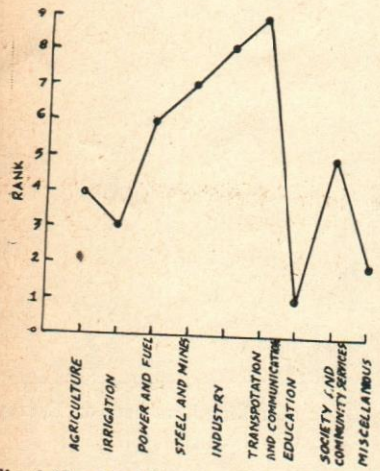


Fig. 3 (f): Ranking in respect of Capital Waste

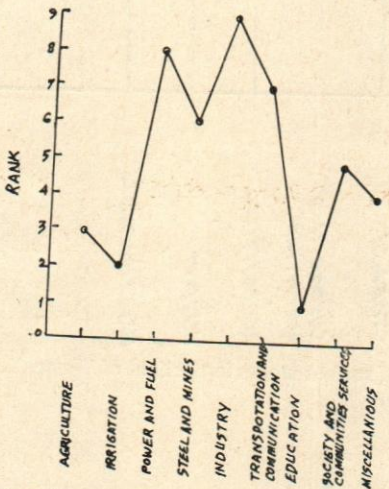


Fig. 3 (i): Ranking in respect of Atmospheric Pollution: Sectorial Ranking for Resource Waste and Pollution

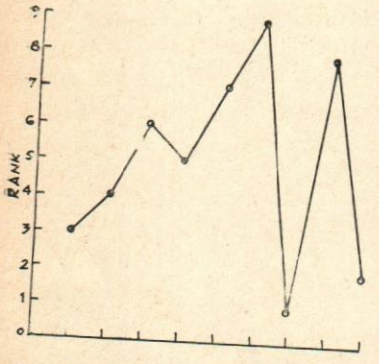


Fig. 3 (g): Ranking in respect of Utilities and Services Waste

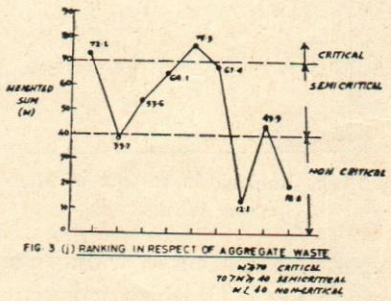


Fig. 3 (j): Ranking in respect of Aggregate Waste

W > 70 Critical

70 > W > 40 Semicritical

W < 40 Non-critical

requiring tight waste control, while the Power and Fuel, Steel and Mines, Transport and Communication are semi-critical and can be taken on second priority. The waste control may be relaxed in the remaining noncritical sectors.

In addition to this, some estimates of waste in different sectors have also been derived; some sector-wise broad estimates are given below.

(a) The Agriculture Forms the Most Critical Sector

There exists a variety of scattered wastes in agriculture sector including crop residues, grain waste, agro-industrial by-product, animal waste, fisheries waste, forest waste etc., some broad estimates are:

- ☐ According to a CSIR estimate about 50% of the total wheat produced goes as waste. The break up is as follows (22):

Field loss	25%
Storage loss	
(a) Insects and pests	3-5%
(b) Rats, birds etc.	10%
Transportation loss	15%
Distribution loss	2%

- ☐ The average response of fertilizer to crop production is on lower side; according to an estimate the average response to fertilizer is 22%
- ☐ Every year about 13 million tons of rice husk is wasted which is equivalent to the waste of 39×10^6 million Kcal (13).
- ☐ The agricultural productivity is very poor in India, which

indicates the colossal wastage of land, man and other resources in agricultures.

- With 1950-51 as the base year, the generation rate of agricultural residues has increased by 106% in the case of rice and 174% in the case of sugar cane during 1978-79 (18)

(*b*) *The waste, in Irrigation*

Though India is rich in its water resources, it is unfortunate that hardly 5-6% of surface water is put to use. Some broad estimates reflecting waste in irrigation are:

- The irrigation efficiency is of the order of 50% in wheat, maize and sugar cane, and only 30% in paddy, implying excess application of water in these crops.
- Hardly 55% of the quantity of water in canals reaches the field. About 45% is lost in absorption, percolation, seepage and evaporation. The seepage loss is about 20-30% (9).
- Theoretically, irrigation should make it possible for double cropping, if not multiple cropping, but the bulk of the irrigated area in India still continues to be single cropped area.
- 44% of country's total area is under severe soil erosion. Erosion leads to land slides along mountain roads. Out of total catchment area of 77.6 million hectares of 30 major river valley projects nearly 11.6 million hectares require conservation treatment. (Symposium on soil conservation, 1980).
- About 6000 million tons of soil is lost per year due to erosion depriving the country of 6 million tons per year of vital plant nutrients.

(*c*) *The Power and Fuel Position*

The extent of fuel utilization in India is very-very poor. Some estimates of wastage in this sector are :

- Conversion efficiency of various energy convertors is poor, the conversion efficiencies of heat into work are shown in Table 1.

This shows that about 60-70% of the total energy content of fuel goes as waste.

- Average transmission losses are 17-18%, while as high as 27-30% losses are also quite common.
- An average of 25% wastage of fuel is occurring in all mills ranging from small to large.

(*d*) *The Steel and Mines' emerges Semi-critical* :

The waste generated in mines, washeries, blast furnaces, steel mills etc. is generally bulky. Large tonnages of washery taibings and blast furnace slag are generated. Stored coal gets deteriorated and many a times ignites spontaneously. The quantitative estimates of waste in this sector were not available.

Table 1: Conversion Efficiencies of Heat into Work

Energy Convertor	*Efficiency*
(i) Steam Engine (Non-condensing)	5%
(ii) Low temperature condensing Steam cycle	14 to 20%
(iii) High temperature condensing Steam Cycle	35 to 40%
(iv) Automobile Engine (Petrol)	30%
(v) Diesel Engine	35%
(vi) Gas Turbine	55%
(vii) Magnets Hydrodynamic (MHD) plant superimposed on steam plant	50-55%
(viii) Fuel Cell	85-90%

Source : Mishra, R.S., Equipment Utilisation in the Present Context', *Integrated Management*, October 1976, 9.

- The power plant generation efficiencies are as follows:

(NPC, CEA)

Power plant	*Maximum efficiency*
Coal fired	30%
Oil fired	35%
Nuclear	40-45%

The Industrial Sector Deserves Utmost Attention:

This is also a crucial sector as

regards waste generation. There exists a variety of industries generating various typical wastes including manpower waste, capital waste, all unwanted materials may be organic/inorganic, metallic/nonmetallic, hazardous/nonhazardous, salvable/nonsalvable, etc. Some broad estimates are:

- ☐ Excessive productive mandays are wasted due to frequent strikes, lockouts and other industrial disputes. The absenteeism recorded in industry is as high as 30% (7). Some estimates of man power waste in India are shown in Table 2.
- ☐ Though the capacity utilization of industries varies from 20-90%, the utilization is generally on lower side resulting in wastage of capital. The details are shown in Table 3.
- ☐ The activity level in industry is very poor as indicated below (Planning Commission, NSS) :

Sector	*Activity level*
Government	30-50%
Public	40-70%
Private	50-90%

- ☐ According to an estimate capital worth 15,000 crores of rupees is blocked in inventory in the organised sector,
- ☐ A survey carried out by the Central Electro-mechanical Research Institute, Karaikudi, a decade ago estimated the annual cost of corrosion in India at Rs. 1500 million. The estimated figure for wastage of metallic resources by corrosion in U.S. is about 1.25% of the GNP.

Table 2 : Man Power Waste in India

(a) Man days lost due to various Industrial disputes

Year	*Number of disputes resulting in stoppage work*	*Workers involved (Lakhs)*	*Mandays lost (Million)*
1947	1,811	18	16.6
1951	1,071	7	3.8
1961	1,357	5	4.9
1971	2,137	12	16.6
1973	3,240	17	20.6
1974	—	—	40.26
1975	—	—	21.90
1976	—	—	12.75
1977	—	—	25.32
1978	—	—	28.34
1979	—	—	38.1

Source : 1. *Basic Statistics related to Indian Economy* (Planning Commission)
2. *India*, Reference annual, 1976
3. *India Today*, May 1980

(b) Estimated Rural and Urban (Unemployment in million)

S. No. Type of Unemployment	*1971*	*1973*	*1978*	*1983*
1. Rural				
Useful status (chronic)	1.73	1.83	2.00	2.20
Weekly Status	7.04	7.46	8.15	8.98
Daily status	14.21	15.06	16.47	18.10
Urban				
2. Urban status (chronic)	1.88	2.04	2.37	2.77
Weekly status	2.41	2.61	3.05	3.55
Daily status	3.24	3.52	4.09	4.78
3. Total				
Usual status (Chronic)	3.61	3.87	4.37	4.97
Weekly status	9.45	10.07	11.20	12.53
Daily status	17.45	18.57	20.56	22.88

Source : *Draft Five Year Plan (1978-83)* Government of India, Plnnning Commission

It was not possible to assess quantities of waste generation in all the industries. The actual quantities and combinations can be estimated by conducting separate detailed surveys of individual categories, i.e. cement industry, steel industry, chemicals and drugs, etc.

Table 3 : Capacity Utilization in Indian Industries

Period	*Manufacturing Industries*	*Basic Industries*	*Capital good industries*	*Intermediate good industries*	*Consumer good industries*
Average for					
1961-65	87.9	88.2	82.9	89.2	88.5
1966-68	81.1	83.1	65.2	83.6	83.4
1969	80.4	87.8	61.4	79.5	84.5
1970	80.0	80.5	59.2	79.5	86.2
1971	77.4	81.0	56.9	77.0	82.6
1972	79.6	86.2	57.0	81.4	83.0
1973	77.9	82.0	61.6	80.3	79.8
1969-73	79.1	83.5	59.2	79.5	83.2

Source : *Reserve Bank of India Bulletin*, Sept. 1975

The Waste in Transportation and Communication :

This sector contributes towards a major fraction of fuel as well as time waste in the national economy; some broad estimates are:

- ☐ The average fuel consumption of vehicles is about 0.25 litres per km., which is no doubt on lower side and shows the wastage of fuel.
- ☐ A major fraction of the total fuel consumption in transportation can be saved by proper maintenance.
- ☐ Substantial savings in fuel consumption can be achieved by improving the quality of roads. According to an estimate a vehicle giving 13 miles average on bad road will give about 15 miles average on a good road. (Ministry of Shipping and Transportation).
- ☐ According to a study carried by Planning Commission about 10-15% of saving in fuel and upto 25% saving in time may be achieved by removing the checkposts.

(*g*) *The Drainage in Education:*

The rate of return to education in India is quite low and majority of educated people are either unemployed or misfits resulting in wastage of skills and human capital. About 60% of the educated people on employment registers are unemployed. Further India is continuously loosing skill on account of braindrain.

(*h*) *The Society and Community Services Paid Less Attention*

The service sector has not been given much importance in the country resulting in wastage of capital, time, manpower utilities and services, etc.

- ☐ The estimated losses in water distribution system are upto 50% of total supply. The characteristics of municipal wastes vary greatly with the geographical location, season of the year, type of area, i.e. rural or urban, standard of living, physical facilities, industrial activities etc. Some estimates of municipal waste generation rates in different cities of the country, and a typical composition of municipal waste are shown in Table 4.

It is unfortunate that despite of its known consequences the culture of throw away packages is gaining momentum in India. In an industrialized society the quantity of scrapped household appliances is increasing every year. The propensity to generate waste volume per residence increases with the introduction of common onsite storage facility.

For effective solid waste management planning, knowledge of future trends in the composition of solid wastes is of great importance. It has been noted that the percentage of paper and plastic in solid wastes has increased greatly in recent years.

(*i*) *About other Sectors*:

It includes certain other activities that are not covered under other sectors. The estimates of waste under miscellaneous activities could not be obtained. A study has revealed that energy used in cooking is about 1.57×10^6 Kcal/capita/year, which is twice the energy consumed in food eaten.

Due to the lack of appropriate predictive technology and less

Table 4 : Some Estimates of Municipal Wastes in India

(a) *Urban refuse = 600 gms/capita/day*

	Calcutta	*Bambay*	*Delhi*
Pollutants (tons/day)	1100	1000	800
Garbage (tons/day)	2200	2500	—
Sewerage (tons/day)	—	1363	750
Domestic effluents (million lit)	—	328	200
Industrial effluents (million lit)	13	22	20

(b) *Typical composition of residential solid waste by weight*

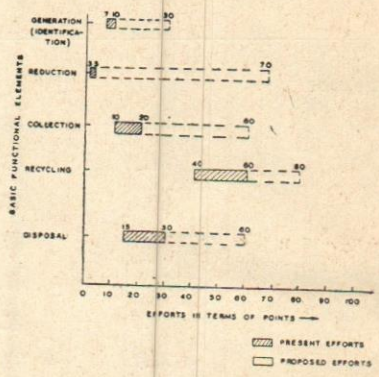
Waste material	*Per cent*
Paper	35-45
Food waste	10-20
Glass and ceramics	5-10
Metals	5-10
Grass and Leaves	5-15
Textiles	2-6
Wood, Plastics, Rubber, Leather and inert materials	4-6

Source : Survey conducted

emphasis on nature conservation and control, country is loosing millions of lives, man power as well as live stock, and the property including structures worth crores of rupees every year on account of natural calamities like floods, droughts, cyclones, earthquakes etc. It has been estimated that about 75% of the organisations do not resort to safety codes, which is leading to hazardous accidents.

The Criticality of Functional Elements

The approximate fraction of efforts being put to various functional elements have been determined for various questionnaire responses. The total present Waste Management efforts in India have been assumed to be equivalent to 100 points. The ranges of efforts in terms of points have been ascertained for each element and rationalized on the basis of information obtained from personal interviews and published literature. It has been found that at present major stress is being given on recycling, while the waste reduction function is generally being ignored. To expedite the Waste Management function. it is proposed to increase the efforts by 200%. In view of the criticality of various elements as visualized by survey, the targets of efforts in near future on various functional elements are proposed by incorporating the suggestions obtained from the survey. The results of the analysis are graphically shown in Fig. 4.



Assumptions :

Total present efforts for Waste Management = 100 Points

Total proposed efforts to expedite Waste Management in near future = 300 Points

Fig. 4: Functional element wise analysis showing the ranges of present efforts and the proposed targets

Projecting Per Capita Estimates

The data on waste under various responses has been derived to common bases like waste/capita/day. The average of such common bases has been found for similar types of organisations, and finally the estimates are projected at national level by considering the sectoral outlays, power requirements, man-power allocation etc., and rationalizing the results on the basis of the data available from literature and that derived from secondary sources. Some per capita estimates are derived of residential, commercial, industrial and other types of wastes for urban sector, rural sector and the nation separately, and are shown in Table 5.

Table : 5 Per Capita Estimates of Solid Wastes

gm/cap/day

Solid wastes	*Urban*	*Rural*	*National*
Residential	600	300	400
Commercial	200	50	100
Combined	150	100	120
Demolition/Construction	150	50	90
Street and Alley	70	30	50
Industrial	300	100	200
Miscellaneous	200	50	100
Total	1670	680	1060

Source : 1. Survey conducted
2. Derivation from secondary sources

Summing up

In the wake of increased industrialization and urbanization the problem of Waste Management in the various sectors of economy has become critical and immediate attention is needed to solve the problems related to waste. There is a pressing need to aggregate the past work done and coordinate the Waste Management activities from systems point of view.

The results of the survey has indicated that, a substantial amount of various types of wastes are generated in different sectors, with tremendous potential for waste reduction in various spheres of activities, and unlimited scope for recycling of agricultural, industrial aud municipal wastes in Indian context. Agricultural and Industrial sectors are found to be critical in respect of aggregate waste deserving top priority for Waste Management.

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MBT TRAINING HAS MADE GREAT STRIDES

Dwivedi, R.S.

Organisations need to use trust-based training for their executives and trade union leaders to enhance the origanisational, managerial and union effectiveness

The MBT training is being increasingly used in both healthy and sick organisations in India. It has to accomplish some general and specific goals despite several attitudinal, ideological, traditional and habitual barriers. It uses a scientific procedure and its course content involves varied topics in the areas of organisational behaviour and human resource management with specific stress on theory and applications of management by trust. It applies latest methods and techniques of training adapted to Indian culture and organisational climates. The effectiveness of the training is established through immediate feed-back by the participants, fore-and-after measures (Pre-and post-MBT performance) and follow-up analysis of opinions after several months of the programme.

This paper has been presented at the International Seminar on Labour Management Issues in the Third World Development, organised by Faculty of Management Studies, University of Delhi at Ashoka Hotel, New Delhi from January 4-7, 1983. An earlier version of the paper has been published in Lok Udyog, *February, 1982.*

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MBT (Management by Trust) training and development programme is gaining increasing recognition among Indian managers and trade union leaders. As a contingency approach to training, it takes into account organisational climate prevailing at point in time. Frequently, it forms a part of long-term MBT organisational change and development programme. However, its relevance as an independent, developmental experience cannot be denied. As a part of long-term programme, its duration is four to six weeks, two to three hours a day while as an independent experience, it involves one to two weeks, three to six hours a day. Hitherto, it has been exposed to several hundred managers and trade union leaders of many healthy and sick medium-sized and large public and private sector and multinational organisations in different parts of the country. The programme is characterised by the use of latest behavioural science methods and techniques and stress on the Indian value systems, especially trust and confidence. The goals and barriers, procedure, course content, methods and techniques used and feedback and evaluation of the programme are shared in this paper as an educational experience with practising executives and scholars in the field of management.

What are the Goals and Barriers

The goals and barriers of the MBT training vary in terms of prevailing organisational climate of the enterprise. Generally, in a healthy organisation marked by 'high' and 'above' average trust, the goals of training relate to the attainment of increasing level of organisational health and effectiveness through the improving level of development and effectiveness of its human resources and there are very minor barriers to them. On the other hand, in an unhealthy organisation marked by low and average level of trust, the goals and barriers are akin to those of a sick person, i.e., reduction of strength of the unhealthy conditions causing organisational ineffectiveness and gradual movement towards effectiveness and existence of powerful restraining forces in the system causing immense resistance to change. Specifically, the goals of the MBT training at individual, group and organisational levels include increased output, enhanced job satisfaction, morale and commitment, improved interpersonal and intergroup relationships, collaborative union-management relations, reduction of restraining behaviours such as absenteeism, tardiness, turnover, indiscipline, grievances and unrest and increased level of organisation's strength to deal effectively with external and internal dynamics.

There are several attitudinal, ideological, traditional and habitual barriers to the MBT training in Indian organisations. Attitudinally, the top management has a feeling that the quality of people in the organisation is of a too low standard to make any constructive uses of the highly advanced measures of the

MBT system. It is held that the execution of these measures demands high level of competence which is lacking among people. Rather, it is feared that their 'minds' will change and expectations go up causing immense problem to them. There is also a doubt that the system can lead to indiscipline, insubordination and non-productive efforts. Ideologically, there exists a stereotype belief that the MBT approach will lead to professionalisation of management resulting in delayed decisions, buck passing and reduced loyalty to the company. Traditionally, there exist several 'blind spots' stemming from the assumption that increased interaction and confrontation with subordinates required by the MBT system will minimise the respect and dignity of the 'boss'. Accordingly, the 'boss' resists the idea of frequent face-to-face interactions and confrontations with the subordinates. Likewise, the subordinates avoid interaction with their 'boss' and resist the proposal for frequent meetings with them intentionally for fear of any unpleasant happenings arising from it. Perhaps, these beliefs arise from traditional Indian authority system. Habitually, 'old timers' (Senior executives) are the greatest enemy of the MBT training both in public and private sector organisations. These 'old timers' perceive a large gap between their behavioural patterns based on Theory X and those of the MBT approach stemming from Theory Y. Because of these habitual behavioural patterns, they consider the trainer and the trainees as a threat to their survival in the organisation and accordinlgy, put every effort to undermine the MBT measures and sometimes even the personal image of the trainer and trainees.

Notwithstanding the above barriers to the attainment of goals of the MBT training, it has made great strides in recent times probably because of deep-rooted cultural value system supporting trust and confidence, democratic value system adopted by the Government, growing discontentment among the 'new generation' managers and trade union leaders arising from the distrusting attitude and autocratic style of the 'authority' figures and the effectiveness of MBT measures in accomplishing both tangible and intangible and short and long-term goals of the organisation.

How to Conduct it

The programme is usually launched with the initiative of the top management, especially managing director or general manager. However, sometimes, it is initiated by training manager with the approval of the top management. Once terms and conditions course-content, place and duration of the programme are finalized, attempts are made to select managers and trade union leaders, if any, for participation. The trainees are selected from a single department, different functional and hierarchical groups and representative trade union(s) depending upon the prevailing needs in the company. They are adequately informed about the nature and relevance of the programme. As a prerequisite, it is ensured that the top executives participate in all the sessions either as observers, conference leaders or active trainees. The number of participants in each session ranges from twenty-five to thirty. The seating arrangements in the training-room are made in different shapes depending upon the nature of methods and techniques used. The relevant training material including books and programme outline are distributed to the participants before hand. After the welcome address by the chief executive, the trainer provides a brief introduction to the programme and stresses the need for open expression of ideas, opinions, and feelings to ensure adequate involvement of the participants.

Prior to the exposure of the MBT training, attempts are made to administer a series of test including Rotter's Inter-personal Trust Scale (RITES), Dwivedi's Trust Distrust Industrial Scale (DIDIS), Self-Assessment of Key Managerial Orientations (SAKMO) and Leadership Effectiveness and Adaptability Description (LEAD) to assess generalised interpersonal trust, individual, group and organisational trust and distrust, managerial orientations and leadership, respectively. The scales are administered in pairs in two session; frequently, in the interim period a film is shown on "Effective Listening". The participants are given a feedback of individual and group performance on these measures at appropriate contexts. Another administration of these scales, usually after six months, provides an evaluation of the impact of the training. The sequence of course-content and methods and techniques of training are planned psychologically to ensure utmost

interest, involvement and effective learning of the participants. At the end of the programme, a questionnaire is administered to analyse the opinions of the participants about the immediate impact of the training on them. Of course, the final evaluation of the training is made after a specified period using several criteria such as before-after-measures, morale, production, performance-appraisals and opinions of the superiors, subordinates, peers and those of the participants themselves.

What it Covers

The course content of the MBT training for managers involves varied topics in the areas of organisational behaviour and human resource management with particular emphasis on theory and applications of management by trust-definition, measurement and development of trust at individual, group and organisational levels, relationships of trust and distrust measures with performance factors including production, morale, merit ratings, absenteeism, tardiness, turnover, discipline, accidents, unrest, etc. designing organisational structure based on trusting relationships to obtain more output with lesser input, optimising organisational processes such as decision-making, communication, control, leadership and motivation by trust, assimilating individual, group and organisational conflicts in the system by trust in a manner that constructive rather than destructive results are accomplished and integrating individual, group and oranisational goals by trust. In addition to discussing different concepts of the above MBT model, some topics are further stressed in view of their relevance for managing human resources, effectively. These topics include harnessing motivation and building morale of employees, leadership and effective supervision, effective communication, managing conflicts and allied behavioural concepts. Obviously, the major theme running through these topics is trust and confidence.

Frequently, attempts are made to discuss different management styles and techniques suitable for the organisational climate of a particular organisation. Based on the diagnostic analysis conducted before the exposure of the course, organisational climates are classified as: low trusting, average trusting, above average trusting and high trusting. For example, the organisational climate of a private sector company was diagnosed to be "average trusting". Therefore, the optimal management style and techniques to provide effective results in this moderately unhealthy organisation included: (a) high-task and high relationship leadership behaviour, (b) safety and social hygiene factors (incentives), (c) theory x supervisory attitude towards subordinates, (d) system 2 (benevolent autocrat) and system 3 (consultative) management styles, (e) XA and YA behavioural patterns, type 2 control system (job enlargement), partial control by follower or equal control contracting and allied techniques suitable for managing people marked by rational economic or social "man", dominance of child or parent ego state. "I 'm not OK, You're OK" life position and problem to both leader and follower. However, attempts are made to indicate the long-term repercussions of these measures and stress the need for using increasingly trust based styles and techniques with the improving climate of the organisation.

Likewise, as the organisational climate of a public sector enterprise was marked by "high trust", the most appropriate management techniques and style for discussion in this highly healthy organisation were: (a) low-relationship and low-task leadership behaviour, (b) Self-actualising motivators, theory Y managerial attitude, management style beyond system 4, YB and XB behavioural patterns, type 3 control system (job enrichment), follower control contracting and allied styles and techniques for managing people characterised by self-actualising "man" dominance of adult ego state and "I'm OK, You're OK" life positions and problem to neither leader nor follower. Similarly, techniques and styles relevant for "low trust" and "above average trust" are stressed depending upon prevailing climate in a particular organisation at a point in time.

The course content of the MBT training for trade union leaders largely relate to improving union effectiveness and tactics and strategies of collective bargaining. Specifically, stress is laid on measures to attain union's objectives, optimising organisational structure of the union by trust, optimising decision making, communication, control, motivation and leadership processes in the union by trust, measures to assimilate intra-and

inter-union conflicts by trust, approaches to integrate individual, group and organisational goals in the union by trust, and trust-based approach to collective bargaining. Following the contingency approach, the nature of approaches discussed depend upon the prevailing climate at a point in time in the union organisation in particular and the company in general.

What are its Methods and Techinques?

In addition to the use of lecture method for providing the facts of organisational life, the other specially designed methods and techniques used in the MBT training programme include conference and buzz sessions, case studies and critical incidents, role playing, sensitivity training, transactional analysis, Johari window, in basket, and business games. These methods and techniques are used in the programme because they stress democratic principles facilitate the growth of integrated mature personality and encourage the development of human values, especially trust and confidence.

The conference method is used to discuss a problem prevailing in the management or the union organisation and identified before hand, a case or a critical incident. Frequently, the entire participants are requested to discuss the given issue in "buzz" sessions involving break-up of conference in severe small groups of five to six persons. Each small group discusses the issue and reports its views to the entire conference session subsequently to provide a pooling of ideas to solve the problem. Both the "buzz" and "conference" members are required to select their discussion leaders whose role consists in encouraging discussion, stimulating competition and reflecting the feelings of participants.

A series of ten case studies involving varying levels of trust and confidence are frequently used depending upon the training needs of a particular company. These studies provide facts of organisational life summarising varied experiences and raising complex human and industrial relations problems in general and those of group dynamics, performance apprasial, morale, personality dynamics, effective and ineffactive supervision, union-management conflict, trade union leadership and intra and inter-trade union rivalries in particular. Likewise, six critical incidents relating to interpersonal and functional conflicts, informal system, morale and productivity, morale audit, resistance to change and sensitivity training, are used to provide a laboratory type of exercise for applying bahavioural approach to resolve human problems and make effective decisions at work.

Role playing is frequently used to develop empathy, mutual understanding and interpersonal skills among trainees. Frequently, superiors play the role of subordinates while subordinates play the role of superiors in simulated familiar work situations (i.e. carrying out a work-plan, appraising performance, etc.); trade union leaders play the role of managers while managers play the role of union leaders in simulated industrial relations situations (e.g., negotiating a contract, rapresenting grievance of members etc.).

Sensitivity training and transactional analysis are used in long term MBT project to improve interpersonal relationship and increase trust and confidence. Sensitivity training involves face-to-face emotional rather than intellectual learning regarding on-going behaviour in the group. Frequently, the training group meets continuously for several days, two hours a day without any preplanned topic for discussion. In this unstructured situation, the trainer attempts to facilitate the feedback process and check any emotional shocks to the participants. In transactional analysis, attempts are made to facilitate analysis and understanding of one's own and others' behaviour by assessing transactions of participants in simulated familiar day-to-day behavioural situations. Stress is laid on maintaining a balance between three ego-states-child (emotional), parent (ethical) and adult (rational) and possessing the ideal life position ("I 'm Ok You're OK" feelings) rather than life positions marked by "I'm not OK, you're not OK, "I'm not OK, you're OK" and "I'm OK, you're not OK" feelings.

Johari awareness window is used frequently to improve interpersonal relations and trust-worthiness among participants. It involves four selves: (a) the open self (reflects behaviour, feelings,

and motivation known both to oneself and to others), (b) the blind self (reflects behaviour, feelings and motivation known to other parties but not to the self), (c) the hidden self (reflects behaviour, feelings and motivation know to the self but not to others and (d) the unknown self (reflects behaviour, feelings and motivation known to neither the self nor to other parties). Exposure and feedback processes are used to cause a redistribution of awareness and changes in both the size and shape of the four selves. Stress is laid on increasing the size of the open self by enhancing self-disclosure and one's active solicitation of others' awareness.

In-basket method is used to develop decision making skills and provide on-the-job reality of the manager's in-basket to the participants. The most frequently used in-basket involves an exercise in human relations, especially personal and organisational problems. The participants are required to deal with a works manager's in-tray containing twenty-three papers, individually and discuss subsequently in syndicate the decisions made and compare performance. Likewise, depending upon the prevailing problem in a company, a variety of business games are used to provide understanding of work situation, decision making and dynamics of human behaviour in organisational settings by stimulating interest, creating new problems and opportunities and providing built-in motivation. Sometimes, depending upon availability, a series of films is shown to reinforce the learning of several topics, concepts and practices specified above.

In addition to the above methods and techniques, feedback on LEAD is employed as a measure to enhance understanding of situational leadership among participants while managerial grid seminar based on individual's test performance is used to develop concern for high task and high relations.

What has it Accomplished ?

The trainees provide varied feedback about the MBT training at the end of the programme. Typical responses of participants are cited here to analyse the relevance of different methods and techniques for designing the future programmes. In general, pointing to the MBT exposure, a chief executive from an international pharmaceutical company asserts that although he has participated in numerous executive development programmes in India and abroad either as observer or trainer, he has come across for the first time such informative lectures in the area of behavioural science. Business games, case studies and critical incidents have been cited as most interesting and rewarding experiences by the participants. They point out that business games inject a spirit of competitiveness and attract their full attention while case studies and critical incidents innovate their thinking by stimulating intense discussion and a multitude of view points. It has been indicated by several participants that transactional analysis and Johari window are highly appealing concepts and provide vivid insight into the complexity of human behaviour. Role playing is considered a vital tool in the understanding of other parties' viewpoints and resolving conflicts. Sensitivity training is visualised as a prerequisite to industrial democracy and participative management. They visualise that it provides a safeguard against the full expression of even resentful attitudes and unpleasant opinions towards the authority figure and an opportunity to understand and identify "sore spots" and recognise the needs and contributions of others in the organisation. Some of the participants indicate that although in-basket is a stress causing method, it seems to be a significant developmental device and provides realism and challenge. They also express appreciation for feedback given to them about the levels of trust and distrust, managerial-orientations and leadership effictiveness and adaptability.

Specifically the trainees (i.e. senior managers) of a leading public sector enterprise expressed the following opinions about the MBT training :

"1. The course is helpful because it stresses mutual trust between individual and groups which has become important in today's changing environment for the effective attainment of objectives. The case study, business game and Japanese films depicting trustful culture in that country simply and effectively highlighted the need for mutual trust in the organisation.

2. The course is interesting and can be considered as an important programme to suit the present need of the organisation. The case study is interesting while role playing excellent.

3. It is a useful, nice and precise programme. The course should be given to all levels of personnel in the company.
4. The course is relevant and interesting as it highlights the present problem of the company in the form of labour management trust gap.
5. The programme on MBT was received with very great enthusiasm and warmth in the organisation. Being an organisation in dire need of solutions to control its falling personnel morale a tool of this kind is very essential. The films show has helped to gather some insight into the MBT principles.
6. The course has helped me to understand some concepts of MBT. This is to be practised and results seen. I intend to practise MBT in my area of activity and see the results.
7. The course was highly educative to me. The case study and questionnaires were very interesting.
8. Feedback on trust level was good. The MBT is an enriched course on behavioural science as well as organisational development. This is very important but complex area.
9. The course has been very good, especially with the case study and role playing. This is the first time I have heard of MBT and been enlightened as to how important it is to build-up trust. I do have some peers in our organisation whom I mistrust. With the help of this workshop, I shall build up trust with them. As an individual I have been trying to build up trust with my subordinate executives and supervisors. But my attempts with the workers have not been successful so far. With the help of this workshop I shall go on trying again and again.
10. The Course is very good. Explanation on how subordinates should behave so that the boss has trust in him is very good and should be practised by every individual.
11. First and foremost, the information regarding the group ratings gave a good starting point for realising where we are today.
12. Course material was excellent. Discussion and case study good. A good start has been made in the development of trust in organisation.
13. MBT course is very useful. We are able to understand our leadership effectiveness and managerial orientations. Today's need of organisation trust is very much brought to the notice of the management. This sort of management course has to be conducted often.
14. The Japanese films are very good indicating that trust is built from the childhood. Trusting each other in the family promotes development of trust in the organisation. Can we Indians reach the level of trust and commitment obtained in Japanese organisations?"

Likewise, the trade union leaders from four participating unions expressed the following opinions about the MBT course :

"1. This is one of the best courses. I shall implement it and teach to all employees, not only in this organisation but also in India.
2. The lectures are good and valuable for the future working of the union leaders.
3. This course is very useful for me. There are many points for improving knowledge. This will help us to perform good activities and avoid activities which are not good. It will also help the leaders in building trust with workers, members and management. The course is a reality of our life and I am very glad to learn all these things.
4. All the lectures and explanations are useful for future activities of the unions. I have gathered some important matters from this course. I have learned various structures of union and management orientations. Film shows is very useful for encouraging discipline and hard work in India.
5. From the MBT lectures, I have learned that trust between union leader and members is very necessary. But this trust is hampered by political pressures, management tactics, present-policy of the Government and their tactical implementation causing confusion among employees. But the MBT viewpoints are valuable

ones especially regarding union's internal discipline, leadership, organisational structure, etc.

6. I am very glad to attend this course on "Management by Trust." The detailed guidelines regarding union structure, union leadership, etc. will give more advantage in my future life. I shall maintain my leadership in a good manner and at the same time receive assured reliance of my peers as well.
7. The MBT Seminar on union effectiveness by trust is very useful and has stimulated a lot of ideas. It should be given to all employees.
8. I am very much satisfied after listening to good explanation on trust specially, the talk on the growth (or welfare) of the union, how the union leaders should work and how the union members should work, attracted me very much.
9. The course was simple and appropriate for us. The work of the labour unions and the duty and behaviour of the leaders and members are explained. I assure you that we will follow them.
10. Today, it was explained that union leaders should work with cofidence. But the management should also have confidence on union leaders and labourers. Only then the labour relationships would be in good shape.
11. Our union works/takes decisions after consulting its members to solve any problems. We have been following most of your methods/guidelines. It would be helpful to continue in that way. However, the management is waiting to take revenge on the active members of the union and its way of working. Therefore, I think that it will be very useful for us (the labourers), if you explain "management by trust" to the management here and to the central government also.
12. Today's discussion on MBT will be particularly useful for our future. Also we, had a good chance to know many important factors like how the management should treat the union leaders, how the union leaders should treat the management and how the union leader should recognise (give importance to the opinions of union members). At the same time, we also had a good chance to express our opinions. We had a chance to come to know how the labour relationships should be kept/maintained unaffectedly. On the whole, I am very happy that I had a chance to know many new factors."

In addition to the immediate feedback of the participants, MBT training programme, as a part of the long-term OD project, has been evaluated subsequently, after six months; however, fore-and-after evaluation of the independent MBT training has yet not be made for practical difficulties. Attempt has been made to assess the impact of MBT system as a whole in the plants of a multinational company (organisation A) and a private sector enterprise (organistion B). The pre-MBT and post-MBT levels of trust and distrust and performance measures of these organisations are shown in Table 1. Comparativily, there took place slightly more improvement in terms of trust in organisation 'B' (5 per cent) than organisation 'A' (4 per cent) while there was more improvement in terms of distrust in organisation 'A' (9 per cent) than organisation 'B' (5 per cent). Likewise, there occurred more improvement in terms of production in organisation 'A' (45 per cent) than in organisation 'B' (7 per cent). While there took place more improvements in terms of morale and turnover in organisation 'B' (10 per cent, and 21 per cent, respectively) than organisation 'A' negligible). Incidently, improvements in terms of absenteeism (19 per cent) and accident (32 per cent) remained equal in both organisations. Obviously, the objectives of MBT programme in both organisations have been accomplished markedly. While organisation 'A' has achieved the objective of 'effective performance' considerably, organisation 'B' has recorded marked improvement in terms of "organisational climate enriched with trust and confidence".

Specifically, in organisation 'A', during the preceding 2 years, significant economic and behavioural growth has taken place and it is attempting for the best possible technology in the world. Probably, it has entered the "take off" stage of its economic growth and the self-perpetuating circle of the MBT has

Table 1 : Levels of Trust and Distrust and Performance Measures before and after MBT Interventions in the two Organisations in India

Trust-Distrust and performance measures	*Before MBT (for 6 months)*		*After MBT (for 6 months)*	
	Organisation-A (N=408)[6]	*Organisation-B (N=120)*[6]	*Organisation-A (N=409)*[6]	*Organisation-B (N=120)*[6]
Trust (Mean)	3.47	3.20	3.62 (4%)[5]	3.35 (5%)[5]
Distrust (Mean)	1.59	1.71	1.44 (9%)[5]	1.62 (5%)[5]
Production (Mean)[1]	25.34 (17.22)[2] (Rs. in lakh)	194.30 (MT)	39.25 (25.07)[2] (Rs. in lakh) (45%)[5]	208.19 (MT) (7%)[5]
Morale (Mean)	3.76	3.10	3.81 (1%)[5]	3.42 (10%)[5]
Absenteeism (Mean)[3]	1.69	1.36	1.37 (19%)[5]	1.10 (19%)[5]
Turnover (Mean)[4]	.052	.056	.052 (%)[5]	.044 (21%)[5]
Accident (%)	.74	2.5	.50 (32%)[5]	1.7 (32%)[5]

1. Average monthly production 2. Deflated value of production 3. Average days per blue collar employee during the period 4. Average per non-supervisory employee during the period 5. Improvement percentage 6. Number of regular production workers.

started working in it. In organisation 'B' despite acute shortage of base paper from July 1980 to December 1982, there has occurred marked improvment (14. 4 per cent) in production as compared to corresponding period before the MBT interventions and its financial position has improved considerably. It has embarked upon the installation of a highly sophisticated paper coating, machine and diversification of its business including wall paper and paper projects. There prevail harmonious relationships marked by trust and confidence among different functional and hierarchical groups. Perhaps, the management has become skilled enough to deal with external and internal pressures and cope effectively with the turbulent environment of today.

The usefulness of MBT training as an independent experience is established on the basis of opinions of the peers, superiors, subordinates and the trainees themselves after several months of the programme. It has been widely indicated by the top management that as a result of the MBT training, most of the executives have become more skilled in decision making and problem solving process, interpersonal relationships, handling of human problems, managing conflicts and allied behavioural aspects of managing people. It has been asserted by subordinates that their superiors have started trusting and treating them as mature person capable of taking independent decisions and that, in turn, they have started trusting their superiors as a result of their supportive behaviour and improved attitude. Some of the superiors indicate that their subordinates have become more versatile and trust-worthy after the MBT training. A chief accountant of a multi-national company claims that participation in the training has improved not only his organisational life but also family life. He believes that because of his own increased level of interpersonal trust and decreased amount of interpersonal distrust, his adjustment has improved markedly in work situations and that he had been saved from divorce from his wife in family setting. A president of a representative recognised trade-union of a private sector company asserts that the managerial attitude and behaviour have improved substantially and, in turn, his union has become more cooperative with the management as a result of participation in the MBT training workshop. The general manager of a leading multinational company points out that the relationships, mutual understanding and trust and confidence between different functional and hierarchical groups have improved substantially after several months of a two-week training programme.

Whatever be the real gains, MBT training seems to be a highly promising approach in a turbulent environment of today's organisations marked by widespread apathy, indifference, irresponsibility,

minimal compliance, rivalries, antagonism, hostility, sabotage, etc. It forms probably one of the most vital approaches to optimise human performance through increased motivation in an improved organisational climate marked by high level of mutual trust and confidence and a significant device to improve the quality of working life in modern organisations.

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LAST DATE FOR ENTRY : The last date for receipt of entries is 15th June, 1983. The Entry Form and further details may be had from Under Secretary (Admn.), Department of Personnel & A.R., 5th Floor, Sardar Patel Bhawan, Sansad Marg, New Delhi-110001.

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NOW IS THE TIME FOR INNOVATING TOBACCO CULTIVATION

Srivastava, P.K.

If technology and engineering can be used to innovate tobacco cultivation in its different phases, why not cultivators come forward to do so as a measure to improve productivity of this important commercial commodity

The tobacco crop is grown in a variable range of agro-climatic zones which includes heavy black cotton and light sandy soils. There appears to be wide scope of application of both basic and applied technology to increase the production and productivity. The paper discusses the various phases of operations in tobacco cultivation in India, starting from seed bed preparation to packaging of tobacco for export where engineering/technology research work may be taken up for boosting the production and productivity.

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India produces over 390 million kilogrammes of tobacco from an area of 4.9 lakh hectares (Table 1). In addition to 7.5 lakh farmers engaged in cultivation, the crop provides employment to more than 3 million people in several other allied activities such as curing, grading, redrying, packaging and in industries producing cigarettes, bidies etc. The government of India gets a revenue of about Rs. 390 crores by way of excise duties. Thus tobacco cultivation is very important in Indian economy and needs special attention. Unfortunately at the current state of available engineering and technology this particular crop has been untouched by its advantages and there seems to be a wide range of various agricultural fields where engineeirng and technology research may increase the production and productivity. This paper deals with these various agricultural and processing operations where engineering research could be taken up.

The Current System of Crop Production

The crop production forms a major dimension of cultivation. The tobacco crop is produced in a wide range of soil and climatic conditions. Practically every state in India grows one type of tobacco or the other. However the cultivation of this crop is concentrated in certain zones as may be seen from Tables 1 and 2. These tables show that agro-climatic conditions under which tobacco is grown are quite variable. Thus, tobacco, which is tropical in origin and thrives best in warm climates is being grown under a very wide range of conditions viz. tropical, sub-tropical and temparate zones. Being a short duration crop, it is possible to grow it at any latitude and altitude provided a mean temprature of 20 to 32°C. prevails for a period of 80 to 120 days at any time of the year. Due to its enormous leaf area and short period of growth, the water requirements of this plant are very high. Relative humidity of the atmosphere has very important bearing on the moisture balance in the soil and plant and consequently on the yield and the quality of tobacco produce. In India, the relative humidity in forenoons vary from 74.4 to 90.7 per cent during tobacco season. Tobacco is very sensitive to the physical and chemical properties of the soil as far as different varieties are concerned. The best soils are those which are open, well drained and properly aerated. The plant is highly susceptible to injury from flooding. Cigar, hookah, chewing and bidi tobacco are grown on sandy loam to clayey loams. The crop is raised either on irrigation as

Table 1 : Area and Production of Tobacco in India

States	*Area, 1974-75 hectares in thousand*	*Production in Million Kg.*
Andhra Pradesh	195.2	181.7
Assam	6.9	5.1
Bihar	9.1	7.4
Gujarat	88.5	127.4
Haryana	0.4	0.3
Himachal Pradesh	0.4	0.2
Jammu & Kashmir	0.4	0.2
Karnataka	39.5	19.7
Kerala	0.7	1.6
Madhya Pradesh	2.1	1.1
Maharashtra	13.2	6.3
Meghalaya	0.4	0.3
Orissa	15.4	11.8
Punjab	0.1	0.1
Rajasthan	3.5	2.9
Tamil Nadu	11.3	10.6
Tripura	1.1	0.4
Uttar Pradesh	8.7	8.4
West Bengal	11.9	8.8
Delhi	@	0.1
Mizoram	0.4	0.4
Total All India (1974-75)	409.2	394.8
Estimated (1975-76)	362.9	360.0

Note: @ Below ha.
Source: Directorate of Economic and Statistics, Ministry of Agriculture and Irrigation, Govt. of India, New Delhi.

in Madras and U.P. or as semi-irrigated crop as in Bihar, Bengal & Karnataka or as a dry crop as in Maharashtra and Andhra Pradesh. In the last case the soils generally retain adequate moisture to sustain the crop. A notable exception to the general rule regarding soil requirements is found in case of cigarette tobacco which is grown as a dry crop on heavy, black soils having poor drainage. Black cotton soil of Andhra Pradesh occupies the first place among the various soil types accounting for more than 95 per cent production of F.C.V. tobacco in the country. This soil, containing about 60 per cent clay possesses uniform cloddy structure and is so compact that it can not be worked on until thoroughly soaked. But when very moist, it becomes highly sticky and unworkable. The swelling and shrinking nature of this soil is such type, that in summer larger cracks develop often 15 to 25cm wide and several cms deep. As already mentioned, the crop is grown here as a dry crop on conserved moisture, received as rainfall, prior to planting which usually commences in October. Because of shift in weather pattern in current years, normal preparation of land has become difficult, as there is sometimes heavy rainfall even in this season and farmers are forced to resort to mud planting in wet season and sometimes they have to transplant in dry soil in drought season. This endangers the crop production in absence of some suitable tillage operations and technology.

In case of F.C.V. tobacco the crop with a deep root zone is highly benefitted with a fertilizer placement at a depth of 15 to 23 cms. in subsurface zone. There is yet no efficient and economical deep fertilizer placement implement available. The one designed and developed about

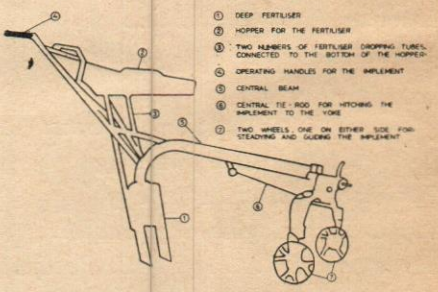

Fig. 1 : Deep Fertiliser Implement

20 years back at Central Tobacco Research Institute, Rajahmundry (A.P.) (Fig. 1) for such purpose is very heavy and un-efficient in fertilizer placement and requires very high traction power (two pairs of bullocks).

Table 2 : Approximate Area of Different Types of Tobacco Grown in India

Tobacco Type	*Area in Hectares*
F.C.V., (A.P., Karnataka, Gujarat)	117,200 ha.
Sun Cured 'Natu'	15,000 ha.
Country cheroot (Lanka)	10,000 ha.
Cheroot, Tamil Nadu cigar	15,000 ha.
Bidi, Gujarat	80,000 ha.
Karnataka, Nippani	32,400 ha.
Hookah, (West Bengal and U.P.)	11,000 ha., & 6,500 ha.
Chewing, Tamil Nadu	9,600 ha.
Chewing and Hookah, Bihar	9,000 ha.

Source: Directorate of Economic and Statistics, Ministry of Agriculture and Irrigation, Govt. of India, New Delhi.

Tobacco is first grown in nurseries to raise healthy, vigorous seedlings and then transplanted into fields. While selecting suitable location of nursery beds due consideration is to be given to surface and sub-surface drainage and assured supply of irrigation water. Water logging however would prove to be fatal.

Tobacco seeds are of very small size and the seed rate is very low. About 2 to 3 Kg. per hectare of well cleaned, processed pure seed is the optimum seed rate. The seed is mixed with sand or some dilutent and broadcasted on the surface of beds and mixed with fingers. This seed bed is now pressed with feet or rolled with wooden or hume pipe rollers, the object being to get better contact between the seed and soil moisture without which only poor and uneven germination results. The seedlings are transplanted annually in pre-prepared field in absence of any transplanter. The tobacco crop in India is affected by 21 diseases out of which 12 are fungal. Various fungicides and weedicides are used to control them. The crop is harvested by sickles either by stalk cutting or by priming, which is one of the most labour consuming operations. Table 3 shows the production of various types of tobacco in India.

The Existing Methods of Processing

The other important field of tobacco cultivation is its processing, known as curing which is regulated drying of fresh leaves in curing sheds or barns. Chemically, curing refers to the metabolic process of the leaf cells during progressive drying, fermentation to changes after death of cells whether brought about by enzymes and micro-organisms and aging to intracellular postmortem process under low moisture conditions when bacteria or fungi can not intervene. The curing operations followed in India are dependent on several factors such as tradition, convenience, market value of the crop, consideration of economic production, etc., Depending upon the type of the tobacco, the method of harvesting and the maturity of the leaf at time of harvest, four methods of curing may be distinguished namely:

- ☐ Flue curing
- ☐ Air curing
- ☐ Fire curing
- ☐ Sun curing

Out of all the above methods, flue curing is more common. It is done by stalking the tobacco leaves

Table 3 : Approximate Production of Different Types of Tobacco Grown in India

Types of Tobacco	*Production in Million Kg.*
Cigaratte tobacco	
(i) F.C.V.	120.0
(ii) Other than F.C.V.	36.0
Bidi	100.0
Cigar and Cheroot	15.0
Hookah	30.0
Chewing	65.0
Snuff	5.0

Source: Directorate of Economic and Statistics, Ministry of Agriculture and Irrigation, Gov. of India, New Delhi.

into specially constructed structures called barns, which are artificially heated and temperature is gradually raised till the leaves are dry. These barns are constructed with bricks and mud or lime mortar. Sometimes they are built over bricks and stone foundation with split bamboo mats and plastered with mud but they last only for a few years and their maintenance cost is high. These barns have adjustable ventilators to regulate inside humidity, by letting in dry air at the bottom of the barn and allowing the hot humid air to escape from the top in required quantities. One or two furnaces are connected to flue pipes made of mildsteel to pass the flue gases produced in the furnace by burning coal. A chimney is provided with a damper to regulate the flow of flue gases. In order to have uniformity in curing it is very important that only leaves from the same harvest should be put in the barn. For a barn of size 4.8 × 4.8 × 4.8 cu. meter, (Fig. 2) 1.5 to 2.0 tonnes coal

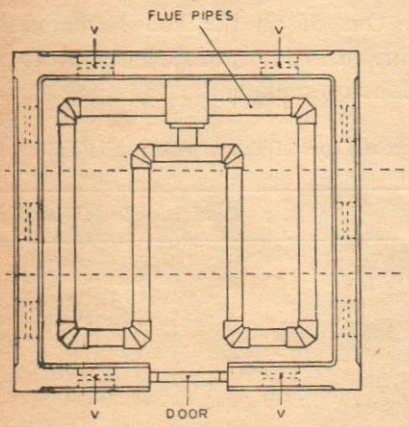

Fig. 2 : Flue Curing Barn Plan

is used and curing usually takes 5 to 6 days to be completed. In the production of F.C.V. tobacco, the cost of flue curing alone constitutes 25 per cent of cost of production.

Flue cured tobacco grown in India is practically exclusively in the hands of small farmers having holding between 2 to 5 hectares. These farmers have little means and do not know much about the recent technology. About 50 per cent of the tobacco grown in India is exported and exporters require special packaging based on grading according to the position of leave on plant. Not to use this method from beginning means not only duplicating the processing costs but also increasing the handling losses.

Mechanizing Crop Production

Research related to following points is very much required to increase the production of tobacco:

- ☐ Application of soil water management techniques in varied agro-climatic and soil nature conditions.
- ☐ Design and development of some suitable tillage implement operated by low traction power which may enable the farmers for deep summer ploughing to increase the production which is at present done by crow-barring. This may improve the quality of tobacco as well as yield.
- ☐ Design and development of some suitable deep fertilizer placement implement for fertilizer placement at a depth of 15 to 23 cms. in sub-surface zone.
- ☐ Design of suitable surface channel and drainage outlets in nursery beds so that surface soil is always moist (not wet) otherwise the germinating seeds which are on the surface or close to the ground will dry out.
- ☐ Design and development of suitable seed drill to ensure even distribution of seeds in fields.
- ☐ Design and development of transplanter which could open furrows for the seedlings and press soil around them after their placement in furrows.
- ☐ Design and development of suitable harvesting equipment to reduce the time and labour consumed in harvesting.
- ☐ Design and development of a device to remove midribs which will reduce the time and cost of threshing and drying operation.

The New System for Post Harvest Operations

The following measures are proposed to mechanize post harvest operations:

- ☐ Studies on sun drying in place of flue curing of tobacco leaves for cigarette production.
- ☐ Design, development and construction of suitable and cheap barns based on heat mass transfer studies to ensure more uniform conditions of curing by minimising losses of heat from its walls and roof.
- ☐ Development and use of suitable device to control the

humidity and temperature in barns for safer and better curing in less time and cost. It may be noted that currently, the humidity is controlled by adjusting the height of a bent iron sheet over ventilator of 0.6 × 0.3 sq. meter size by a pulley arrangement. Ridge ventilators may prove useful in temperature and humidity control for conserving heat and to produce better quality tobacco.

- ☐ Utilization of aluminium pipes or any other suitable materials in place of mild steel pipes to increase the thermal efficiency of barns.
- ☐ Use of agricultural wastes like tobacco wastes and sawdust or paddy husk briquettes as fuel source.
- ☐ Use of locally available cheap materials like palmyrah and plastic for construction of barns for sun shade and air curing methods.

The Contribution from Agricultural Engineering

There is a vast scope of mechanization in tobacco cultivation in India relating to the 3 major disciplines of Agricultural Engineering.

- ☐ Adoption of required soil and water management techniques in both light sandy and heavy black cotton soil.
- ☐ Design and development of suitable farm machinery and implements particularly to suit black cotton soil.
- ☐ Design and development of proper processing techniques and structure to reduce the cost of curing.

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OF PRODUCTIVITY THINKING

Volume XXIII of the *Productivity* embraced varied aspects of productivity system in different settings. It discussed organisational structure (4), development (1) and effectiveness (28, 35), planning (26, 50), motivation (49) and control (7, 48) processes and selection (12), management training and development (15, 53) programmes. It also highlighted contribution from several disciplines such as ergonomics (5), production management (6, 17, 18, 20, 30) and computer science (20, 21, 25), maintenance (31) and materials (45) management and analysed issues including price-quality interface (46), cost reduction (44), working conditions (10) and efficiency (11). Attempt has been made to stress core themes including problems and prospects of productivity (19, 22, 43), improvement of productivity (14, 29, 33, 51) and capacity utilisation (24), productivity in relationships to incentives (9), and wages (34) and technological improvement (38). The issue also dealt with marketing problems of small-scale industries (23), management of development (53), agricultural innovations (32, 47) and rural development (27, 37). It covered general issues such as waste management practices (2, 3), inflation (8), family planning (16), public distribution system (13, 29, 36), water management (40), profitability of manufacturing industries (39) and export performance and prospects (41).

The issue provided analytical and descriptive reviews of books on different subjects including personnel (54, 60, 61), labour productivity (68), linkage of bonus with productivity (69), production planning and control (63), productivity of electrical machinery industry (65), executive health (55), management of large organisations (59), industrial development (67) and potential survey (56), transfer of technology (57), instrument science (66), crop production (58), economic development (64) and export promotion (62). Lastly, it embodied comprehensive bibliographies and abstracts on job satisfaction (70) productivity (71) and time management (72).

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31.	Project Management	Aug. 9-13	Bombay	Managers & Engineers in the area of Project Planning & Execution	RD Bombay
32.	Project Management	Oct. 3-8	Srinagar	Managers & Engineers in the area of Project Planning & Execution	RD Chandigarh
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35.	Participative Management	May 30-June 4	Srinagar	Industrial Relation & Personnel Managers, Trade Union Leaders	RD Chandigarh
	AGRICULTURAL PRODUCTIVITY				
36.	Management of Agricultural Inputs	April 5-9	Ahmedabad	Personnel from State Farms, Financial Institutions, Extension Agencies & Govt. Deptts.	RD Ahmedabad
37.	Management of Rice Milling Operations	Nov. 1-5	Delhi	Rice Millers, Govt. Officials	HQ DDG (MS)

(Turn to Page 476)

Productivity of Electrical Machinery Industry—

A Comparative Analysis of Karnataka, Maharashtra and West Bengal

Rajalakshmi, K.

What comparative productivity trends electrical machinery industry reveals and what prospects it has in Karnataka, Maharashtra and West Bengal

Bangalore : Indian Institute of Management, 1981, 90 pp.

Reviewed by Dr. R. C. Sharma, Reader in Management, Kurukshetra University, Kurukshetra-132119.

The study is a good beginning highlighting the need for further research in the field. The study has assumed added significance inasmuch as it deals with the problem of productivity of Electrical Machinery Industry, the products of which have a vast export potential besides being in constantly increasing demand. The three states, viz., Karnataka, Maharashtra and West Bengal, selected for the comparative analysis of the productivity of electrical machinery industry, have their own relevance. While Maharashtra and West Bengal are the foremost producers of electrical goods in India, electrical goods industry is the leading industry in the manufacturing sector in Karnataka contributing 18 per cent of state's total output. The period covered by the study (from 1961 to 1975) is fairly a long period making it possible to take into stock the role of various productivity parameters quantified in the present study. Meaningful empirical data collected and analysed meticulously in the study may be considered in making managerial as well as operational decisions.

The study has brought to light the phenomenal increase achieved by this industry in Karnataka in various aggregates, viz., net output, gross output and fixed capital by 1975 as compared with the figures of 1961. While Karnataka's share in this industry at national level has increased from 6.9% in 1961 to 14.9% in 1975 in respect of total net output, from 7.3% in 1961 to 13.9% in 1975 in respect of employment, and from 5.6% in 1961 to 8.4% in 1975 in respect of fixed capital, the shares of these aggregates pertaining to Maharashtra and West Bengal have shown a considerable decrease during the period of study. Thus, Karnataka appears to have a relatively more promising future so far as the electrical machinery industry is concerned.

Linear and quadratic trend equations have been fitted to the three aggregates, viz., employment, net output, and fixed capital (in constant prices) of this industry with respect to all the three states compared in the study. The quadratic term is significant only in respect of fixed capital in all the three states compared in the study and employment in case of Maharashtra. All the three states reveal positive and statistically significant trend co-efficients. Trend co-efficients are higher for Karnataka than those of Maharashtra and West Bengal.

The study analyses various partial productivity and cost efficiency ratios. Though labour productivity shows an increasing trend in all the three states specially after 1967-68, in West Bengal which occupied the first position in 1961, it stands reduced to third position from 1969 onwards. The capital productivity is the least in 1967 but thereafter shows a rising trend. While unit material cost shows a decreasing trend in all the three states, the real wage rate has steeply risen upto 1971 and decreased thereafter. Total factor productivity index indicates a continuous and steady increase of the index in Karnataka till 1973 followed by a slightly decreasing tendency thereafter. While Maharashtra shows a steady increase in total factor productivity after a temporary decline in 1968, West Bengal shows a noticeable decline all through the period of the study. Such inferences made by the study are of great significance for the industry.

Cobb-Douglas production models have also been applied in respect of the above three states. It has been worked out that while the labour electricity of output is significant in the three states, the capital elasticity of output is low. The trend co-efficient though positive in all the three states, it is statistically more significant in Karnataka and Maharashtra as compared with West Bengal. The marginal productivity of labour has also shown an increasing trend though it is relatively higher in Karnataka and Maharashtra. So far as raw materials elasticity of output is concerned, it is statistically significant in case of Karnataka and Maharashtra as compared with West Bengal. The present study is significant inasmuch as the Cobb-Douglas production functions have been utilised to forecast net production for this industry for the year 1990 which has been estimated at Rs. 78.75 crores, Rs. 48.56 crores and Rs. 29.73 crores in Maharashtra, Karnataka and West Bengal, respectively. The study points out that in the absence of concerted efforts, the future for this industry in West Bengal is not promising.

By using constant elasticity of substitution function (CES function) in this study, the Elasticity of Substitution (σ) has also been estimated for electrical machinery industry in respect of the three states. It has been worked out by this study that for Maharashtra σ is much more than unity and reveals a decreasing tendency during the period of the study. σ as per this model varies between 0.81 and 0.87 for Karnataka and between 0.88 and 1.07 for West Bengal during the period studied. Neutral technological progress is significant in Karnataka (7.2%) and Maharashtra (4.8%) as compared with West Bengal (1.3%). The nature of bias in the non-neutral technological progress has also been estimated indicating that capital saving technological progress has occurred in the earlier phase of the study period and capital using technological progress during the later phase.

Though the present study has been carried out scientifically following proper research methodology and using reasonably good language and expression, the value of the study would have been further enhanced if the comparison had been made only among the private sector units in the three states and further if a distinction would have been made between the producer goods and consumer goods instead of aggregating it as has been done in the present study. Besides, it would have been better if the proposal of labour-capital substitution had been made only after taking such factors as price and quality of the products into consideration. Efforts should have been made to ascertain whether the electrical machinery industry has taken full advantage of management techniques and principles and whether there existed provisions for adequate research and development and personnel involvement before arriving at certain conclusions and making recommendations.

On the whole, the present study has not only paved the way for further research in the matter but also provided useful information and guidelines. The study deserves appreciation from all concerned.

Labour Productivity—Socio-Economic Dimensions

Srivastava, J.P.

What motivates the workers to enhance their productive efficiency for accomplishing an increasing per capita output and how growth in labour productivity through incentives influences the cost economy

New Delhi : Oxford & IBH Publishing Co., 1982, 297 pp.
Price : Rs. 65

Reviewed by Dr. R. S. Dwivedi, National Productivity Council, Lodi Road, New Delhi-110003.

Productivity is a function of several technical, economic, organisational, human, cultural and socio-

political factors. It has been analysed in its varied dimensions by inter-disciplinary researchers in India and abroad. The present book is related to socio-economic dimensions of labour productivity. It is divided into two parts and ten chapters. Part I provides a general theoretical framework for productivity while part II examines the role of institutional change in productivity and presents macro and micro level case studies to support hypothesis formulated in the study.

Specifically, chapter 1 examines the significance of human factors in productivity while chapter 2 provides a rationale of productivity growth. Chapter 3 clarifies the concept of productivity in its varied forms and chapter 4 provides a basis for formulating a hypothesis that morale can indirect measure of motivation) is positively related to productivity. Chapter 5 describes different types of incentives and suggests a hypothesis that work motivation is a function of both economic and non-economic incentives. Chapter 6 is devoted to the analysis of relationship between management and productivity. Chapter 7 critically examines varied aspects of institutional changes needed for introducing structural changes in a traditional economy and indicates their role in Indian context. Chapter 8 embodies a macro-level case study of India to analyse external environmental determinants of productivity whereas chapter 9 presents a case study of Bhilai Steel Plant to illustrate the practice of incentive systems obtained in public sector in India. Finally, chapter 10 provides a summary of major findings of the study.

Notwithstanding its several implications for designing incentive systems for improving productivity, the study makes simplistic assumptions. Indeed, human system is highly complex and its effective application demands a consideration of numerous variables at a point in time. Therefore, the author's conclusions drawn from the study should be viewed with caution. However, it does not reduce the relevance of this book in understanding socio-economic factors underlying labour productivity in Indian context. Both practising executives and academicians will find it a useful readings.

Manpower Management : An Integrated Approach to Personnel Management and Labour Relations

Dwivedi, R.S.

What methods and techniques eminent practising executives find useful for effectively managing human resources and why and how an understanding can be developed into the complex and constantly changing multi-dimensional individual and group relationships in different organisational settings in India

New Delhi : Prentice Hall of India, 1980, XI+452 pp.
Price : Rs. 20.00

Reviewed by Mr. H.V.V. Cbellappa, Associate Professor, Shri Ram Centre for Industrial Relations and Human Resources, New Delhi-110005.

The book provides an integration of thirty-four articles, both Indian and foreign, on significant aspects of human resources management, grouped under the following heads: Manpower Management: A conceptual framework, Manpower Planning, Manpower Recruitment, Training and Development, Compensation, Motivation for Effective work, Participation, Performancc Appraisal, Trade Unionism, Collective Bargaining, Conflict and Cooperation.

The articles have been selected for their relevance to the Indian Context and provide a sound foundation in theory, principles and practice of manpower management. Several of them have earlier appeared in different Indian and foreign professional journals. Some are original exclusive contributions to the book.

Each section of articles is preceded by an introduction by the author. This highlights the current concerns and issues under that sub-theme and gives a summary of the ideas developed in the succeeding articles. The author notes that in view of the complex, constantly changing and expanding characteristics of our know-

ledge and understanding of human behaviour and actions, no single book could be expected to include adequately every subject theme in depth. The present book is an attempt to selectively stress those developments which appeared to be of greatest significance.

The book is designed for use in courses on personnel management and industrial relations. Significant discussion questions and useful supplementary readings have been given at the end of each section. A subject index is also available.

Managers and administrators could conveniently gain insight into sound concepts, theories and their applied aspects in manpower management from the articles included in the book. The selection of articles has been made judiciously to provide a coherent and inter-linked treatment of the different themes. This is a difficult task of integration in which the author has achieved commendable success. Two original articles of the author on "The Concept and the Process of Collective Bargaining" and on "The Gandhian Trusteeship System" are included. Several senior practitioners, besides academicians, have also contributed their experiences in translating concepts to workplace management of manpower.

The publication has been subsidised by the Government of India through the National Book Trust and is therefore low priced for the rich and rewarding knowledge it imparts.

Personnel Management in Government

Aleem, M.A.

What the administrators in government departments need to understand and practise for effectively harnessing human motivation to work

New Delhi : Oxford & IBH Publishing Company, 1981, 272 pp. Price : Rs. 60

Reviewed by Mr. Rahul Bhatnagar, Deputy Director (Beh. Scs), Western U.P. Productivity Council, Ghaziabad-201001

Human resources development has been given an indifferent handling, hitherto. In the modern context 'humah resources' have become scarce as far as the skills are concerned, as contrary to the emergence of umpteen professional and technical institutions, imparting formal 'skill building' education.

The book under review has been exclusively written in Andhra Pradesh but does provide a representative glimpse of the national situation of changing trends and techniques of personnel management in the Government sector.

The book brings into focus the various facets of governmental personnel functioning. The author has made sincere effort which though lacks the punch of a professional, is marked by the depth of an academician.

The book certainly shall provide a dip into the intricacies of the State bureaucratic working to students who require reference material. The book succeeds in leaving the impression that professional personnel management is yet to emerge as an organizational necessity in the State working rather than a constitutional validity as has hitherto been the surmise. The excesses of the democratic working are apparently the in-built sources of the streams of corrupt administration. The democratic doctrinnaire overrides the statutory directive. The author, here, deserves a pat for his genuinely bold exposition of the 'Intra-organizational bottlenecks' of the State administration which ought to be taken care of without fail and delay. The book provides the guideline to streamline the limping administrative structure.

Linking Bonus with Productivity

Suri, G.K.

What problems arise in linking bonus above the statutory minimum with productivity under divergent technological, organisational and market situations and what can be done to resolve them

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The issue of bonus has always been a lively topic in the academic parleys and in various form of practitioners both. Bonus is widely accepted as the right of the working class on the grounds of justice, equity and good conscience and has constantly been a ticklish issue for expert committees.

Of late, bonus has assumed sharper focus as it is increasingly being linked to productivity. This linkage has been mooted for reducing labour tension and for satisfying legitimate aspirations of workers and owners. Such linkage has, however, opened a pandora's box; has raised more difficulties than it has proposed to solve. Productivity-linked-bonus seeks answers to the following problems:

(a) Concept of productivity;

(b) acceptable methods for measuring productivity in the context of bonus; and

(c) determination of agreeable share of productivity as bonus.

The book under review is an heartening endeavour to put the entire issue in its proper perspective.

The book inter-alia, a document of the proceedings of a Seminar organised by the 'Centre' with the assistance of the I.C.S.S.R. and attended by several private and public sector undertakings, leading trade unions and participants from academic circles, makes an incisive analysis of the conceptual work, incorporates the diverse views of the interest groups, and presents some supportive case-studies.

The book is divided into three parts. The first part is an overview of the origin of productivity-linked bonus, subsequent developments, and of research studies. The section following this part is more significant; it deals with the diverse views of trade unions and employers; of particular note is the new bonus formula suggested by Naval Tata. Case studies of some key public sector organisations in India like Railways, Steel and Coal and a few others, prepared by the 'Centre', have been intelligently used in this part.

The second part of the book records the recommendations of various technical sessions. The length and breadth of differences in the approaches of unions and owners indeed reveal the complexity of the task. Employers pleaded for bouns to be paid only in case of profit; trade unions unanimously held that parameters of productivity were different from profit. Academics opined, on the other end, that productivity defies description hence for the sake of developing smooth industrial relations employers may be well advised to pay bouns. This approach, they believe, is more tension free.

The third and final part of the book contains appendices outlining a brief resume of settlements and agreements on productivity linked bonus in several organisations including Post and Telegraph Department. A summary of important judgement of the Supreme Court on this issue and the select bibliography as reference is a welcome addition. One fancies that the last section should have received more attention in its organization and presentation. It would have been better if this section had identified key-issues for intensive research.

The book, on the whole, is yet another feat for the 'Centre' which over the years, has earned a reputation of bringing out several worthwhile publications. The author is a known and experienced researcher, consultant, in the field of industrial relations. Looking at the enormous reference-value, the book is reasonably priced and is a valuable addition for researchers and practitioners alike.

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39.	Corporate Planning	June 21-23	Hyderabad	Chief Executives, General Managers & Corporate Planning Managers	RD Madras
40.	Corporate Planning	Oct. 4-8	Udaipur	Chief Executives, General Managers, & Corporate Planning Managers	RO Jaipur
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