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PRODUCTIVITY

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—Editor

Role of Productivity in Economic Growth†

NN Wanchoo*

Improved Productivity is very important, even crucial, for economic growth. Since economic growth is accelerated by the best use of resources and since productivity advances also depend upon the optimisation of resources, obviously, there is a direct link between productivity and economic growth. Productivity is not merely the output per worker or the productivity of labour alone. There may be productivity of capital also. Productivity can also be improved by better technology, by better management, by more efficient use of raw materials, by avoidance of wastes and a number of other factors.

FROM time to time certain words become fashionable in current usage and it is probably true to say that the more fashionable a word becomes, the more it is misused and the hazier become its connotations. Everyone starts to use the fashionable word or expression without clearly visualising what exactly the favoured word connotes. Fashionableness, therefore, becomes a means of concealing precision of meaning and thought. I am inclined to consider that "productivity" is one such word in modern times. Is it surprising, therefore, that in common parlance very often "productivity" is confused with "production" and sometimes productivity and economic growth are treated as synonymous.

Now, while improved productivity is certainly very important, even crucial, for economic growth, let us not equate it with economic growth itself. Such growth may depend upon the availability of natural resources. It may be seriously influenced by the availability or otherwise of foreign aid; natural and other disasters, e.g., wars may give it a serious setback; the terms of trade may affect it seriously, but none of these factors need affect productivity. Since economic growth is accelerated by the best use of resources and since productivity advances also depend upon the optimisation of resources, obviously there is a direct link between productivity and economic growth, even though the two are by no means synonymous. One may safely affirm, however, that growth can be frustrated by disregard of productivity.

An indirect confirmation of the close link between productivity and economic growth is provided by certain statistics. If in a some-

* Chairman, National Productivity Council, New Delhi.

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what crude or rough and ready manner we regard the Gross National Product of a country divided by its total population as a measure of its productivity, then it has been found by a study of the statistics that those countries which have a high productivity rate have also a high rate of economic growth and certain other countries with a low productivity rate have shown a low rate of economic growth. This connection between productivity and economic growth cannot be accidental.

Productivity : Relationship Between Inputs and Outputs

Strictly, productivity is a relationship between inputs and outputs. The inputs may be of various kinds: land, labour, capital, etc. If with a given set of inputs, by a more efficient use of them you can produce more, i.e., your output increases, then your productivity improves. Productivity also improves if with a relatively smaller addition of inputs you get a proportionately larger output. It is this relationship between inputs and outputs which determines productivity. I would like to emphasise that inputs may be of different kinds—there can be inputs of labour, of capital, of plant and machinery, of technology, etc. Productivity is not merely the output per worker or the productivity of labour alone. There is such a thing as the productivity of capital also—what we call the capital-output ratio. In agriculture, output per unit of land is a useful way of measuring the efficiency of land use. Then, too, productivity can be improved by better technology, by better management, by the more efficient use of raw materials, by the avoidance of waste and a multitude of other factors.

What is really important in improvement of productivity is that the total cost per unit of output should be reduced to the minimum and not merely the labour cost. In fact, it is not only conceivable but has sometimes actually happened that while labour productivity has improved, total productivity has gone down, as measured by the total cost per unit of output. Therefore, while discussing the role of productivity in economic growth, one should always bear in mind total productivity rather than labour productivity alone. It is hardly necessary to labour the point that all improvements in productivity are not the result of the efforts of workers alone. Productivity can be improved by the judicious injection of capital, by the adoption of improved technology and by better management performance.

Having said all this, I would point out that popular beliefs, even popular fallacies and superstitions, have often a remarkably solid foundation in facts. If we often confuse labour productivity with total productivity, that is surely because ultimately it is the human factors which govern and organise all other factors. Capital and technology, by themselves, cannot produce goods. It is some human agency which has to organise, control and utilise the plant and machinery or the raw materials or the better technology. In this sense, the human factor has a primacy over the other factors and, therefore, in the last resort, it is human factors in an enterprise, viz., the management and the workers, who are at the root of the most efficient utlisation of all other factors of production.

Role of NPC

It was after the last World War that considerable attention began to be paid to productivity by the war-shattered economies of Europe. A European Productivity Agency came into existence after the war as a concrete manifestation of the importance of productivity and, later, in Japan, a Productivity Council was set up in 1953. In India too, following a study of Japanese practices, the National Productivity Council was set up in 1958, supported by six Regional Directorates and about 45 local Productivity Councils. Many Asian and other countries have established their Productivity Councils in the last 15 years. The National Productivity Council of India covers training programmes, promotional work, consultancy services, productivity research and organisation of study teams and tours. To provide a forum for exchange of information and experience, an Asian Productivity Organisation with headquarters in Tokyo, Japan,

was set up in 1961. I mention these developments to highlight the importance attached to the concept of productivity advance during the last 15 years or more.

I should add that productivity is not something with which the National Productivity Council or the Local Productivity Councils or only specialists are concerned. It is not a matter of evolution of work-norms, procedures, time and motion studies and incentive systems alone. These are unboubtedly of significance in the drive for improved productivity and ought to be attended to. They are, however, the mechanics or only some of the mechanics of improved productivity, but not at the heart of it. The heart of the matter lies in the proper motivation of the human factors of production, viz., labour and management and trade unions. Productivity is also a matter of attitudes. Thus Professor Gunnar Myrdal in his well-known book, the "*Asian Drama*," says that it is not so much the deficiencies in the supply of capital as the attitudes to work and institutions that keep the underdeveloped countries poor and retard their progress. The utmost attention has, therefore, to be given to the improvement of the quality of the human material and its proper motivation—whether managers, trade unionists or workers. We have the famous vicious circle operating here. If you have low productivity, you have low incomes and low standards of living: these in turn generate low standards of health and education, which are bound to result in low productivity. The problem of productivity has, therefore, to be attacked on a broad front by improving the quality of the human material and its attitudes. This has to be done by raising the improvment of productivity to the level of a national purpose, and not leave it as a concern of the specialists alone.

Primacy of Human Factors

The spectacular successes of West Germany and Japan in the post-war period are a striking demonstration of the importance of the human material in the rebuilding of a national economy and growth. It is true that these countries were assisted by massive injections of foreign aid, but it is essentially their reservoir of trained and skilled human material, both managerial and workers, with necessary discipline and cooperation, that brought about such a striking transformation in their post-war economies in so short a time. While investment of capital and plant and machinery is needed for growth, it is even more important to invest in the human material.

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But human beings in any country do not live in a vacuum. They live in a particular social, economic, political and cultural environment. The framework provided by this environment, the institutions in which labour works, all colour their attitudes to this question of productivity and economic growth. Thus, for improvements in agricultural productivity, an appropriate system of land tenure and ownership is necessary to give the farmer a sufficient stake in increased production. Management itself has a very important responsibility, for the quality of the leadership provided by them and their attitudes to their work-force can make a world of difference to the response and cooperation they can evoke. The quality of education of both the workers and the managers is also of considerable significance. While many of the weaknesses will take time to overcome and can be overcome only by a determined and purposeful effort, as a part of a larger longer-term national plan, let us see what can be done in the shorter term.

Need for Efficient Management

In the shorter term, the crux of the matter lies in (a) improving the quality of management

The crux of the matter lies in improving the quality of management and improving the motivation of workers so as to enlist their full cooperation in the drive for productivity.

and (b) improving the motivation of workers, so as to enlist their full co-operation in the drive for higher productivity. So far as management is concerned, normally one may expect that they would be interested in improved productivity since such improvement would assure them higher profits. But this assumption is not enough. Modern industrial establishments have become so large and complex that management can no longer succeed by hit or miss methods. It has indeed become a science or an art which has to be learnt and can be taught. The manager can be taught good methods of inventory control and personnel management. Above all he has to provide enlightened leadership to his work-force and has himself to display a co-operative and sympathetic attitude to his labour force. Courses can be devised to teach managers all the elements of good management and to motivate them in the right way in the complex and difficult social conditions in which they function today. The teaching of the art and science of good management, whether in a University, college, or a specialised institution and whether by way of Seminars or Symposia is, therefore, an important part of the drive for improved productivity.

Motivation of Workers

But even more important is the proper motivation of the workers and the trade unionists. The worker has to be motivated to work harder and to co-operate fully in the drive for improved productivity. Good industrial relations, therefore, constitute the heart of the problem. How is the workers' co-operation to be enlisted? Apart from providing good working conditions, proper grievance procedures, appropriate human relations, for all of which a good manager should be responsible, in the present climate of industrial unrest in this country, the whole-hearted co-operation of the workers will not be available unless they are given a powerful economic motivation. The workers have to be made to appreciate that improved productivity will mean not only larger gains for their employers but also greater social justice for them and an improvement in their own lot. In other words, the fruits of productivity advances must be shared equitably between the workers and the employers. Without this I cannot see any serious prospect of labour-management cooperation in this country with a view to improving national productivity.

Sharing Gains of Productivity

For some years past now, the National Productivity Council has been trying to bring the workers' representatives and employers to agree to some common national formula for sharing the gains of productivity. Our efforts have not succeeded so far. In fact, we ourselves doubt now whether a universal formula of general application can be evolved in this difficult field. We are, therefore, working on a somewhat different idea of having, four or five models to fit varying conditions which, if acceptable to both workers and employers, could be recommended for adoption to individual enterprises to facilitate the conclusion of negotiated agreements in individual cases. Acceptance of even such models would, I feel, represent a significant advance. The essential prerequisite, however, is a change in attitudes on both sides. I have more than once impressed on my employer friends that it is futile to argue about how the larger cake is to be divided if in the absence of an agreement on the scheme of division, there is in fact no larger cake. I am, therefore, convinced that it is in the enlightened interest of the employers them-

selves that they should approach this question in a spirit of generosity.

While on this question of sharing the gains of improved productivity, I would like to add that besides the employer and the worker, there is a third party to the division, viz., the rest of the community. It is surely proper that some benefit should also accrue to the community, either by way of a reduction in prices or by way of an accretion to the national exchequer, which can be used for the general weal. If the entire gains of improved productivity in an industry or an undertaking are appropriated by the employers and workers of that industry or undertaking, then while a limited section of the community benefits, the rest of the community derives no advantage from the increase in national productivity. It is obvious, therefore, that real wages of workers in any industry should rise at a rate slightly lower than the increased productivity of that industry, so that the community as a whole may also prosper.

This subject of sharing the gains of productivity is often bedevilled by arguments regarding the contribution of the various factors of production in such improvement. Measurement of the effect of various factors in increased productivity is a highly complex subject and sharing the gains of productivity should not be made a statistical exercise of determining the respective shares of capital, labour or technology. Sharing the gains of productivity has to be treated as a philosophy of better industrial relations rather than a mathematical division.

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Positive Role of Trade Unions

In Indian conditions, the attitude of trade unions has a powerful influence on the productivity drive. While some trade unions have unreservedly given their support to this concept, others obviously have definite reservations. The problem is complicated by the existence of numerous trade unions of different political persuasions and philosophies in the same unit or in the same industry. In such a situation, a rivalry develops between the various unions to enlist the support of the workers by making higher and higher demands on the management. It is obvious, therefore, that in our conditions of work and living, not only have we to educate and motivate the managers and the workers, but we must also seek the support of the trade unions of different persuasions by providing proper courses for trade union workers and leaders. We in the National Productivity Council are trying to do this in our own limited way, but this is an important field for a national endeavour.

Importance of Small Scale Industries

I come now to another powerful element in the Indian situation which must greatly influence our approach as well as the approach of labour and trade unionists to this question of higher productivity and economic growth. I refer to the question of growing unemployment which represents a most serious problem for the Indian planner. We have no shortage of manpower, though we have a serious shortage of capital. Now in economic terms it is essential for us to maximise the use of our scarcest resources and we can afford to be little more liberal in our use of the manpower resource. This means that what is most suitable for many Western economies which have serious shortage of manpower, but are comparatively well-off for capital is by no means the most suitable method for us. Thus large, capital-intensive, fully automated units which may be ideal in

Western conditions are by no means the most appropriate for us. Hence, the importance given in India to small-scale industry, the employment potential of which per unit of capital employed is larger than for bigger units. Hence, also the search for what is called "Intermediate Technology", viz., technology which while being modern does not go to that degree of automation or capital-intensiveness as would seriously affect its employment potential. Hence, also the opposition of Indian labour to the idea of automation. All this does not mean that we should be content with inefficient methods of production, that we should forego the economies and efficiencies of large-scale production, but it does mean that in any given instance we must not uncritically accept methods and scale of production which may have been found to be the most efficient in the West in the totality of circumstances prevailing there.

It is not surprising that in the Indian context automation is a bugbear to labour, for they see in it a denial or lessening of employment opportunities. Labour sometimes sees a conflict between employment and higher productivity. While higher productivity, by providing for increased economic growth, *in the long run* leads to more employment, the question that labour often asks is 'what happens in the short run?' In the long run we are all dead. It is not much use telling labour that in a matter of four to five years or more, improved productivity will lead to higher employment by way of accelerated economic growth (as has been the experience of all developed countries), if meanwhile unemployment increases. Most productivity schemes in India, therefore, must proceed on the basis that there will be no retrenchment; which means that our aim must be not to produce the same amount of goods with the employment of a smaller number of men, but rather the aim should be to produce a much larger amount of goods with the employment of the same force. Or, if we are going to employ immediately a smaller work force, alternative gainful and useful employment must be found for the rest. Thus it is abundantly clear that techniques and methods which are most effective abroad have to be modified for adoption in this country to suit our conditions.

Diversified Production

India started off planned economic development with a low capital base and poor infrastructure, hardly 20 years ago. She had, however, a long tradition of intellectual and scholastic excellence, and practical skills in a number of production processes. Her continental economy now provides developmental experiences in a wide variety of lines, and on a very extensive front, for nearly five hundred million people under most challenging conditions. Except for certain jute and textile products and a limited quantity of iron and steel, by and large most of the requirements of manufactured goods irrespective of whether these were boot polish, baby foods, or bicycles were imported from abroad only 20 years ago. Today almost the entire range of the consumer goods of our people are produced within the country, and the number of registered factories is more than eight times of what it was in 1948. In the overall picture, in some areas our successes have been beyond our expectations, in some areas just modest, and in some well below our expectations. India's size, the pressure of population on the land, the socio-economic conditions that she has inherited from the past, the low capital base of her economy, the lack of requisite infra-structure with which she started her economic planning, and above all the poor state of her agriculture and its dependence on rainfall must be kept in view in understanding our achievements and failures after independence.

Modernisation of Agriculture

It is not possible here to give an account of all our experiences. Rather than narrating our successes, I would like to give an instance of what was till recently a major inadequacy in our developmental activities, though it is so no longer. This happens to be agriculture. Insufficient emphasis on agricultural extension, and what is even more important, agricultural productivity has been a weakness not only in India but in several other developing countries. Admittedly, modernising agriculture requires a good deal of industrial inputs which meant a

reasonable degree of industrial progress. Still, as we look back now over the last two decades, it appears that perhaps much more headway could have been made in the agricultural work through greater emphasis on irrigation, superior quality seeds and improved agriculture methods, without requiring heavy industrial inputs. Side by side, greater allocation of resources could have been made to promote those industries which provided the requisite modern inputs for industrialising agriculture.

In India, the green revolution is now taking place and agriculture is being industrialised or, at any rate, making reasonable headway towards industrialisation. Agriculture, far from being the least productive sector, in fact provides not only the maximum scope for productivity rise but also indirect growth benefits in the way of enhancing real wages and expanding the national market.

Two Stages of Economic Development

It would be relevant to recall here Dr Nicholas Kaldor's two stages in the process of economic development of a country. According to Kaldor's thesis, in the first stage, profit is calculated as the surplus, after providing for the subsistence level wages for the working population. In the second stage, when as a result of economic development, the real wages go well above the subsistence level, then profit as per plan is first deducted, and the balance is declared as a surplus to be distributed as wages, which incorporates incentives along with it. Dr Kaldor is perhaps thinking a little ahead of his time, but the importance of providing a minimum subsistence level wage to the workers as an essential prerequisite for development can hardly be exaggerated. In fact, it is not merely the social ethics of a welfare state that would justify this, but also the very compulsions of the economy for sustaining a steady growth rate. If a worker does not have enough to eat, does not have elementary education, shelter, medical facilities, it is futile to talk about productivity rises to him, as the absence of the facilities I have mentioned would inevitably give rise to such frustrations and discontent, generating negative multiplier effects and damaging the economy to such an extent that it would make stable social and economic development very difficult indeed. If we accept Kaldor's thesis of subsistence level wages as the essential foundation for economic growth in the developing countries, then this naturally lends extra emphasis to agricultural development, as most items of subsistence in the developing countries emanate from this primary sector.

The objective of my talk has been to make a critical self-appraisal of a major area of our economic development. The National Productivity Council, for want of resources, has not been able to make any headway in the field of Agricultural Productivity. But the Local Productivity Councils and the National Productivity Council should certainly become dynamic centres of activity in providing realistic productivity services of practical value in agro-based industries, storage, marketing, transportation and distribution of agricultural products.

Emphasis on Quality

There are many other aspects of productivity to which one could refer. For instance, we need greater awareness throughout industry for quality control. Productivity does not mean the larger production of goods of any quality. Then there is the importance of technology, particularly of borrowed technology. Poor productivity also results from a lack of trained manpower and improvements in productivity can often be brought about by the avoidance of waste and by the better use of plant and machinery, which are more within the sphere of the managers than of the workers. However, I hope I have said enough to emphasise the role of improved productivity in accelerating economic growth and in particular that the heart of the problem lies in improving the quality and motivation of the human factor. Special techniques for the improvement of productivity can be taught with comparative ease, but bringing about a change in attitudes is a more difficult business, in which leaders of all sections of the community must play their part. It should, in fact, be a national goal. □

Role of Inventions in the Perspective of Development

N.J Kamath*

Economic development in the world of today is characterised by an ever-accelerating growth of science and technology, which play a decisive and dominant role in increasing agricultural and industrial production. As we go along the road towards industrialisation it is imperative that we develop the ability to solve our technological problems and keep constantly improving and innovating the technology we have found necessary to borrow. To this end, it is necessary to have sufficient number of people who can absorb, adopt and apply the knowledge and techniques they have acquired. Besides developing the habit of applying scientific and technological know-how, it is necessary to create through appropriate incentives necessary stimulus to the development of indigenous talent. There is virtually no limit to the areas in which inventions and technological innovation can be pursued. Yet, we need to concentrate on those areas for technological innovation as have a distinct utility in India's present stage of development and perspectives beyond.

INDUSTRIAL development, side by side with the growth of agriculture, has a key role to play in economic development. It is an accepted practice today to refer to the countries of the world as developing countries on one hand, and developed or industrially advanced countries on the other. A common characteristic of the economies of all developing countries has been the small contribution made by their manufacturing output to the gross national product, as against the very much higher levels achieved in the industrially-advanced countries. It is the realisation of this fact that brought home to the first Asian Conference on Industrialisation, held at Manila in 1965, the imperative necessity that the developing countries of the Asian region, aim at a greater degree of self-sufficiency in the production of industrial goods.

Two Decades of Planning in India

Planning over a period of two decades in India after Independence has taken the economy out of its traditional rut and infused into it a sense of dynamism. The national income has increased nearly two-fold since 1950-51 and despite the rapid growth of population the per capita real income has also registered an increase of over 28 percent. Industrial output has gone up by about 162 percent, while the increase in agricultural output between 1950-51 and 1964-65 was 64 per cent. The total volume of investment in the economy has risen more than four-fold in the first 15 years of planning. Apart from this, the basic infrastructure of the economy has received a big push as reflected in its impressive growth. To cite a few examples, the installed capacity for power generation rose from 1.7 million KW in 1950-51 to 9.0 million by 1967-68 and the volume of freight handled by railways more than doubled while the production of steel ingots went up from 1.47 million tons in 1950-51 to 6.50 million tons in 1968-69.

Widening Gap Between Nations

While this adventure of raising India from an underdeveloped country to a fast-developing

*Joint Secretary, Ministry of Industrial Development, Government of India, New Delhi.

economy in which every member of the society is to be provided with a minimum standard of living has been laudable, the economic difficulties that have been dogging our progress have continued to persist. The major task in the economic field today is one of accelerating the pace of economic growth in India as in other developing countries. During the 60's which were ushered in as the First United Nations Development Decade, the gap between the developing and the industrially-advanced countries has been continuously widening instead of being reduced. If the 70's which have been launched as the Second UN Development Decade have really to mature as a decade of development and not one of frustration and disappointment, then it is imperative that developing countries like India take a real leap forward in their effort towards industrialisation.

Role of Science and Technology

Economic development in the world of today is characterised by an ever-accelerating growth of science and technology. It is axiomatic in the economic planning of developing countries that science and technology should play a decisive and dominant role in increasing agricultural and industrial production. In the story of man three movements have been recognised as having brought about cataclysmal changes in the established order. They are: religion in the middle ages, industrial revolution in the 18th century, and the socialist revolution in the 20th century. To these three great movements in the history of mankind, we can now add a fourth, namely, the scientific and technological revolution.

Innovation Chain

The life-blood of science and technology is the process of successful innovation. This process consists of a whole chain of activities starting from research, moving through development, design and engineering on to commercial production which extends to marketing, sales and after-sales service. The transfer along the chain from research to production is long and difficult. It is a problem not only for a developing country like India, but also for the industrially-advanced countries in the competitive world of today. The main point about the innovation chain has been brought out in the report on the brain-drain that was published by the British Government, as follows:

"We consider...that there is sufficient recognition, at all levels of our society, of the fact that the source of national wealth is in the creative, productive industries of this country. It is here that the enginner, technologist or scientist, has both the greatest contribution to make and the greatest challenge to face. We recommend that Government and industry should combine to emphasise that new ideas alone do not create national wealth and prosperity, and that they contribute to national prosperity only when they are vigorously exploited in productive industry."

Development of Technological Know-how

In her inaugural address to the conference on the Application of Science and Technology to the Development of Asia, in August 1968, Prime Minister Indira Gandhi observed that developing countries though backward in science have an advantage in that, they can sometimes telescope centuries into a few years, take advantage of the experience of others and perhaps even alter the sequence of change. While agreeing that import of technological knowhow becomes inescapable when we do something for the first time, she has observed that growth cannot be sustained on borrowed or even adopted technology. As we go along the road towards industrialisation it is imperative that we develop the ability to solve our technological problems and keep constantly improving and innovating the technology we have found necessary to borrow. To this end, it is necessary to have a sufficient number of people who can absorb, adapt and apply the knowledge and techniques they acquire in an effective and productive manner. The availability of people with the right kind of skills alone will determine the direction and rate of economic growth in developing countries.

Providing Stimulus to Indigenous Talent

It follows that the right kind of training has to be given to men, women and children to ac-

quire the skills and cultivate as second nature the habit of applying scientific and technological knowhow to the ordinary business of day-to-day living. Side by side with training opportunities that are provided, there must also be incentives which can create the necessary stimulus to the development of indigenous talent for science and technology.

Role of Inventions Promotion Board

It is in this function of providing the necessary incentives that the Inventions Promotion Board has an important role to play. The Board has the responsibility to encourage and inculcate the spirit of inventivity amongst independent workers, artisans, technicians and other persons. It assists in guiding the country's inventive talent in the most fruitful channels and promotes ideas and inventions by sutitable technical and financial assistance. Towards the achievement of these tasks set for it, the Inventions Promotion Board offers grants for development of useful ideas into inventions and gives awards as incentives for useful inventions.

How an Invention is Born

It will not be out of place here to say a word about the creative process which gives birth to an idea that grows into an invention. The creative process, as Brewster Ghiselin has observed, is the process of change, of development, of evloution, in the organisation of subjective life. Even to the creator himself, the earliest effort may appear to involve a tryst with disorder because the creative process is not an elaboration of the established. The first requisite, therefore, is to transcend the established order. This is the reason why in order to invent, one must yield to the indeterminate within him, or more prcisely, to certain ill-defined impulses, which seem to be of the very texture of the ungoverned fulness which John Livingston Lowes has called "the surging chaos of the unexpressed". The mind in creation and in preparation for it nearly always requires some management which may be said to have two major elements: discovering the clue that suggests the creative end to be reached and assuring a certain economic movement toward that end. Among the conditions to which every inventor must submit is the necessity for patience. Understanding, discipline and hardwork are the other essential qualities in the creative process. Shortly before his death, Pavlov, advising young men on the requisites for effective pursuit of science, wrote :

"Remember that science demands from a man all his life. If you had two lives that would not be enough for you. Be passionate in your work and searchings".

Areas for Technological Innovation

There is virtually no limit to the areas in which invention and technological innovation be pursued. But innovation can have a value only if it is based on discernment or choice. It is, therefore, necessary for us to concentrate on those areas for technological innovation as have a distinct utility in India's present stage of development and the perspectives beyond. To mention a few important areas, we have agricultural research, particularly in the field of rice and commercial crops; industries, particularly those notified as core industries as also those 121 items in which there are significant technological gaps; foreign trade, particularly in the field of product adaptation, as in import substitution. Inventions in these specific areas are bound to be of significant value in India's economic development.

Investment in Man

It has been observed that in the economic planning of developing countries science and techonology should play a decisive role in increasing agricultural and industrial productivity and to this end the necessary training and incentives would require to be provided. Let it, however, not be forgotten that science is not merely a tool, a gadget or an instrument, but a habit of mind. In the final analysis it has to be the aspirations, the ideas, the inventions, the innovations of man that will determine whether the untapped resources of this earth can be transmuted for the well-being of mankind. This is why it becomes a rewarding adventure to inculcate, to promote, to develop, to nourish, and to acclaim the ideas and inventions that may lie dormant in the minds of men. Investment in man is the highest and most infallible of all investments. □

Productivity Studies in Relation to Manpower Planning

Navin Chandra Joshi*

Human resources capital is a major factor in the development process and must be fitted into any general economic plan in its totality. From the productivity trends, a high degree of complimentarity exists between a certain type of production method and the kind of labour force needed for it. An industry's productivity depends on the composition of its labour force and a detailed classification of occupations is needed for efficient manpower planning. The Industrial occupation structures and their corresponding productivities provide the manpower experts with an ideal tool for testing the practicality of a development plan.

In the context of developing nations, industrialisation implies a sharp break with the past. Although a few of the established trends may continue, yet the major thrust of industrialisation reflects a new direction in the forward movement of their economic sectors. If rapid progress is to be made in carrying out an industrialisation programme, a minimum of statistically-related planning must take place. While the plans of developing countries take manpower resources into account, too few economic planners considered human capital as a major factor in the development process.[1] It is only in recent years that due emphasis has been placed on this factor but the complete knowledge of it is still rather limited. The human resources factor must, therefore, be fitted into any general economic plan in its totality. And the projection of future manpower requirements within the framework of a general economic plan must require that the projected industrial output be related to the manpower required to produce that level of output. It should be recognised that the higher rate of growth of gross capital formation had a favourable effect on the productivity of net capital formation on account of "embodied" technical progress; it also permitted a substanial increase in the efficiency of labour, in so far as new skills were needed to cooperate with capital.[2]

Labour—the Significant Input

Manpower projections are based on the premise that a given skill composition reflects a given state of technology and hence, productivity. Therefore, the planning of an industrial sector requires considerable understanding of the process by which inputs are transformed

* Head of the Department of Commerce, Hastinapur College, New Delhi.

1. "But the kind of productivity-consciousness we need is one that includes the human factor in the calculation of inputs and outputs that keeps the human costs to the irreducible minimum and recognizes that industry produces men in addition to goods."—KF Walker in Productivity and Progress, edited John Wilkes, Angus and Robertson, Sydney, 1957, pp. 21-22.

2. Jorge M Katz, Production Functions, Foreign Investment and Growth, North-Holland Publishing Company, Amsterdam, 1969. p. 117.

into the desired outputs. In economic theory this transformation is represented by a production function showing the outputs which can be obtained from various combinations of inputs, assuming a given state of knowledge. Most production functions in economic literature concentrate upon the combinations of capital and labour and hence, the process of substitution of capital for labour and *vice-versa* takes place.[3] However, little attention has been paid to the type of labour that must be combined with a given type of capital. Indeed, production has been considered to deal with relative quantities rather than with qualities of factors. The focussing of attention on the type rather than on the relative amount of labour is certainly of great significance in modern times with advancing technology and better educational facilities for creating skills.[4] The apparent increase in structural unemployment in highly-developed economies as also the growing awareness of the investment characteristic of education has reoriented the productivity concept in terms of quality inputs.[5] Similarly, in developing countries this type of realisation must become universal because of the lack of skills to achieve the desired levels of productivity, regardless of the amount of capital they employed.[6] Thus, "Despite the high level of their human resource development, the advanced countries still face critical manpower shortages. These are no less serious than the problems confronting the less developed countries, but they are the consequence of a different set of imperatives or pressures."[7]

Problems of Unemployment and Low Productivity

In the light of the above discussion it is discernible that solutions to the problems of unemployment and low productivity are hampered both by the failure of economic theory formally to incorporate labour as a homogeneous input, and by the paucity of research into the work force composition of different industries and its relationship to productivity. From the productivity trends, there is reason to believe that a high degree of complementarity exists between a certain type of production method and the kind of labour force needed for it. In other words, a certain level of technology (and hence, a certain level of productivity) should be represented by a specific kind of organisation and by a specific kind of capital equipment made to work by a labour force whose occupational composition is well-defined.

The manpower data should permit inter-industry and inter-country comparisons of key occupations because these occupations represent skills crucial for development and are intimately linked to technological variations.[8] The data should be sufficiently detailed to show

3. Describing the difficulty in applying solely the concept of labour productivity in under-developed countries, Dr. GC Beri suggests that it might be helpful to measure the productivity of capital equipment and/or of raw materials and fuel in addition to that of labour. See his article 'Concepts and Measurement of Capital Productivity' in NPC Productivity Journal, Jan-March, 1970.

4. "We are all aware of the problem of 'quality'; we know that failure to adjust for changes in it leads to biases in conventional measures of productivity trends and we would probably agree that output measures for services are generally sorely afflicted by this problem. Many service outputs are highly intangible or qualitative in nature."—Arthur B Treadway in "Production and Productivity in the Service Industries", edited Victor R Fuchs, National Bureau of Economic Research, New York, 1969. p. 56.

5. On the question of measuring labour productivity, DH Butani says that a manhour of 1967 is not a manhour of 1961, much less of 1969, for the economic and social changes of the last two decades have transformed the very quality of labour: the skills, the attitudes, the educational background have undergone a sea-change." Vide his article "Problems of Measurement" in Productivity Journal, July-September, 1969. p. 343.

6. "For developing countries too, although the share of labour may be half of national income or less, it is essential to concentrate on this particular input, as it is a key factor of the strategy of development, one which in spite of an abundant literature is still being too neglected. In the Denisonian 'framework', labour is a quantity index obtained through a quantification of quality factors." Cf. Productivity and Economic Planning, O. E. C. D., Paris, 1970. p. 22.

7. Frederick Harbison and Charles A Myers: Education, Manpower and Economic Growth, Oxford & IBH Publishing Company, Bombay, 1968. p. 166.

well-defined jobs that can then be grouped into classifications of closely-related jobs having the same level of skill and requiring the same types and amounts of education and training. It may, however, be noted that census/occupational data are gathered without regard to the content of the jobs reported. It is only the job content that can offer clues about the degree of complexity of the work and the degree of skill needed to perform it. "Rationalization of jobs plus extreme specialisation following upon rapid technological development tend to make the work of the operative very simple, lacking in challenge to his faculties and sometime repetitive and boring...One way to make jobs more desirable and interesting is to enlarge their content."[9]

The job content is especially important for comparisons of the occupational structures of industries that are at different levels of mechanisation. For example, the job titles by themselves can confuse the difference between modern machine skills and traditional artisan skills. The more technically advanced an industry, the greater is the likelihood of specialisation and, therefore, of the facts that the work will not require traditional skills, even though the traditional titles continue to be used.[10] The low productivity textile industry may have a high proportion of skilled weavers, while a high productivity textile industry may have comparatively fewer weavers who are actually semi-skilled machine operators. Such examples could be multiplied with respect not only to manual-worker's jobs but also to white-collar and service ones as well.[11]

Need for Special Surveys

The irresistible conclusion is that the census of population should not be used to obtain the occupational information with regard to the industrial sector. Special establishment surveys similar to regular manufacturing and industrial surveys or censuses should be conducted for the purpose. The occupational data used at present are neither as refined nor as detailed as could be desired. Most of the blue-collar occupations in India are mixtures of skills combining skilled and semi-skilled workers without the job-content oriented dichotomy. The figures of professional and technical workers also include skilled craftsmen and supervisors, thus inflating the proportion of high-level occupations in industrial work force. Despite these shortcomings, however, certain tendencies are clearly visible between the occupationol groupings and productivity.

Technical Skills and Productivity

There can be a direct relationship between professional and technical workers and productivity.[12] As productivity increases, the proportion of professionals and technicians must rise. In contrast, the proportion of white-collar workers in many industries seems to

8. "...the use of employment series to fill the awkward gaps seems actually to be one of the best procedures for productivity comparisons." *Vide* The Measurement of Production Movements by Carter, Reddaway and Stone, Cambridge University Press, 1965. p. 39.

9. Ganguli HC: Industrial Productivity and Motivation, Asia Publishing House, Bombay, 1961. p. 78.

10. Solomon Fabricant observes, "Despite its importance, productivity is a subject surrounded by considerable confusion. For this there are a number of reasons. First, people employ the same term but mean different things. As a consequence, various figures on productivity change come into use, and these often differ in significant degree. Further, the rate of productivity change is not a fixed quantity. What the past or current rate of productivity change is will depend on the particular period for which the calculation is made." See Fabricant: Basic Facts on Productivity Change, National Bureau of Economic Research, Inc., New York, 1959. p. 1.

11. "If low productivity industries are making the greatest contribution to the entire industrial output, there would be conclusive evidence of a misapplication of resources." R Balakrishna, Measurement of Productivity in Indian Industry, University of Madras, 1958. p. 76.

12. "....for high productivity in industry, three groups of people—skilled craftsmen, technicians and technologists—should be available in adequate numbers. Of these, skilled craftsmen form the basis of any industrial system while technicians and the engineers may be necessary for design, maintenance, administration and research." Srecnivasan, K.: Productivity and Social Environment, Asia Publishing House, Bombay, 1963. p. 102.

evidence no distinct pattern as productivity changes. The belief that an increase in the proportion of managerial personnel results in an increase in productivity is unfounded, once a minimum proportion is established. However, this is not to say that there is no connection between the quality of management and productivity. In general, industries in countries with predominantly low-productivity, have a high proportion of service workers in comparison with the industries in high-productivity countries. The proportion of blue-collar workers in the labour force is generally inversely related to productivity. This trend is even stronger in the proportion of unskilled workers.

It may thus be concluded that an industry's productivity depends on the composition of its labour force and that a detailed classification of occupations is needed for efficient manpower planning. This might, however, conflict to a certain extent with the position of those who hold that the educational level of a nation's population is a major determinant of productivity. To be explicit on this aspect, it may be noted that it is not the educational level but the 'skills' of a nation's work force that seem to count most, and the two are not necessarily synonymous.[13] A traditional index of the qualifications needed for an occupation is the educational level of its holders, but this is by no means the only standard by which to judge occupational requirements.[14] Economists and educators tend to stress formal education but not the other important ways by which people acquire skills. It is, therefore, not surprising that there is little knowledge about the level of education or the amount of training needed by those in semi-skilled or in skilled blue-collar jobs.[15]

Although, the way to become a skilled worker is not clearly delineated, the training of craftsmen may require years of formal schooling as well as additional years of on-the job training and work experience. Training may be substituted for schooling and *vice versa*, so that skills appropriate to one occupation may be transferable in varying degrees to other occupations. There are multiple paths of skills acquisition, all leading to the same objective—to turn out persons who can meet the work requirements of various occupations. The myth that formal education automatically yields a higher level of productivity may even have harmful results in countries that lack the resources to educate large masses of people destined to become blue-collar workers.

Tasks Before Manpower Planners

From the foregoing analysis we can deduce that the usual purpose of a manpower projection is to enable the authorities to plan the educational facilities that will be required to furnish the necessary skills. Sometimes plans are implemented even when manpower projections

13. Jagdish Bhagwati feels that "Although it is possible to plan so as to aim at matching the supply and demand of skilled personnel as the economy progresses, the practical problems can be acute and may prevent rational planning. Thus, for example, there is a tremendous demand in the developing countries for more higher-education institutions. Instead of trying to produce graduates and technicians who are both well-trained and just sufficiently numerous to be absorbed in the growing economy, the politicians in these countries typically opt simply for more admissions and more institutions". Cf. The Economics of Underdeveloped Countries, World University Library, London, 1966. p. 184.

14. P Sargant Florence observes that "Many of the great discrepancies in productivity between countries are the result of different degress of mechanisation; but the discrepancies between factories in the same country and especially between workers within the same factory are usually the result of different conditions affecting the 'human factor', and among these conditions we must now proceed to enquire how far the economic incentives can raise productivity." See "Productivity and Economic Incentives", Davison, Florence, Gray and Ross, George Allen and Unwin Ltd., London, 1958, p. 36

15. "Our inability—as yet—to measure quality of labour adequately thus probably leads us to overemphasize in some degree the contribution of productivity and labour scarcity to the rising trend of real hourly earnings and correspondingly to underemphasize the contribution of investment in education and other factors of personal capital." Fabricant, op. cit., pp. 34-35.

are not available. The plans in developing countries should project production targets first and then refer the quantified data to manpower experts for assessing the needs of skills before the plan is put into operation. The manpower planner can check the feasibility of a plan by determining whether the requisite occupational skills are or will be available to complement the proposed investments. The industrial occupational structures and their corresponding productivities provide the manpower planning authority with an ideal tool for testing the practicality of a development plan. They also help the allocation of investment with a view to maximising employment. Indeed, the differences in the growth rates of physical productivity in different industries or countries may be, quite possibly, a reflection or result of the varying degrees of investment efforts made in the industries or countries rather than of any development-divergencies between the relative industrial efficiencies which can be reliably indicated only if a super-structure of firm-wise and plant-wise (rather job-wise) analysis of the factors causing the observed changes in the physical productivities involved is built up.[16]

A rapid increase in productivity in one industry may displace a large amount of unskilled labour and at the same time put pressure on some scarce occupation.[17] When the two types of labour cannot be mutually substituted, one way to provide employment for the displaced is to expand industries that employ them in relatively large numbers. Another way is to increase the supply of the scarce skill.[18] The statistical data linking changes in the occupational mixes and in the productivities of different industries may suggest which industries should be encouraged in order to absorb workers of a given type. Such data can also suggest which industries should be discouraged from adopting new techniques if the only way to carry them out is by pirating irreplaceable key workers from other equally essential industries.

The occupational compositions of various industries give good clues as to the importance of different occupations in different industries and serve to identify occupations in them. They offer a way of ensuring greater accuracy of forecasts and are also a means of making more realistic manpower projections. The introduction of boundaries imposed by the availability of occupational skills makes the development plan feasible. Moreover, each industry can have a variety of productivities (and hence, occupational distributions) and capital requireeents. We may then choose, for example, to have high productivity in metals and low productivity in textiles, or high productivity in chemicals and low productivity in sugar and beverages. The choice of productivity will thus ultimately be governed in part by the allocation of scarce skills. □

16. BB Lal: Industrial Productivity and Economic Growth, Chaitanya Publishing House, Allahabad, 1965. pp. 115-116.

17. "What should be recognised, however, is that the problem of achieving a high rate of increase of productivity is intimately associated with the efficient allocation of resources. Artificial support of declining industries not only causes misallocations today, but, more important, retards the growth of productivity." Salter, WEG: Productivity and Technical Change, University of Cambridge, 1960. p. 153.

18. "If productivity indexes try to get at shifts in production functions, adjustments will be made for some input quality changes, but the adjustments are unlikely to account for all the growth in output. For example, changes in quality of labour that are the result of investments in education would be allowed for in as much as these may be expected to affect the return to that labor." Cf. Paper by Edward F Denison in Output, Input, and Productivity Measurement, National Bureau of Economic Research Inc., Princeton University Press, Princepton, 1961, p. 375.

19. Jan Tinbergen rightly concludes that "If it is the aim of an economy that its production should develop smoothly, that is, that its national production should be a certain constant growth-rate, it is possible to calculate, as it were backwards, how many persons there must be at each of a number of successive periods both pursuing a course of study or training and having completed their training." See his book *Development Planning*, World University Library, London, 1967. p. 138.

Productivity in Small Firms

Sushila Thakur*

Small Industries Sector has been assigned a very important place in India's development plans because they provide large scale employment opportunities and ensure a more equitable distribution of national income. In terms of magnitude of investment and expansion in physical terms, small firms have shown a continuous growth. Progressive improvement of productivity is one of the principal vehicles of growth. Modern small industries which are capital saving and labour intensive have a strong case in the development process. Once the small units become economically viable and productive, they can contribute immensely.

WITHIN the Indian development strategy, cottage and small scale sector has been assigned an important position. The industrial policy since the Second Five Year Plan emphasised the role of basic and heavy industries using modern technology. This led to a choice in favour of large enterprises involving heavy investment. Indivisibility of technology for the producers' goods enforced this choice. Nevertheless, it is important to recall that within the Mahalanobis model[1], the cottage and small units found a logical role on two considerations. First, the increasing purchasing power as a result of investments in the heavy and basic industries called for 'higher volume of marketable surplus of consumer goods' in order to cushion the inflationary pressure. Second, along with the programmes of strengthening the "foundation of economic independence" through the manufacture of producers' goods, the objective of creating additional jobs in a chronically labour-surplus setting could not be overlooked. These led to a systematic thinking on the role cottage and small scale units could play in the industrialization programme.

*Lecturer in Economics, Daulat Ram College, University of Delhi.

1. PC Mahalanobis, "Draft Recommendation for the formulation of the Second Five-Year Plan (1956-61)" in Papers Relating to the Formulation of the Second Five-Year Plan.

The Industrial Policy Resolution of 1948 recognised that cottage and small firms were suitable for better use of local resources as well as local self-sufficiency of consumer goods. Even the 1956 Industrial Policy Resolution noted that the small scale sector was a means for providing large-scale employment and ensuring a more equitable distribution of the national income. The Panel of Economists for the Second Five Year Plan was conscious of the technical inferiority of the cottage units, and their weakness to face competition from the large and technologically-superior units. The need for more jobs and increased supply of consumer goods, however, influenced its thinking in advocating the 'Common Production Programme' with protected place for the cottage and small scale sector. Later, the Village and Small-Scale Industries Committee supported a programme of progressive expansion of village and small-scale industries in order to ensure creation of larger employment opportunities and increased supply of consummer goods of common demand. The Committee did not ignore the value of superior technology, but it was greatly concerned about the possibility of technological unemployment in the process of development through modern technology. From this followed the dual-technology model for Indian industrialisation. There was an implicit assumption that the modern-technology sector will expand, and the inferior technology

of the village and small sector will improve. The committee[2] stated:

"Where new capital investment has to be made, it should be made as far as possible only in improved equipment or where existing equipment is itself capable of being improved by addition or adaptation.... the plan of development of village and small industries in the second and subsequent five year plan periods will be concerned with the progressive improvement in productivity and in the conditions of life and work of the large number of persons engaged in this sphere, with comparatively little disturbance to their locational and social set-up.

Plans and the Small Scale Sector

The investment in the village and small industries under the Five Year Plans went on increasing. The total actual investment in the Second Plan was Rs. 2650 million, the corresponding magnitude of investment visualised for the Third and Fourth Five Year (Draft) Plans being Rs. 4250 million and Rs. 5500 million respectively. The figures for the public sector investment in this sector are Rs. 900 million in the Second Plan, Rs. 1500 million in the Third Plan and Rs. 2700 million in the Fourth Plan.

It is clear that the performance of the village and small units are vital within the basic strategy of development planning. In addition, considerable portion of the scarce investment resources has been diverted to this sector. Small firms account for nearly 90 per cent of the number of units and 16 per cent of the total investment in the Indian factory sector. In addition, there is a large sector of village industries. In terms of the magnitude of investment and expansion in physical terms small firms have been growing.

Capital Shortage and Small-Firm Productivity

Improving productivity progressively is one of the principal vehicles of growth. The crucial role of industrial technology cannot be overemphasized in this context. Productivity of human factor grows with the progress in industrial technology. But technological improvement is invariably a capital-intensive proposition. This introduces a limitation on the pace of development in capital-short economies like India faces the problem of capital allocation in such channels of investment as accelerate the rate of development with minimum of social cost. The latter consideration emanates from the pressure of democratic polity within which development planning has to take place. Advanced industrial technology is highly productive. But its two features—(a) capital intensity and (b) labour saving—impose economic as well as social constraints. As Dandekar and Rath[3] point out, advanced industrial technology in capital-short economies present a situation similar to the concentration of land holdings in few hands. Redistribution of land and technological possibility of productive intensive cultivation on small plots allow social concerns to suitably modify economic decisions without the sacrifice of productive efficiency.

How far then the socially-desirable redistribution of scarce capital is possible without jeopardising the efficiency considerations? The small scale and village units become relevant in this context. The crucial issue is to find a "method by which the small amount of capital that the economy has may be distributed among a large number of workers". The case of labour-intensive technology is advocated in this context.

It is important at this stage to keep in view some choices within the small scale sector itself. Broadly three may be noted: (i) A technology could be capital-saving and labour-intensive per unit of output, (ii) Another may be labour-intensive but not capital-saving per unit of output, (iii) And, yet another could even be labour-intensive as well as capital-wasting per unit of output. On economic criteria, the first is perhaps the best where technology permits substitution of scarce capital by abundant labour.

2. Report of the Village and Small-Scale Industries (Second Five-Year Plan) Committee, Chapter 11, Planning Commission, Government of India.

3. VM Dandekar and Nilakantha Rath, Poverty in India, 1971—Chapter VI.

The desirable factor-mix is consistent with productivity. The second also allows more employment without adversely affecting capital productivity. But the third alternative begins to acquire the character of a relief operation. The social concerns for employment promotion adversely affect the optimum use of capital. But on occasions, avoiding social cost may be less costly than what the rough and ready economic calculation may indicate.

On productivity consideration, the first two should have priority, but the place for the last one also cannot be entirely denied. This does not amount to advocating the case of inefficient and backward technology. Two considerations are important. First, with an inefficient start, such firms could improve their level of performance. This incidentally was the assumption behind the policy of common production programme. But the experience with the Khadi production programme is not very encouraging. In the Third Plan, it was clearly stated that in the case of village industries the objectives were: "(a) to improve the productivity. . . . and reduce production cost; and (b) to reduce progressively the role of subsidies, sales rebates and sheltered markets". But the need for subsidy persists.[5] The subsidy suggested for the New Model Khadi is of 50 paise per square metre. In the case of traditional and Ambar Charkha Khadi, the level of subsidy was 80 paise per square metre. In 1965-66, the incidence of subisdy as a result of 'technological gap' was of the order of Rs. 70.5 million. In addition, the loss due to interest-free loan amounted to Rs. 20.7 million. As Dandekar and Rath summarise[6], the net outcome of the programme was "to provide productive employment worth Rs. 70.2 million and to distribute subsidy worth Rs. 91.2 million." This is no doubt a kind of unemployment insurance, and certainly involves a less productive use of capital. This clearly is a case of failure in improving the technology in one area of the village industries sector.

Second, despite being economically less efficient village and small sector adds to the volume of much-needed consumer goods. Assuming that (a) inflationary pressure will grow as a result of investment in the capital-heavy producers' goods sector, and (b) socially-explosive unemployment situation will continue to demand attention, even these capital-wasting units seem to acquire a plausible case. Perhaps, one of the inevitable cost of capital-shortage is a less efficient use of some capital.

But the modern small firms which are capital-saving and labour-intensive per unit of output as well as labour-intensive but not capital-saving per unit of output have a strong case in the development process.

Human Factor and Small-Firm Productivity

When the case for small firms on the basis of more equitable distribution of capital appears strong, it is important to explore all sources of their additional productivity. Quality and quantum of physical capital are important. But the human capital in the form of managerial know-how and craftmanship, etc., can contribute a lot. In fact, the returns from physical capital can considerably improve by a more alert handling of the use of human capital. The kind of human manipulation determines the extent of waste, breakage, machine-down time on the one hand and the quality of production on the other.

Among the three levels of human resources in the small sector—managerial, supervisory and workers—the last two need greater care. The owner-manager is always exerting enough to get the most out of his investment. The limited managerial personnel and economic vulnerability force on small firms a special kind of technique of human handling. Unlike in the large firms, a purely contractual relationship has to be replaced by a personalised, even familiar kind of relationship. A supervisor can supervise better if he shares shop-floor authority. This authority, by known evidence, he is able to exercise in generating effective response from his fellow-workmen.

The personalised approach and delegation of shop-floor authority to supervisors need to be

4. Ibid
5. Ibid
6. Ibid

supplemented by a suitable scheme of financial incentives. Money is an effective motivator. It is likely to be doubly effective at the lower levels of industrial wages as in India. The instrument of financial incentives in the context of the small scale sector is very potent due to two reasons: (a) unionism has not yet brought institutional rigidity, and (b) the pay packet is still not that structured. Thus through financial as well as non-financial incentives the contribution of human factor towards productivity could be considerably improved. This will increase the output per unit of capital.

Productive Small Sector and Other Gains

Once the small and village units become economically viable and productive, they can contribute immensely to the process of development. The regional imbalance in development contains the seeds of tensions. Small firms by their locational flexibility can make significant contribution. The stagnation of the rural economy needs activisation with a programme of gradual industrialisation. Here again small firms can contribute. But the sad state of semi-urban rural industrial estates calls for caution in this regard. Our programme for decentralised industrialisation cannot overrule all economic considerations involved in industrial location.

Complimentarity Between Large and Small Sectors

Once the basic foundation of the economy has been laid, small firms quicken the pace of spread of growth multiplier over the entire range of the economy. This is true for the development economies as well. But this requires a careful integration of small firms in large enterprise. The use of sub-contracting and farming-out technique can be used with advantage. This kind of interrelation between the large and the small sectors will eliminate the risks of competition. In addition, the managerial know-how of the large firms will help the performance of the related small units. Such arrangement need to be introduced at an accelerated pace.

In underdeveloped economies, small firms are particularly suitable because of the nature of their management being less complex. Large capital-intensive plants multiply the risk of managerial inefficiency. The sad state of several of our large public enterprises illustrates how much more cost of it is to be large and inefficient. After all, the magnitude of subsidy by the taxpayers to the village industries is an insignificant amount compared to the subsidised losses of several large national enterprises. These inefficient giants in addition block large amount of capital, and at the same time, do not generate sufficient number of jobs for the unemployed millions. The inequality of capital distribution becomes oppressive indeed. But the economic and social case of small firms will need to be strengthened by improved productivity. More careful technological choice, relentless effort to improve it, and a conscious care for the better use of human capital will help much. Despite much governmental effort through the Small Industries Service Institutes, much remains to be done in this sector.

Need for Capacity Utilisation

A concerted effort for capacity utilisation should have the first priority. All factors hindering the utilisation of idle capacity should be identified and dealt with expeditiously. Second, the search for economically-superior technology for this sector must proceed beyond the theoretical possibility alone. This requires a relentless effort, for there is no one 'appropriate technology' to suit the national factor endowment. And, in the process of development, the factor endowment is itself subject to change. Third, the gaps in the managerial capacity should be filled. In this context, integration of small firms with the successful large enterprises offers some promise. Fourth, in the future programme of development the decision on location, product, and technique, the tests of economic efficiency should be applied more rigorously. Lastly, the several government-structured bodies to promote the small and village industries must be asked to earn their continued existence on the quality of performance of this sector. Their achievement rather than popular slogans should be the test. □

Enlisting People's Participation in Agricultural Productivity

DS Sawhny*

The technological break-through in agriculture can be sustained and improved only if the economic motivation can be extended to large number of small farmers and agricultural labourers. Time has come to appeal to the sense of patriotism of all those engaged in the development of agriculture—farmers, rural institutions, financing institutions, etc., with a view to mobilising public opinion on a nation-wide scale in favour of accelerated agricultural production. The need is for creating communication channels for enlisting people's participation and mobilising public opinion. Towards this end, the author suggests an action programme.

PARTICIPATION is a comprehensive term and would embrace such distinct and diverse factors as (i) the active response of the primary producer (e.g. the farmer, the fisherman, the cattle breeder); (ii) the activisation of non-official leadership at the village block and district levels; (iii) the role of all-India or regional non-government institutions and organisations in agricultural development.

So far as the economic motivation is concerned, the new strategy of high-yielding variety crops has undoubtedly provided to those farmers who are covered by it, the required incentive in the form of the higher yield per acre. The technological break-through which the new seeds and other scientific discoveries are bringing about, will be effective only if the economic motivation can be extended to the large numbers of farmers with small holdings and agricultural labourers whom the new strategy has not been able to involve so far. It is, therefore, the most urgent and massive challenge both to the administration and to non-government sector to create an environment of economic motivation to the large number of small farmers and producers both in irrigated and nonirrigated areas.

The impediments to the involvement of the people could be identified with the following among other factors, as being largely responsible for the want of active response from the large number of producers:

a. Poor land-man ratio.

b. Tardy implementation of the land reform measures particularly those regarding giving land to the tiller and tenurial security; fragmentation of land into uneconomic holdings, inadequacy and unreliablity of land records.

c. Underemployment or unemployment in rural areas and non-enforcement of minimum wage policy for landless labourers; lack of subsidiary productive activities to supplement income from non-viable holdings.

* Sawhny's Fruit Farms, Srinagar.

d. Inadequacy of financial investment in the agricultural sector, particularly loans and grants for small farmers, fishermen, etc. Cumbersome procedure for providing loans to farmers and unrealistic basis for security.

e. Insufficient attention to the building up (and maintenance) of infra-structure such as land reclamation, irrigation, marketing facilities, etc., particularly for relatively dry areas which constitute the bulk of the cultivated land in India; irksome procedure for the supply and availability of inputs such as seeds, implements, pumps, pesticides, etc. and lack of integration of the supply of inputs with specific production schemes.

f. Occasional want of understanding of the problems of non-governmental field organisations on the part of the local officials.

g. Illiteracy of the majority of the rural labour force of the country, thus placing them under a perpetual handicap.

While accepting self-interest in economic life as being the primary motivation for peoples' participation, the people concerned with the progress of agriculture are looking for an idealistic base to structure the national prosperity. What should be the contents of this idealistic motivation?

The continued imports of foodgrains for feeding the people is a serious challenge to national pride and self respect and the time has come to appeal to the sense of patriotism of all people in agriculture—farmers, rural institutions, government officials, financing institutions, food trade, etc. to mobilise public opinion on a nation-wide scale in favour of accelerated food production in order to eliminate import of food grains.

The second idealistic base should be to supplement the technological revolution by an equally-deliberate and well-considered social transformation in the rural areas. This transformation should aim at achieving equality of opportunity for all producers of food and to create conditions in which the image of good life—material well-being and well-earned leisure may become a reality for the large number of small farmers and agricultural labour. This objective of social transformation through constructive activity and organisation provides a challenge to idealism, spirit of dedication and opportunity for hard and sustained work to the youth of the country. Equally, this would be a relevant non-economic motivation for voluntary agencies at various levels.

For promoting people's participation and mobilising public opinion the following methods of communication could be profitably adopted:

(i) Direct mobilisation of farmers and village communities at general meetings so that even the humblest villager may have an opportunity for expressing his views and contribute to the village development plan.

(ii) Meetings, seminars and conferences at block and district levels for farmers to enable them to exchange views and receive new ideas ;

(iii) Organisation of demonstration on farmers' own fields and making known the examples of successful production programmes of private farmers, giving recognition and status to farmers and arranging for inter-State exchange visits of farmers ;

(iv) Increasing facilities for film shows in villages, including mobile projecting units ;

(v) Making available transistor radio sets in large numbers at low cost and adjusting radio programmes so as to provide the requisite motivation as well as technical guidance ;

(vi) Constructive use of the medium of television for agriculture.

(vii) Promotion of and encouragement to traditional media such as folk plays, songs, etc. so that not only are the

Continued imports of foodgrains is a serious challenge; the need is for mobilising public opinion in favour of accelerated food production in order to eliminate imports.

smallest villages covered but the humble folk and tribal artist has the opportunity for self expression leading to self confidence.

(viii) Organisation of training of farmers, fishermen, etc. as a part of specific production programmes so as to give them skill for using new-technology, including the skill of functional literacy: establishing two-way communication with farmers to activise their participation and where necessary to promote functional literacy for the purpose.

(ix) Use of the medium of press in giving prominence to reports and activities on food production particularly efforts of individual farmers and organisations.

Action Plan

While these methods of communication would prepare the environment for peoples' participation, it is felt that such an environment cannot be sustained unless at the non-governmental level specific programmes are organised by various agencies and organisations. Stress has to be laid on three general principles in this connection: Firstly, non-governmental organisations should undertake those programmes for which they have a special expertise and where their effort will supplement the larger programmes undertaken by various state agencies. Secondly, it is important that non-governmental organisations should preferably undertake programmes at the field level in specific and limited areas before they launch country-wide or larger regional programmes. Thirdly, the local conditions and needs should determine the type of programmes that may be undertaken.

The following, among other activities, are mentioned as possible priorities for the consideration of non-governmental organisations:

a. Non-governmental organisations can function as the local agencies to assist farmers participating in specific schemes or projects in selected areas according to their special competence or interest. This assistance can be for providing services such as drilling of tubewells, devising of individual farm plans, acting as intermediaries between the farmers and the Government and financing agencies, providing common services such as plant protection, tubewells and other minor irrigation works etc. Before undertaking the programmes, the non-governmental organisations will have to identify the major requirements and aspirations of the people in the selected areas.

b. With intimate knowledge of the local conditions, non-governmental organisations can create conditions favourable for the implementation of certain aspects of land reforms such as consolidation of holdings and distribution of surplus land.

c. Non-governmental organisations have a special role to play in promoting savings among farmers in areas that are coming under the impact of new technology and higher production. In particular, they can supplement the efforts of commercial banks to attract deposits and promote savings groups.

d. Village level planning attempted in the past by governmental agencies has often run into difficulties. Non-governmental organisations appear to be in a better

position to take up in a limited way and in specific areas village level or even individual farmer level planning related to specific production programmes.

e. As a consequence of the new strategy of agricultural production, modification of food habits is an important task which can effectively be promoted by voluntary groups. In so doing, they will have to prefer programmes which do not add to the cost of food.

f. Farmers' training is an essential component of the new agricultural strategy. It has to be production-centered, and may also include agro-technical training skills. Therefore, every scheme for stepping up food production should have in it specific provision for the training of primary producers including women. While Government has an important programme of farmers' training and functional literacy, it is not only possible but necessary for non-governmental organisations (including Universities and Colleges) to contribute to these programmes. However, a non-governmental agency organising farmers' training would be well advised to take up composite programmes in which training is one component along with production and provision of services to the farmers. Isolated programmes of training are not likely to enlist ready response from the farmers. It has also to be emphasised that literacy programme should be functional, that is to say, related to the terms, forms and other specific needs of the farmer for carrying out a production programme.

g. Rural works programmes involving earth work, (and food for work projects) soil conservation, soil testing, and other similar activities should be undertaken not only by governmental organisations but also by non-governmental organisations concerned with youth, both institutional and non-institutional. In this connection it is important that programmes like the National Service Scheme,

Farmers' training is an essential component of the new agricultural strategy. It has to be production-centred and should also include agro-technical training skills.

Planning Forums in Colleges etc. of the Ministry of Education and Youth Services should also involve non-governmental organisations in the areas concerned.

For undertaking programmes of this kind, non-governmental organisations have to be given facilities for the training of their workers and leaders in the skills of planning, organisation, communication as well as in more specialised fields concerned with agricultural production. For such training, facilities already available at Universities, Gramsevak Training Centres and other Institutions should be utilised.

Organisations and Agencies

While recognising the value and importance of the net-work of extension agencies throughout the country under the Community Development Programme and stressing the need for their continuance, it may be pointed out that participation of people in agricultural production calls for supplementing of this structure by small professional groups of farmers and other kinds of primary producers bound by common operational interests and functioning at the grass-root level. These farmers' groups (for which various names can be used such as farmers' forums, farmers' discussion groups, farm radio forums and *Charcha mandals*, etc) may be small—15 to 20 members each—and should emerge as

both self-study circles and common service units as well as agencies for two-way communication with researchers and the administrators, etc. The responsibility for promoting such Farmers' Groups lies both on Government and non-governmental organisations and may be treated as an essential component of major production programmes.

Secondly, cooperative institutions which have already been showing signs of adjustment as called for by the challenge of the new strategy of agricultural production will need to play a more positive role not only by stepping up their loan programmes, but by widening their base among small farmers, and also by improving their efficiency through coordinated action with both *Panchayati Raj* institutions and the personnel of Agriculture Departments responsible for production of programmes and schemes.

Thirdly—apart from professional organisations of producers, it is necessary that the gaps in the *Panchayati Raj* system should be filled by the efforts of other non-governmental organisations at various levels. The validity of such organisations will lie in their having links with the grass-root organisations.

Efforts at State Level

In order to provide leadership and continuing source of strength to peoples' participation in various programmes visualised above, three steps perhaps at the State level may need to be taken:

1. Steps have to be taken to build up a cadre of qualified individuals who would be in a position to operate on behalf of non-governmental organisations in selected areas for initiating production programmes before they are taken over completely by the local communities.

2. In any national-level movement or organisation that may be launched, a dynamic and practical role of youth in food production and in solving food problems should constitute the core of its programmes.

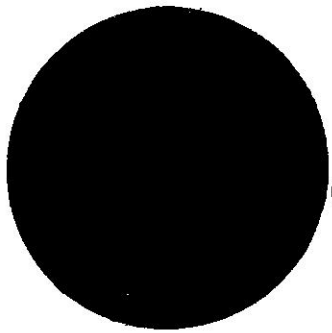
3. In policy formulations regarding agricultural production at various levels adequate considerations may be given to the problems and points of view of farmers, particularly of small farmers.

More than 80% of the population is constituted of farmers, engaged in different sectors of agriculture. Unless efforts are made to organise and discipline this large bulk of our population the socio-economic measures will not be translated into reality. This leads to the basic question of whether the Government as a matter of policy will grant recognition to organisation/organisations of farmers constituted for promoting the interests of farmers and farming community.

To afford adequate opportunity to all the farmers, commodity-wise and regional considerations will have to be kept in view also. With proper organisation, there is no doubt that the farmers will be able to pull their weight proportionate to their numbers in the State Legislature, and the performance of the elected representatives to promote the interests and causes of the farming community would receive more focussed attention at the hands of all political parties. □

The world is moving so fast these days that the man who says it can't be done is generally interrupted by someone doing it.

—Elbert Hubbard



cial Section

LABOUR PRODUCTIVITY

the tissue site, for which oxygen is essential. Thus the capacity of an individual to carry out work is dependent on his maximal capacity to utilize oxygen during exercise. This is generally referred to as 'Maximal Oxygen Uptake Capacity' or 'Aerobic Capacity'. Work Physiologists throughout the world have accepted 'Aerobic Capacity' as a measure of the work capacity of an individual. Even for Indian subjects of different age groups their capacity for work in terms of maximum work rate on a bicycle ergometer or their speed of work in professional tasks have been found to be dependent on their maximum oxygen uptake capacity as can be seen from Table 1. Whatever factors influence the aerobic capacity of an individual also influence his work output indirectly.

Table 1

RATE OF WORK DEPENDENT ON THE MAXIMAL OXYGEN UPTAKE CAPACITY OF INDIVIDUALS

	MAXIMUM			
Oxygen Uptake capacity (Lit/min.)	*Work rate Kgm/min*	*Arbitrary units of House. laying*	*Wet hose rolling*	*speed in Fireman's lift*
2.34	1180	2.97	2,39	1.30
2.11	1008	2.88	2.24	1.18
1.81	904	2.43	1.70	0.89
1.74	857	2.61	1.49	0.90

(Ramaswamy et al 1969)

Stature and Work Capacity

The Maximal Oxygen Uptake Capacity of an individual depends on the development of his heart and lungs and on the amount of muscle mass in his body or in general on his stature. This is obvious from the data reported for young Swedish boys and gymnasts and different categories of Indians, and reproduced in Table 2.

Table 2

INFLUENCE OF STATURE ON MAXIMAL OXYGEN UPTAKE CAPACITY OF INDIVIDUALS

Subjects	*Ht. cm.*	*Wt. kg.*	*Maximal oxygen uptake capacity lit/min.*	*References*
Young Swedish boys and gymnasts	145	40	2.3	Astrand 1952
	182	70	4.2	
	180	74	4.3	
	176	70	4.1	
	174	66	3.8	
Indian non-athletes	163	48	2.0	Ramaswamy *et al* 1969
	165	57	2.7	
Indian athletes	171	55	2.9	Ramaswamy *et al* 1970
	176	68	3.7	
Indian industrial workers	162	43	1.9	Saha 1971a
	173	61	2.6	

Naturally, an Indian worker with an average body weight of about 55 kg. as against the 70 kg. of his western counterpart, will have only 80% of the work capacity of the latter, if all other conditions are comparable. But, all other conditions are not also equal as will be discussed in detail.

In this context, it is advisable to evaluate the energy requirement in terms of oxygen uptake, of each of the major activities in industrial jobs and keep this as a guideline during recruitment of workers for these jobs. Men with relatively higher oxygen uptake capacity can be selected for high-energy involving activities, and the others for the less strenuous jobs. Such rationalisation is still to be tried in our industries.

Age Effect

Apart from stature, increasing age is another important factor which affects the physical work capacity of man. Studies carried out in India and abroad, have shown that at ages between 20 and 30 years, the work capacity is almost

steady and maximal and above 30 years it starts declining. This is a biological effect of age which is prevalent in all human beings as can be seen from Table 3.

Table 3

REDUCTION IN THE MAXIMAL OXYGEN UPTAKE CAPACITY DUE TO INCREASING AGE

Subjects	*Age*	*Maximal Oxygen uptake capacity (work capacity) (lit/min.)*	*References*
Indian Army personnel	20-30 yrs.	2.92	Malhotra *et al* (1966)
	31-37 ,,	2.69	
	38-43 ,,	2.39	
Indian Fire-fighting Personnel	21-25 ,,	2.35	Ramaswamy *et al* (1969(loc *cit*)
	31-35 ,,	2.27	
	41-45 ,,	2.01	
Dock workers	26-30 ,,	2.63	
	36-40 ,,	2.46	Saha (1971b)
	46-50 ,,	2.24	

That means the output potential in any industry where manual work counts, depends on the age pattern of the workers. Hence for jobs involving heavy manual unskilled labour, workers under 30 yrs. should be preferred and lighter jobs should be entrusted to older workers, or in other words, there should be a judicious fitting of the workers to their job situation. However, for jobs involving special skill and knowledge, it is not merely the physical fitness of the workers but also their experience, which will count. In the Indian industries, such rational approach is still to be introduced.

Nutritional Factors

The role of nutrition on the work capacity of an individual is well known. Sufficient intake of calorie, protein and B-group vitamins is very essential for maintaining man's capacity for physical work. In a classical study in the USA by Keys *et al* (1950), wherein carefully chosen highly-motivated volunteers were subjected to semi-starvation for 24 weeks, they lost 25% of their body weight. Along with this, their capacity for work as judged by Harvard Step Test was reduced to one-third. After 20 weeks of rehabilitation, even though their body weight was restored to the original values, still their work capacity was only 75% of the prestarvation values. Data provided by Keller and Kraut (1962) for Germany during the second war and and post-war days show that when a nation as a whole suffers from calorific inadequacy, this will seriously affect the industrial output of the nation.

It is common knowledge that the average Indian worker suffers from a certain degree of malnutrition, and hence will be incapable of much of physical exertion. One may argue that since most of the industrial operations are now-a-days mechanised, there is no necessity for much of physical exertion on the part of the workers. Whereas this may be true to some extent, still it cannot be denied that there are still many operations wherein manual labour is very essential. In this context one may have a rough estimate of the impact of food calories on the physical activity potential. Out of the daily food caloric intake of an average Indian worker, nearly 1200-1300 calories will be utilised to cover his minimum energy requirement during the 16 off-duty hours.

In light activities he will be utilising food energy at the rate of about 120 Kcls per hour and in moderately heavy activities at 180 Kcls per hour. Since during the shift work in modern industries the activity pattern of the worker will be a mixed one, we can put the average energy requirement at 150 Kcl/hour or 1200 Kcl, for the 8-hour shift. If the daily calorie intake of the worker is only 2000 Kcl, then 1250 out of this will go to meet the requirement during the 16 off duty hours and only 750 will be available to meet the requirement during the shift hours. This will enable him to work effectively for only 5 hours. If he is provided free food or subsidized food so as to enable him to receive an additional 450 Kcl, his effective work period will go up by 3 hours. Thus, from the productivity point of view, free or subsidised

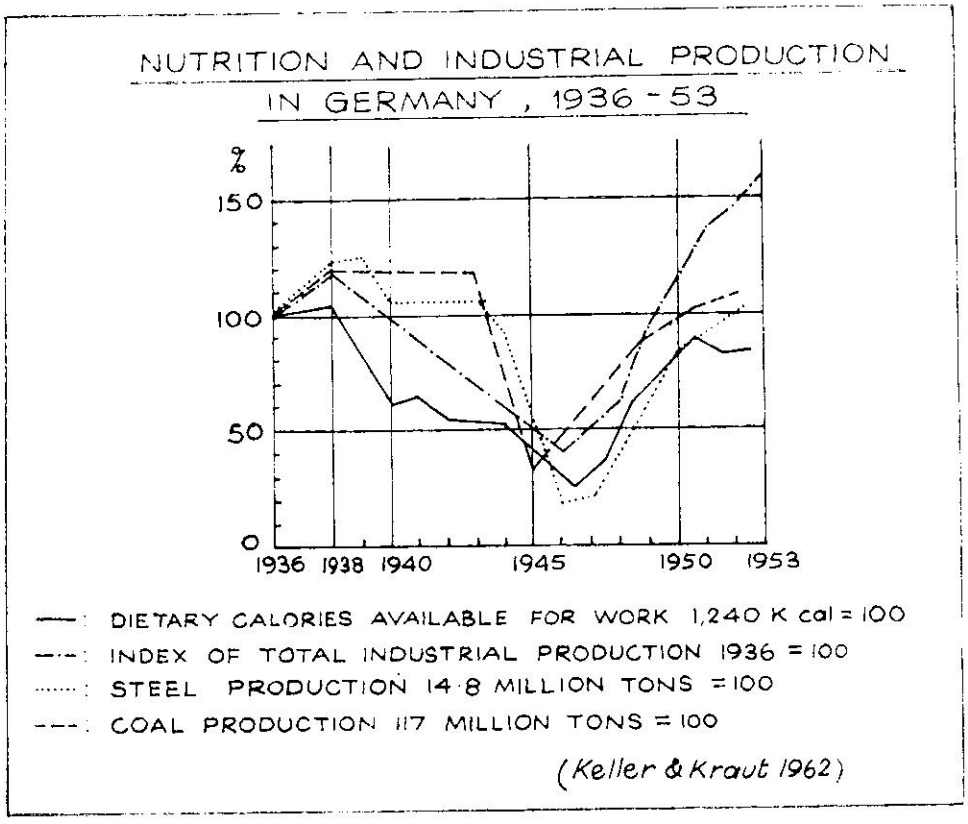


Fig. 1

meal, if provided by the management, will be a good investment.

Another important nutrient, depletion of which from the body will reduce the work output is 'water'. Studies carried out in Indian Industries have shown that a worker in the steel rolling mills may lose as much as 1 litre of sweat per hour during the shift (Sen *et al* 1966). In some sections of the textile mills, the sweat loss may be 0,5 litre per hour (Sen *et al* 1964). Unless such heavy fluid loss from the body is compensated, man's work rate will be reduced as will be discussed elsewhere in this paper.

Physical Factors

Apart from the biological and nutritional factors discussed, there are certain physical factors such as environmental heat, noise and illumination which influence the performance of man.

Thermal Stress in Working Environments and Work Capacity

An important physical factor which can be reasonably expected to reduce the work output is the thermal stress in the working environment.

The microclimate within the industrial premises is influenced by the outside environmental

conditions as well as heat sources inside. In the tropical climate of India the ambient environment in many parts of the country is very hot for major part of the year. Besides this, if there are heat sources as in steel and glass industries, foundries, etc. the total heat stress on the worker will be quite high. Added to this will be the heat produced within the body due to the physical activity of the worker. Of these, the environmental heat stress depends on the air temperature including radiant heat, if any, and the prevailing humidity and wind conditions. Specialists in heat studies have worked out a unified index called 'Corrected Effective Temperature' (CET) which takes into account all these three factors. A very early study carried out by the Chief Adviser of Factories (1957) in this country indicated the possibility that when the thermal stress in the working environments goes on increasing gradually from 78° F CET upto about 85° F, the workers involved in a moderate activity do not have any subjective complaints and there is no deterioration in the work output also. But when the temperature is increased beyond this, there is a gradually increasing expression of discomfort from the workers and along with it work production also starts deteriorating sharply. This can be seen from Fig. 2 where the results of the above study are reproduced. Other subsequent studies from the Central Labour Institute (Sen *et al* 1964; Saha 1970) at Bombay have shown that in many industrial environments the CET exceeds this critical value of 85° F. This means that unless measures are taken to keep down the effect of thermal stress on the workers, their output will be reduced.

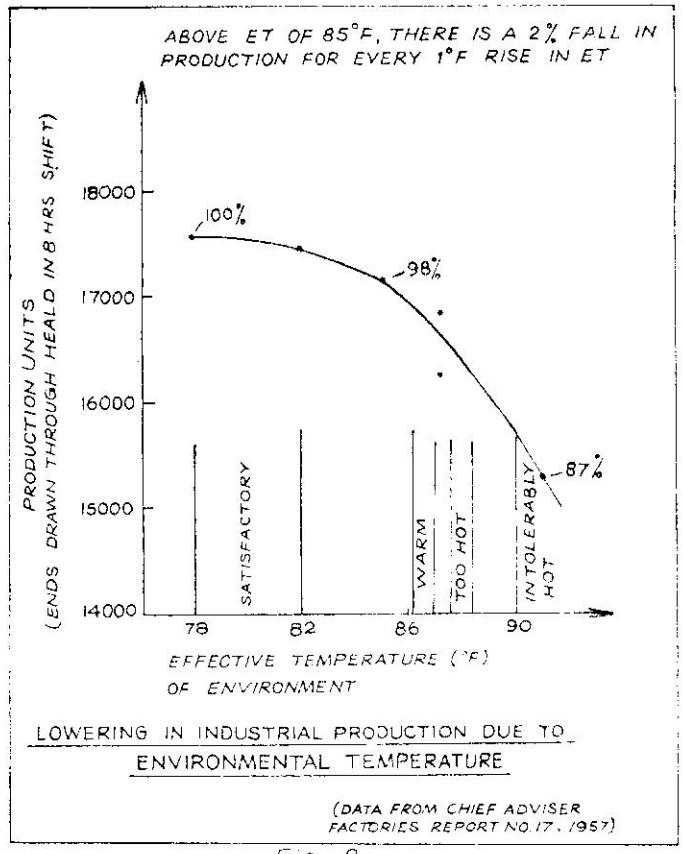


Fig - 2

One such measure is to isolate the heat sources wherever possible so that heat is not transmitted to the other parts of the plants. Where this is not feasible due to some reasons, other measures should be resorted to, such as introducing liberal and rational rest pauses so as to maintain the average rate of work at an optimal level ensuring minimal metabolic heat production and maximum total work turnover in a shift. The workers should also be encouraged and if necessary, forced, to drink as much of water as possible during the shift. If they are allowed to drink water *ad libitum*, they invariably do not consume enough water normally. If they do not consume enough fluid to compensate for the sweat losses and consequently suffer from dehydration, their capacity for work will be appreciably reduced, as can be seen from the following results reported by Craig and Cummings (1966).

Table 4

DEHYDRATION AND MUSCULAR WORK

Extent of dehydration	*Maximum walking time possible*		*Pulse rate*	*Rectal Temp.*	*Skin Temp.*
	Absolute	*%age*		*C*	*C*
0	8' 6"	100	196	37.5	36.0
4.3%	3' 57"	49	201	38.4	36.6

Noise

Yet another physical factor which we are normally prone to ignore is the prevailing noise in the working environments. Apart from its nuisance value, noise is also proved to cause hearing impairment in a large percentage of workers of the middle age group, who are chronically exposed to the hazard (Walworth 1967).

Apart from this, exposure to intense noise level during work shift seems to reduce the output of the workers. Thus (Weston and Adams 1935) have shown that under otherwise identical conditions, when weavers in a weaving shed with a noise level of 96 dB were made to use ear plugs their output was greater than when no ear plugs were used (Fig. 3).

Of course, the productivity under such situations may be affected by so many other factors also, like adaptation to the noisy environment, motivation and so on. However, these results suggest that probably even in the Indian work environments there is the necessity for periodic noise surveys; and where intense noise levels are monitored, possibilities of isolating the noise at the source itself and preventing it from the general working environment should be explored. If this is not feasible, then the workers should be issued personal protective equipments such as ear plugs or ear muffs of optimal design and they should also be motivated to make use of these equipments.

Table 5

HEARING IMPAIRMENT IN DIFFERENT AGE GROUPS DUE TO RISE IN OCCUPATIONAL NOISE LEVEL

	Percentage of population with impaired hearing			
	Age—grops			
	20-29	30-39	40-49	50-59
Non-Noise general populaion	3	5	12	22
Population exposed to noise level of:				
85 dB	2	8	13	23
90	3	9	16	28
95	5	13	22	36
100	7	18	29	45
105	8	27	40	58

(Based on data from HT Walworth 1967)

Illumination

Optimal conditions for illumination inside working premises, are also necessary if visual stress on the workers is to be avoided and accidents prevented. Under suboptimal illumination conditions, the rate of work and the total output may also be adversely affected.

Exposure to Chemical Pollutants, Fumes and Dusts in Working Environment

Besides the numerous factors discussed earlier, workers in many industries are exposed to toxic chemicals, fumes or dusts. It has been established that some of these chemicals such as sulphurdioxide and oxides of nitrogen affect the respiratory system of the man. Some others like benzene, lead and carbon monoxide reduce the haemoglobin in blood and thereby reduce man's capacity for work. In some other industrial situations the workers inhale toxic dusts such as silica dust, cotton dust and asbestos fibres all of which have a chronic effect on the lungs, thus lowering the respiratory functions of

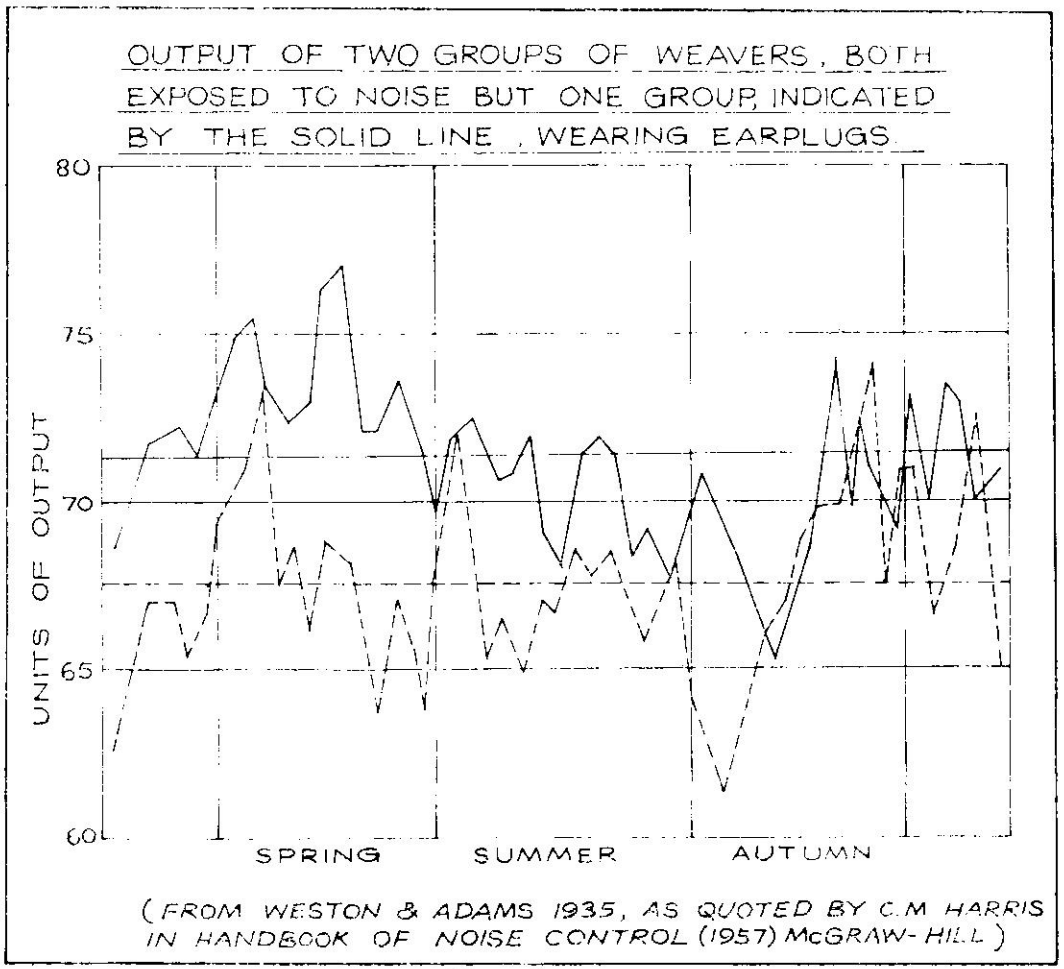


Fig-3

man. Experimental work carried out in India had shown that when the respiratory functions are lowered the performance capacity is also lowered (Table 6).

Even though we do not have statistics on the extent of actual lowering in the production capacity of the workers due to these chemical hazards, still we can expect a reasonable loss due to this factor until and unless some adequate preventive measures are taken. Such measures should include periodic assessment of the air-borne concentration level of such pollutants in the working environments, and implementing suitable control measures where warranted. Besides, there should be periodic medical examination of the workers to ensure that they are not afflicted.

Rationalised Rest Pauses During a Shift

Even though working at 50% of their maximal oxygen uptake capacity is the optimal rate to be maintained during an 8-hour shift, in actual prac-

There is a popular but wrong impression that only by offering incentives the output of the workers can be increased to their maximum level.

tice there are bound to be more strenuous work periods followed by rest breaks, which may be either scheduled or unscheduled. Current experimental data indicate that if rest pauses are to be really beneficial, these should not be in the form of long rest pauses at the end of prolonged and continuous work periods, but should be well interspersed between short work intervals (Christensen 1962). Further, it is essential that such rest is taken in rooms which are well separated from the working environments vitiated by atmospheric pollutants, heat and noise. In a tropical country like ours, it is further desirable, that such rest rooms are adequately cooled.

Table 6

WORK CAPACITY OF MEN AS INFLUENCED BY THEIR LUNG FUNCTION

	Subject groups			
	I	*II*	*III*	*IV*
Maximal Breathing Capacity-litres/min (Lung function)	153	132	118	100
Maximal oxygen uptake-litres/min (Work potential)	2.34	2.11	1.97	1.74
Speed index in a professional job	2.39	2.24	1.94	1.49

(Ramaswamy *et al* 1969)

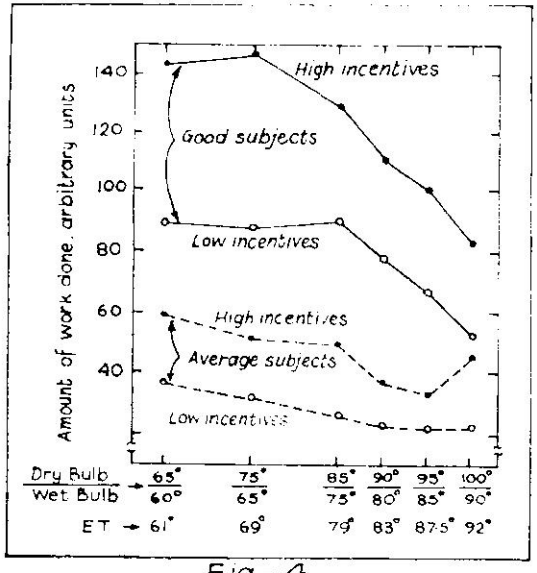


Fig - 4

Role of Incentives

There is a popular but wrong impression that only by offering incentives the output of the workers can be increased to their maximum level. So long as the biological and physical factors limiting the performance capacity are not remedied, offering incentives alone will have little effect. Fig. 4 reproduced from Mackworth shows that only if all the factors like maximal fitness, minimal environmental stress and high incentives go together, there can be the maximal output possible.

Conclusion

In conclusion, it can be stated that numerous factors in the Indian environment, some of them biological and some of them physical are res-

ponsible for the lower productivity of an average Indian worker. These factors are to be remedied by suitable preventive measures if we really want the productivity in the country to go up.

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"India is a great country and has inbuilt resources and capacity with which it can do things which are beyond the comprehension of many others in the world."

—Indira Gandhi

Sharing Productivity Gains

MR Meher*

It is a truism that higher productivity is the key to higher standards of living. In a developing economy, labour cannot build for itself and the community a better life except on the firm foundation of a higher level of productivity to which it has to make its contribution.

At the trade unions' conference held by the Ministry of Labour recently, the plea of the Union Labour Minister, Mr RK Khadilkar, to the trade union movement for increasing productivity and his emphasis on productivity bargaining evoked no response. Some of the labour leaders even suggested that increasing productivity was not their business.

It is true that the primary responsibility for raising production and productivity rests with the management. It has responsibility to raise productivity by proper organisation, improved equipment, systematic plant maintenance, improved materials, inventory control, waste reduction, proper personnel policy, etc. But the workers also have a stake in improving productivity and can make a substantial contribution to it. As observed by the Union Labour Minister in one of his statements, "It is time that the leadership of the trade union movement in our country woke up to an awareness of the needs of the present situation. If they have shown their zeal for protecting the interests of their members, let them take an equally aggressive interest in increasing production and productivity."

Replying to a question recently in the Lok Sabha regarding the alleged denial of fruits of increasing productivity to workers, the Minister said a precise measurement of the productivity of the different factors of production was, no doubt, difficult. It would, however, not be correct to assume that the workers had derived no gains from increased productivity. The Minister went on to say that for the workers to have their due share, along with other interests concerned, viz., the management and the consumers, in the gains from increased productivity, it was necessary that there should be, firstly agreement in principle on the imperatives of increased productivity and production, and secondly willingness on the part of employers and workers to get together and work out mutually acceptable norms, consistently with local conditions obtaining in given undertakings, for assessing as best as possible, the increases in productivity as well as the equitable shares of the parties in it. These observations sum up the correct position.

* 67, Adarsh Nagar, Prabhadevi, Bombay-25

It is understood that the Ministry of Industrial Development proposes to formulate a comprehensive plan to achieve higher productivity. The Minister for Industrial Development, Mr Moinul Haque Choudhury, disclosed this recently while inaugurating the first meeting of the reconstituted National Productivity Council. The Minister further said that the possibility of holding a seminar on productivity to ascertain the consensus among leaders of industry and trade unions as to the new directions to be provided for creating the most favourable atmosphere for higher productivity was being considered and that it was regrettable that an accepted formula on workers' share in the gains of productivity had not yet been arrived at.

Trade union leaders also have been emphasising the necessity of workers having a fair share in the gains of productivity, but there is no dispute on this proposition. Devising an acceptable formula on a national or a general basis for sharing the gains of productivity is not the problem. The difficulty is of measuring the gains of productivity. On the principles for evolving financial and other incentives to workers for increasing production and productivity, a great deal has been written by industrial experts and others. Nothing more remains to be said on the subject and no further research is needed.

Efforts by NPC

A tripartite committee set up by the National Productivity Council laid down the following guidelines for sharing the gains of productivity. It must not compromise the prospects of continued economic growth; it must not merely be a plan of co-sharing between management and labour, but also among consumers and society at large in the form of Government; it should be simple but at the same time anticipatory of difficulties to arise.

On the basis of the report of the Committee, the National Productivity Council suggested that, after making a provision to meet the interest of consumers, which should not exceed 20 per cent, out of the balance of the gains of productivity, labour should receive half in those industries where their wages corresponded to a fair or living wage, except that (a) where the wages were at a level below the fair or the need-based minimum wage, the share of labour should be larger, to be decided by mutual agreement and (b) where the industry has clearly built up a large free reserve the share of labour will be higher than 50 per cent of the amount available for distribution. After providing for consumer and labour interests, a portion should be reserved for the development of the industry and the rest should be available for remunerating capital.

It is difficult to apply the formula in practice. There would, for example, be a dispute as to what is fair wage or need-based wage. There would also be disputes as to the relative share of labour and capital, assuming for argument that the gains of productivity can be quantified. Moreover, sharing of gains has two aspects, sharing in production-proceeds which is covered by incentives to produce, and sharing of gains which result from the total operations. Labour already shares in the overall profits under the formula of the Bonus Act.

Even if there is an increase in productivity there may, in a particular year, be a loss where extraordinary factors play a big part. There may be good profit notwithstanding low productivity because of external favourable factors like market conditions. Higher production in a concern will not necessarily mean more profits, for financial results also depend on other factors such as the condition of market, the state of consumer demand, availability of fuel and power, cost of transport, Government controls, excise duties, etc. The efficiency of workers is only one of a number of factors contributing to profits.

The increase in production may not be due to increased efforts by workmen but due to investment in modernised machinery or in the rehabilitation of the existing machinery. It would always be difficult to determine the increase in productivity that could be attributable to the efforts of the workers. Besides, it would not be fair if labour is given the same percentage share in the gains of productivity, assuming they can be correctly measured, when the gains are due to factors like investment in better plant,

well regulated supply and good quality of raw materials, improved methods, diversification of products, etc. In so far as there is an increase in profit by these means the workers already share in the prosperity of the concern under the formula of Bonus Act.

Further, while there can be no question that productivity can be increased by suitable incentive schemes, where the conditions are favourable for the introduction of such schemes, incentive schemes are not suitable for all industries. There are industries where it is not feasible to link wages with productivity and time-wage is more suitable, for example, where the output of workers or a group of workers cannot be measured properly in defined units, or is subject to considerable interruptions, or where quality is more important than quantity, or materials are costly and instruments likely to be damaged by undue speed.

The fact is that any system for sharing gains of increased productivity or any system for linking wages with productivity is not capable of being laid down satisfactorily by any mathematical formula such as the one suggested by the National Productivity Council

As observed by one writer "The best antidotes against impediments in productivity are sound management, sensible unionism and the development of good industrial relations." Further, it has to be borne in mind that gains in productivity can be shared in other ways than by money payment, such as shorter working hours, welfare plans, etc. Each incentive scheme will have to be tailored to the particular circumstances of the factory or establishment, on the basis of time and motion studies or past performance or the rated capacity of the plant

Efficiency Level

As observed by the National Labour Commission, employers and workers should formulate a simple incentive system at the unit level on some agreed basis through collective bargaining. Wage incentives should generally provide extra earnings only after a mutually agreed level of efficiency has been attained. To ensure quality of production incentive payments should be generally allowed only if the output has been approved on inspection by the management. Relevant norms in this connection should be laid down. The worker's normal wage should be protected where it is not possible for him for circumstances beyond his control to earn an incentive.

Incentive schemes cannot be introduced to cover all occupations in all industries. The NLC has further recommended that the Government must pursue policies which will contribute to the promotion of sound collective bargaining, even at the risk of some possible conflicts. It is necessary to throw greater responsibility on employers and trade unions to resolve their disputes. It might be mentioned here that the nature of problems in the field of productivity techniques and incentive schemes is such that they can be best tackled by those who are directly concerned with the problems. Such problems cannot be anticipated and provided for once for all, but have to be dealt with, as and when they arise, on the shopfloor. Therefore, the conciliation and adjudication procedures are not helpful in tackling productivity problems. Besides, the technical nature of such problems makes it difficult for conciliation officers and adjudicators to deal with them properly.

Productivity bargaining has made great strides in the UK where trade unions have recognised that in the long run labour can get better wages and conditions of service only from increased productivity. In this country also there have been some agreements between managements and unions on incentive schemes, but there is scope for more such agreements. Higher productivity in an undertaking is a joint responsibility of the labour as well as of the management. Where union rivalry has not affected the social environment and where there has been good industrial relation, successful productivity bargaining can make a significant contribution to the prosperity of the industry and the well-being of the people who belong to it.

—Courtesy: *The Economic Times*

Productivity and Participation:

British Experiment in Productivity Bargaining

Campbell Balfour*

The twin aims of productivity and participation are desired by most industrialised countries in Western Europe, as well as a number of countries in South Asia, India, Ceylon and the Philippines among others. Yet, the problem of achieving those aims is more complex than it appears. Even in Western Europe, some countries have been more successful than others, with the Scandinavian countries leading in developments in workers' participation, while Germany, France and Italy have achieved high growth rates with a lower degree of participation.

WHEN we turn to developing countries such as India, with immense resources of manpower offset by the present difficulties of finding jobs for millions, and a considerable 'social distance' between numbers of employers and workers, how realistic can we say that the two objectives of Productivity and Participation are? The answer must be that present difficulties cannot and should not prevent some steps being taken now which will lead to greater progress in the future.

There is a need to raise real living standards urgently, both to feed and house the population more adequately, and also to realise the economic potential and national aspirations of India. For this, economic growth is necessary and is frequently stressed in the speeches of politicians of high rank. Yet, experience in the West has shown that productivity campaigns and speeches have little effect on production, except for short periods of national crisis. In peacetime conditions, workers rarely respond to abstract calls to work hard for the sake of the country. The goals have to be within their immediate frame of experience and psychologists point out that involvement is necessary for effective task work.

Productivity Bargaining in Britain

The most effective break-through in the field of productivity in Britain in the last few years has been the development of productivity bargaining. Although the emphasis is on increased production, the process also leads to an increase in workers' participation.

In negotiations with unions or workers, the older collective bargaining method centred mainly around changes in pay. Productivity bargaining examines the whole work situation with the aim of greater output or efficiency. It also examines efficiency of management as well as the working methods of employees.

Flanders defines management as "the art of getting things done by other people". Productivity Bargaining shifts emphasis from "keeping them quiet" to an active involvement in

* Senior Lecturer, Balfour University College, Cardiff (UK).

Agreement became the Rosetta Stone for British industry". It could be added that a large number of subsequent aggreements were far less successful than the Fawley Agreement had been, or that oil refining (Fawley) and other flow or process industries with high capital/low labour costs were the best areas for spectacular wage increases traded off against greater job flexibility and less manpower. Such industries also have a high growth rate and can afford yearly wage increases for workers without much difficulty. Discussion about productivity led to numbers of 'phoney' bargains where the employer got the bargaining without the productivity, and wage increases unrelated to productivity were approved by the Department of Employment and Productivity, not out of duplicity, but because the detailed figures for such calculations were not available. Some P.I.B. investigators who went to firms were struck by the fact that frequently few figures were available to measure the relationship between pay and productivity so that some rule-of-thumb assessment had to be made.

In spite of the 'phoney' bargains there were many genuine advances made in a number of industries, and unions and negotiators began to recognise that they must make a number of suggestions about job flexibility and interchangeability, about retraining and training of semi-skilled men to take up certain jobs, about overtime and absenteeism, about unnecessary tea breaks (an important rite in British industry and one of the stumbling blocks in many productivity agreements where the management complained that they were losing nearly an hour's work per day over this ceremony). The Board's study of 'Hours of Work, Overtime and Shiftworking' (Report No. 161, December, 1970, Cmnd. 4554) did much to convince industry that excessive overtime was a sign of managerial inefficiency, leading to slack work throughout the day in order to make overtime available, and making 'wage drift' inevitable.

The main advantage of productivity bargaining in this context is that it enlarged the area of collective bargaining and enabled management and unions to look at the totality of the work situation instead of arguing narrowly about wages and bonus rates. This was a new development in British industrial relations and was bringing the unions closer to the American form of collective bargaining.

Workers' Education and the Unions

Another promising development was that the unions began to display as much, if not more, interest in productivity bargaining than the employers did. The T.U.C.'s assistance was sought by the B.B.C. to make a series of short films about productivity bargaining, which discussed the principles and examined some cases. Thousands of booklets were printed and sold and hundreds of trade unionists were able to study the subject in day-release courses sponsored jointly by the C.B.I. and the T.U.C. Many of these were organised through universities and technical colleges. The effects of this mass-education programme are difficult to estimate, as the television programme was shown at off-peak times and was too simple for the active shop steward. Yet, it did make many workers aware of the possibilities of productivity bargaining and they may have been less nervous about discussing this with management in negotiations.

Significant Results

One result of the wider interest in productivity was that the wide-reaching and often lengthy discussions between workers and management led to a greater exchange of ideas and information in some industries than had hitherto taken place, and the management had to agree to provide information about production and costs of a complexity they had not been asked for before. This helped to break down the traditional barriers of hostility and suspicion which had led to strained relations in some industries.

Over the period of incomes policy more and more unions declared their willingness to negotiate in terms of productivity. A survey of union attitudes by Incomes Data Services Ltd. published in 1970 showed a contrast with the situation in 1966. "Now the situation is very different. Almost all unions are ready to co-operate to negotiate productivity agreements at plant level or to negotiate guidelines nationally."

(I.D.S. 'Study on Unions and Productivity Bargaining', January, 1970, p. 3). At the same time the survey said that few of them had the resources or staff to initiate such bargains themselves.

The T.U.C. issued a booklet on the subject (Productivity Bargaining, 1966) which dealt with the aims and characteristics of agreements, and dealt with a number of points such as gains to workers. "The wages of all workers covered by productivity agreements have gone up .." Wage structures in the plant can be changed by job analysis and evaluation. They pointed out that most productivity agreements "have been concluded in capital-intensive industries where labour costs are small in relation to total production costs and the demand for the products of the industry is increasing". (*ibid* p. 7). Bargaining in labour-intensive industries was more difficult and the purpose of the agreement was to reduce manpower. An interesting conclusion is that the line between joint consultation and negotiation can be crossed and the two processes merged, thus increasing 'union participation in the firm's decision-making'. The support of the T.U.C. for productivity bargaining helped the method to gain acceptance.

In practice there were a number of difficulties. While employers' groups and unions could agree nationally on pay and productivity guidelines, at local or plant level, firms were reluctant to feed figures about pricing policy, production, profits and costs into negotiations with national or district union officials. While more information was sometimes given to the local shop stewards, management still felt that a high degree of secrecy was necessary on some figures, which some of their competitors or large customers would be glad to have.

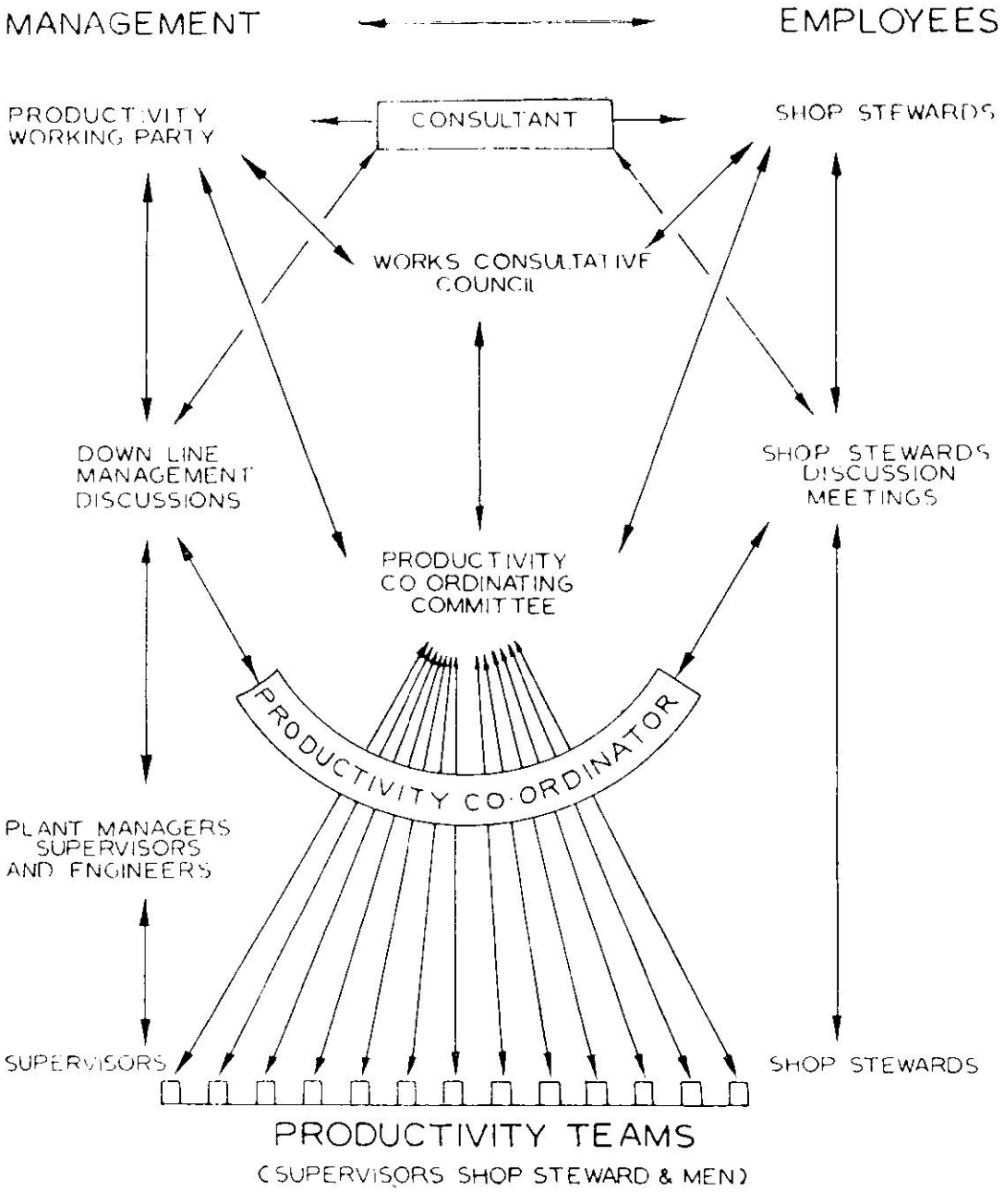
The spread of productivity bargaining did not mean that this followed the guidelines of incomes policy. The P.I.B. had meant this to be one of the corner stones of economic growth as they returned to the theme several times with an interim report (No. 23, December, 1966) and a full report ('Productivity Bargaining', Report No. 36, July 1967, Cmnd. 3311) followed by another ('Productivity Agreements', Report No. 123, August, 1969, Cmnd. 4136). The advice of the Board and the D.E.P. was that the benefits of the increased productivity should be a three-way split between employees, employers and customers with one-third going to each, so that the customer shared in lower or stable prices. In practice this did not happen, as the unions were unwilling and the employer preferred to put the customers' share into profits. The I.D.S. Survey says that "very little note is taken of any Government statements of policy on this question....The productivity bargain is universally regarded as a means of negotiating higher pay on the best terms." (op. cit. p. 4).*

Another defect was the failure on the part of management to achieve the productivity for which they had paid in advance. P.I.B. Report No. 36 says that there is a good deal of ignorance about costs on the management side. There was an imperative need for the managements to relate pay to output. Some managements underestimated the difficulties of measurement which could be caused by changes in materials, product-mix and changing raw material costs.

Yet, the fact that so many unions began to use the language of productivity, and acknowledge that such practices as excessive overtime, craft monopolies and restrictions on output, the need for inter-job flexibility and the reduction of overmanning, existed, was a major step forward. The mutual recognition of problems was the first necessary step towards their solution, although a number of unions were attracted to productivity bargaining as a means of extending trade union control and power in industry rather than as a means of fighting inflation. A large number of plant committees used these agreements to become virtually autonomous of national union control, and to strengthen their bargaining power. In spite of the spread of productivity bargaining strengthening some local unions, the agreements helped to stabilise industrial relations, as long-term commitments had to be undertaken by the unions as to the points agreed upon, and the amounts to be paid.

*For a detailed analysis of the position in India, see 'Sharing the Gains of Productivity' 1967, published by National Productivity Council of India, New Delhi

FLOW OF COMMUNICATIONS AND DISCUSSIONS ON PRODUCTIVITY



Productivity and the Firm

1. The firm can devise an agreement, discuss this at national level with the unions, and bring in the local workers for discussion at a later stage, or
2. The parent company can work out the detailed procedures to be followed, then ask the individual factories to consult at local level. This allows scope for local and technical differences, or
3. The Company provides a broad policy and the local firms work out procedures within the policy.

Participation Within the Firm

There are three possible approaches here. The first is that the management arrange the agreement with the Union officers, then put the idea to the men. Alternatively, the agreement can be worked out by shop stewards and management with the local union officials coming in on salary or wage negotiations. The scope of the discussions is passed on to workers' meetings. The third approach is one of wide participation, bringing in the workers and staff from the beginning. Productivity and participation are built up from the work groups in their different areas.

The third method, the joint problem-solving style, has been used by some firms. The writer has seen some examples of this. Communication was helped by the 'cascade' method, whereby committees met and discussed plans, reached agreement, then committee members reported to other committees, who in turn reported to others. In time each worker and staff member had heard directly about the new scheme.

In one factory, the management employed an industrial consultant, who acted as a bridge between the Productivity Working Party and the shop stewards. Both these groups were nominated to the Works Consultative Council. This in turn was advised by the Productivity Co-ordinating Committee. Below these were Productivity Co-ordinators and Productivity Teams, so that virtually every member was involved in talking and implementing the 'language of productivity'. (see Diagram).

The Language of Productivity

As said earlier, speeches and productivity campaigns cannot succeed in the abstract. Workers and managers believe that the appeal is to their neighbours and not to them. This is why involvement at all levels of the firm in productivity changes is so necessary.

Workers' education and discussion groups within the firm can play an important part in linking the concepts of pay and productivity. These concepts should be dealt with in a straightforward manner, so that management is not open to the charge that higher productivity benefits the firm more than the workers. It should be pointed out that questions of taxation of profits are a political matter and should be left to the politicians.

It is important to present some simple ideas of the company balance sheet as some union leaders can persuade their members that the wage demand creates its own money supply for payment.

The Government can play an important part in this by showing the relation between prices, profits, wages and production. In times of economic or political crisis, a wage-price 'freeze' for a short period is an effective method of persuading unions and management to justify higher wages by higher productivity. The Government and industry should also stress the creation of new job opportunities.

As discussed earlier, the traditional collective bargaining centred around changes in pay. Demands were based on the standard of living, the cost of living, comparative wages and profits, although the first three are not related to productivity, and profits can rise for a number of reasons.

Bargaining on productivity (efficiency in service or clerical sectors) forces the bargainers to use the language of productivity and justify their demands by reference to the real situation in the firm and not to conditions elsewhere. Unless this is done by as many firms as possible in the industrial sector, the bargainers are, in the words of one Indian, 'not distributing wealth, but distributing poverty'. □

Inter-Regional Differentials in Labour Productivity

Promod Verma*

Empirical evidence suggests that productivity differentials are an important variable in the explanation of wage differences between states. Rising productivity enhances the ability of an industry to pay more wages. But it is hardly recognised that higher wages may also induce greater productivity. Thus wage-productivity-wage spiral might explain the growth of high-wage industries. A concentration of such industries in any particular region would thus exhibit the simultaneous occurrence of high wages and greater productivity than the national average.

The objective of this exercise is to explain the reasons for inter-regional differentials in labour productivity. An attempt has first been made to analyse productivity differentials in 1950 and in 1960. A comparison is then made between these two points in time. Thus, this study is essentially a cross-section and comparative static exercise. Later on, a correlation anaylsis is presented to identify the factors which explain productivity differentials. Some policy implications have been raised in conclusions.

It may be noted that "labour productivity" is measured as net value added per worker. This is essentially a statistical concept. Many factors of production contribute to output; one could therefore compute both output worker and output capital ratios. These are partial ratios. Thus labour productivity as a statistical measure does not imply the subjective elements of labour efficiency. Nevertheless, insofar as the willingness and ability of workers to adjust to new technology is concerned, workers' cooperation gets reflected in higher productivity.

Productivity Indices

The data on net value added and production workers are drawn from the annual industrial surveys conducted by the Government of India. Until 1958, the reports were published as the *Census of Indian Manfactures*, but since 1959 they have been enlarged in scope and published under the title of *Annual Survey of Industries*. Apart from the fact that industrial coverage was changed from 1959, a greater statistical problem is presented by the fact that the States were reorganised in 1956. There were readjustments in the existing boundaries of large States—the smaller contiguous States were merged with the larger ones.

Having obtained data from the above-mentioned sources, the following formula was used to arrive at the index of productivity:

$$P_s = \frac{V_s/E_s}{V_y/E_y}$$

where P_s—index of labour productivity for a State

V_s total net value added for a State

* Professor, Indian Institute of Management, Ahmedadad

E_s = total employment of production workers in a State

V_y = total net value added for all States

E_y = total employment of production workers in all States.

The productivity indices are provided in Tables I—III.

Table I

Inter-regional Productivity Differentials, 1950

States	*Net value added (Rs. lakhs)*	*No. of production workers*	*Index of productivity*
West Bengal	7644	4,46,950	88.45
Bombay	10484	4,91,225	110.38
Madras	2604	1,60,984	83.65
U. P.	2554	1,45,835	90.58
Bihar	3054	86,523	182.56
Punjab	390	23,935	84.46
M. P.	562	45,864	63.44
Orissa	152	9,788	80.58
Assam	83	4,913	87.87
Delhi	439	21,927	103.71
Ajmer	46	5,974	40.34
Vindhya Pradesh	6	512	63.61
Travancore-Cochin	50	5,568	46.95
PEPSU	182	8,934	112.62
Himachal Pradesh	3	354	54.20
Rajasthan	96	9,023	55.25
Kutch	8	323	135.07
All states	2,83,92	14,68,334	100

Source: *Census of Indian Manufactures* 1950.

Table II

Inter-regional Productivity Differentials, 1960

States	*Net value added (Rs. lakhs)*	*No. of Production workers*	*Index of productivity*
Andhra Pradesh	2331	1,27,824	54.15
Assam	2564	58,212	131.51
Bihar	6049	1,33,096	135.70
Gujarat	8802	254,284	103.35
Jammu & Kashmir	7793	6,891	33.76
Kerala	2114	1,21,083	52.13
Madhya Pradesh	2088	77,827	80.11
Madras	6176	1,87,649	98.27
Maharashtra	23833	5,75,802	123.57
Mysore	2633	92,616	84.88
Orissa	846	22,558	112.02
Punjab	1668	60,922	81.78
Rajasthan	871	37,916	68.63
Uttar Pradesh	5572	2,04,383	81.39
West Bengal	1·9313	5,82,124	99.05
Delhi	1379	35,340	116.55
Himachal Pradesh	9657	1,317	218.92
Tripura	15	755	60.08
All states	8,64,37	25,80,599	100.00

Source: *Annual Survey of Industries*, 1960.

In 1950, above-average productivity indices were found for Bihar, Kutch, PEPSU, Bombay and Delhi (Table I) The low-productivity States identified were Ajmer, Travancore-Cochin, Himachal Pradesh, Rajasthan, Vindhya Pradesh and Madhya Pradesh. Among the high-productivity States, Bihar and Bombay stand out prominently if one disregards the smaller States. Similarly, Rajasthan and Madhya Pradesh can be singled out as low-productivity States, if the smaller States are disregarded.

Table III

Change in Productivity 1950-1960

States	*Percentage change*	*Rank*
Andhra	12.6	13
Assam	133.6	2
Bihar	30.3	12
Maharashtra	93.9	6
Gujarat	62.1	10
Kerala	92.3	8
Madhya Pradesh	105.6	4
Madras	103.6	5
Orissa	118.1	3
Punjab	73.9	9
Rajasthan	150.8	1
Uttar Pradesh	55.0	11
West Bengal	93.0	7

Source: Tables I & II.

1960 data (Table II) suggest that above-average productivity was experienced in the following States: Himachal Pradesh, Bihar, Assam, Maharashtra, Delhi, Orissa and Gujarat. The low-productivity States were: Kerala, Andhra Pradesh, Tripura and Rajasthan.

In Table III an attempt has been made to measure the change in labour productivity. The following States experienced high productivity increases: Rajasthan, Assam, Orissa and Madhya Pradesh. It may be noted that these States have progressed from a low level of productivity. It is clear that despite higher rates of increase in productivity, these states did not achieve the level of high-productivity States. On the other hand, the high-productivity States exhibited moderate rate of increase in productivity.

The analysis provided thus far suggests that the structure of regional productivity is characterised by wide differentials. In 1950, the lowest productivity index was 40.34 and highest productivity index was 182.56. Similarly, in 1960, the lowest productivity index was 52.13 and the highest productivity index was 218.92. Thus the range was substantial in both years. Higher rates of productivity growth in low-productivity States did not change the situation appreciably.

Correlates of Productivity Differentials

It is customary to analyse growth in output by the method of estimating production functions. But in this analysis we are concerned with output per worker (productivity). Thus a variant of production function approach may usefully be employed. The following model can be proposed:

$$(1) \quad P = f(W, K)$$

where P = net value added per worker

W = wages per worker
K = capital per worker

The model suggests that productivity and wages are positively correlated. A change in wages should bring about changes in productivity. There is ample reason to believe that, *ceteris paribus*, incentive payments result in higher productivity and lower unit labour costs. However, the fact that wages are paid out of the net value added does introduce a simultaneity bias in the estimation of regression coefficient of wages.

It is also suggested that capital intensity tends to influence productivity. An improvement in the quality of capital or an increase in the stock of capital without a concomitant increase in number of workers employed would certainly result in more output. Since output increases but the number of workers remains constant, output worker ratio (productivity) tends to increase. Productivity and capital intensity are therefore hypothesised to be positively correlated.

Two other independent variables may also be considered. First, the existence of a developed labour market may indirectly affect the productivity in any region. In an industrialised region, the availability of required manpower is an added advantage, although high wages might deter firms from moving into high-wage States. However, the advantage of locating in an already-industrialised State overcompensates for such a disadvantage. An indication of developed region may be provided by the ratio of non-primary employment to total population in any region. Second, the existence of a strong trade union movement may also exert an indirect influence on productivity. The acceptance of technical change and of the very industrial way of life is made easier by industrial organisations such as a trade union. In order to elicit the willing cooperation of workers in raising productivity, the employers have often to seek the intervention of trade unions.

The theoretical model can now be re-stated as follows:

$$(2)\quad P = \beta_0 + \beta_1 W + \beta_2 K$$

$$(3)\quad P = \beta_3 + \beta_4 N + \beta_5 T$$

where P = net value added per worker

W = wages per worker

K = capital per worker

N = non-primary employment as a proportion of total population

T = trade union membership as a proportion of non-primary employment

$\beta_{1\ldots n}$ = regression coefficients, with $i_{1-2} > 0$; $i_{1-5} > 0$

Equations (2) and (3) will be estimated by the method of ordinary least squares. However, in order to reduce the simultaneity bias between productivity and wages, an attempt will be made to use the method of two-stage least squares. The two stages will be as follows:

$$(4)\quad W = \beta_6 + \beta_7 T + \beta_8 N \quad (\text{obtain } \hat{W})$$

$$(5)\quad P = \beta_9 + \beta_{10} \hat{W} + \beta_{11} K$$

It may also be indicated that computed ratios will be provided below the regression coefficients and that the significance levels of the coefficients will be as follows:

* = significant at 1% level

** = significant at 5% level

*** = significant at 10% level.

Productivity data already presented are drawn from industrial surveys. The same sources are used to construct indices on average wages and capital intensity. Data on non-primary employment are taken from the Census of Population, while figures on trade union membership are derived from the Ministry of Labour estimates.

Regression results for 1950 are provided in Table IV. In equation (6) the regression coefficient for wages is found to be significant at 1% level. Although the coefficient for capital intensity has the correct *a priori* sign, it is insignificant. The coefficient of determination, corrected for the degrees of freedom, turns out as .604. Thus, the two variables explain about 60% of the variation in productivity. Equation (7) suggests that average wage itself explains almost 60% of the variation in labour productivity. Consequently, the role of capital intensity is found to be almost negligible in the explanation of labour productivity. This observation is corroborated by equation (8). The regression coefficients for other explanatory variables are also found to be insignificant. Equation (12) is computed by the method of two-stage least squares. In this equation, the regression coefficient for wages remains significant.

TABLE IV

Regression Results, 1950

Equation Number	*Dependent Variable*	*Constant*	*Regression coefficients*					R^2	S.E.E.
			W	*K*	*T*	*N*	*W'*		
6	P	−34.89	1.20* (4.29)	.138 (1.09)				.604	21.354
7	P	−13.24	1.667* (4.157)					.596	21.566
8	P	76.938		.077 (.373)				.081	35.374
9	P	93.941		.053 (.283)	2.231 (1.236)	−.974 (.951)		.037	32.335
10	P	111.561			1.908 (1.04)	−.1231 (1.225)		.126	31.761
11	W	96.765			1.758*** (1.440)	−.665 (.990)		.164	32.231
12	P	1.535		.062 (.352)			.838*** (1.841)	.126	30.813

TABLE V

Regression Results, 1960

Equation Number	*Dependent Variable*	*Constant*	*Regression Coefficients*					R^2	*S.E.E.*
			W	*K*	*T*	*N*	*W'*		
13	P	26.633	.514** (2.54)	.183*** (2.07)				.618	16.173
14	P	26.748	.740* (3.842)					.514	18.256
15	P	59.321		.304* (3.379)				.445	19.513
16	P	75.064		.197*** (2.407)	2.438* (3.460)	−.772 (1.498)		.697	14.404
17	W	106.994			1.818 (1.62)	−1.20 (1.56)		.141	31.231
18	P	−91.192		.184 (1.02)			1.772*** (1.849)	.127	30.786

TABLE VI

Regression Results, 1950-1960

Equation Number	*Dependent Variable*	*Constant*	*Regression Coefficients* W	K	T	N	H	R^2	*S.E.E.*
19	P	80.607	.585 (1.531)	—.183 (1.527)				.103	38.18
20	P	66.635	.361 (.968)					.005	39.061
21	P	102.687	—.113 (.963)					.006	39.386
22	P	177.033		—.111 (.851)	.2626 (.723)	—2.551 (.827)		.171	42.487
23	W	41.889		.086 (1.169)	1.988 (.957)	—4.541 (2.560)		.354	24.459
24	P	77.144		—.194 (1.424)			.676 (1.308)	.019	38.897

The results for 1960 are set out in Table V. Equation (13) shows that both wages and capital intensity are significantly correlated with productivity. The coefficient of determination is 0.618. The regression coefficients for both these variables are found significant in bivariate relation with productivity. In equation (16) regression coefficients for capital intensity and trade union membership are found significant, but the coefficient for non-primary employment is insignificant. In this equation, the coefficient of determination has increased to 0.697. Equation (17) has been estimated by the method of two-stage least squares. The regression coefficient for wages remains significant in this equation.

Regression analysis for an explanation of changes in productivity over the period 1950-1960 has not turned out to be satisfactory (Table VI). In equation (19) the coefficient of determination is extremely low. However, the regression coefficient for average wage has the correct *a priori* sign. On the other hand, the *a priori* sign for capital intensity is wrong. Equation (22) shows that the *a priori* sign for trade union membership is correct but the regression coefficient is insignificant. Consequently, none of the independent variables is statistically correlated with the dependent variable.

Conclusions

The data analysed in this paper suggest that during the fiftees, there was wide inter-regional differential in labour productivity. It was found that these differentials in 1950 could be explained by wage differentials. In 1960, several variables were found statistically significant: wages, capital intensity and trade unionism. In general, the statistical analysis supported the hypothesis that productivity differentials tend to be associated with differentials in wages on one hand and capital intensity on the other. The three variables are therefore highly interrelated.

There are various policy implications which

should be noted. In order to raise labour productivity, it may be necessary to establish those industries in which both average wages and capital intensity are high. The analysis highlights the relevance of wage incentive schemes which accomplish the simultaneous increase in productivity and in wages. The analysis also suggests that technological change (an increase in capital/labour ratio) should raise productivity.

In should be noted, however, that the low-productivity States are characterised by labour surplus and by concentration of low-productivity industries. If capital intensity increases in these States, the unemployment situation might further worsen. In the long run, the location of high-productivity industries might create additional demand for labour.

In the short run, introduction of wage incentive schemes seems to be an appropriate policy to encourage growth in labour productivity.

EMPLOYEE GOODWILL

If the supervisor does not listen and offer some encouraging advice or help, employee goodwill can be seriously damaged. For example :

The president of a company passed a group of employees on his way to lunch in the plant cafeteria. Nodding to them—in anticipation of some sort of thanks for the wage and fringe benefits improvement announced that morning—he was dumbfounded to hear one employee say: "I appreciate the increased benefits, Mr. Jones, but I'm more interested in getting my supervisor to order some modern overhead lighting for our department."

Another employee said : "I didn't ask for extra life insurance. I've been asking my supervisor for the last few months to have my worktable fixed so that it doesn't rock."

Another commented : "All winter I've asked my supervisor to look at the radiators near my work station. The wind comes in the windows and gives me a stiff neck. I'd rather be warmer than get a wage raise."

Obviously, listening and a little action would have accomplished much in this situation. The supervisors who seem to have the most whole-hearted support of their workers (who can motivate the workers to produce more than the minimum or who call forth better quality and so forth) are the ones who do not wait for worker complaints and suggestions to come to them. They go out, making themselves available to workers and listen.

—Management Review, March 1970.

Impact of Management Decisions on Labour Productivity

RP Khandelia*

The declining rate of productivity increases in Indian industries warrants investigation into operation management decisions, labour psychology and their attitude towards work. An attempt has been made to identify and explore some of the areas that impede productivity and to suggest remedial measures.

THE poor growth rate of 3% achieved by the Indian Industries during 1969-70 as against South Korea (15%), Taiwan (10%) and even tiny neighbour Ceylon (8%) is rather a sad revelation. The output per head of the advanced countries is at present twelve times that of less advanced, and if existing trends are any indication, it will be eighteen times by the end of the century. Conversely, the population increase in less advanced countries, is 1.5 to 2 times that of advanced countries lowering our standard of living in goemetric progression of 18. To quote Mr EPW da Costa of Indian Institute of Public Opinion and the Market Research Corporation of India, an agricultural bias to our plans and economic policy can only save us from the not-far-off disaster. It was only with the green revolution that the vicious circle of low income—low saving—low capital could be broken. Intensive industrialisation will only serve to complicate the issues.

To strike a balance between the two, the Indian Government has been guided more by the 'Slogan of the Day' coined by certain political parties and then by any evaluation—analytical or conceptual—made by the specialists in respective fields. The productivity of the Nation has been falling at an alarming rate in certain areas: the most crucial being the Durgapur Steel Complex running at 30% installed capacity today. An attempt to evaluate many facets of the problem and submit a constructive and practical approach on all-India basis has by far been lacking and possibly not even ever seriously made.

Certain aspects of labour productivity have been considered here and the effect of 'Management Decisions' on labour psychology and practice enumerated in detail. Decisions lacking critical technical examination and analysis act as a big retarding force and lead to labour inertia. Therefore, the factors of production having a direct bearing on 'PRODUCTIVITY' (Labour productivity in our case) must first be identified before attempting to assess their impact.

In the words of the late Mr Russel of Union Carbide (India): Productiviy is that balance between the factors of industry which will give maximum output for the smallest expenditure of resources, whether these resources are considered in terms of Men, Money, Materials, Machines, or Time.

The 'Employee Productivity' can now be defined as the volume of output that a business concern achieves per hour of work, the level of output being dependent upon men, machines, and methods.

With the background laid out as above, we shall now examine 'Operation Management

* Hindustan Motors, Uttarpara, Hooghly Distt, West Bengal.

Decisions' that influence productivity, with emphasis on labour productivity.

Cash Investment Automation

Mechanisation and automation of industries to produce at mass scale to meet growing demand for the products in the local as well as international markets, technological substitution of processes, equipment rendered obsolete with the latest developments in design and operating methods, replacement of equipment that have outlived their economic usefulness are some of the factors adding up to the formation and installation of more and more complex, automatic and capital-intensive industrial and manufacturing units. The investments in such units have reached the high range of Rs. 30,000 to Rs. 60,000 per worker employed in India. Thus unutilised, underutilised and unattended equipment will lead to a considerable lowering of capital-productivity. Besides, a plant full of outmoded equipment that restricts and restrains productivity will undermine a company faster than anything else. Many company managements still believe that once a machine has been fully depreciated, it costs less to keep it running than to purchase a new model. In majority of cases this is not true. There are others who do not regularly examine and challenge the right of each equipment/machinery to the floor space it occupies.

Also, in India, we have failed in our attempt to effectively bring down and arrest the prices of essential commodities even after resorting to intensive automation of consumer product industries. This has over the period led the labour to believe that automation leading to production at mass scale instead of providing relief to them in the form of reduced costs per unit only serves to accentuate growing unemployment among them.

Lack of initiative for diversification of products and orders to balance surplus plant capacities besides stagnant production schedule maintained year after year by many company managements equipped to produce economies has resulted in forced idle labour and contributed towards unutillised/underutilized capital productivity, thereby lowering the company's whole RCI (Return on Cash Invested). A high asset utilisation ratio will automatically have a beneficial effect on the Return on Cash Invested. Conversely, if more cash is invested in plant and machinery there will be an adverse effect on the Asset Utilisation Ratio and likewise on the Company's RCI.

Therefore, it is imperative to (i) check the utilisation of every expensive piece of plant and machinery and (ii) squeeze more production or service from it. In the words of a well-known company chairman "Use Your Machinery Round the Clock (and Use Effectively); Flog it: Junk it: Replace it". In other words, make sure that you use your capital most effectively.

It is clearly to great commercial advantage to predict and effect substitution, because it enables a company to come in with a new technology, while its rivals continue to develop the existing one to the point of diminishing returns. Limitations of extrapolation from future trends make predicting substitution difficult. For technological forecasts to be of value, they must cover not only the effect of a technological change within its own field, but also its impact on the society as a whole.

The basis for investing in new equipment can be to reduce the manpower requirements. To know this, one way is to audit each new machine at an appropriate time to determine whether it is actually producing the economies expected of it. Another method is to establish whether the labour costs are declining as a percent of sales and if this saving is greater than the increase in the plant's depreciation expense. If the equipment of a plant have been depreciated over 50%, the plant can be said to be producing with old and outmoded machinery, resulting in high cost of production. And the management must go for new investment. However, mechanisation of a unit or replacing the existing machines by those with higher productivity, after manning, is harmful since a portion of labour

employed is rendered surplus. In such situations, alternative employment to these workers has to be found within the plant. This might not cause any serious problems for an organisation taking up expansion programmes in the very near future but will, otherwise, lead to forced idle labour, thus defeating the very purpose of investing in new equipment.

These apart, management sometimes goes in for complex, sophisticated, and costly machines but fail to synchronise the same with the allied services costing, perhaps, 1 to 5% of the cost of the main equipment, viz, handling facilities, loading and unloading devices etc. resulting in restricted over-all productivity. By the time, the facilities are planned, designed, procured fabricated and put into operation, we would have at least lost some of their value. The loss sustained due to delayed commissioning of the process equipment, may be, for small reasons, such as above, is generally ignored which at times is many times more than the original value of the equipment itself.

Unbalanced plant capacity in different work centres/manufacturing departments will also be conducive to restricted employee productivity which can be no higher or better than the collective performance of each section or division. This will result into over-all slackening of efforts in the divisions with capacities higher than other sections entailing loss of capital and labour productivity. Besides, analytical evaluation becomes more difficult as business becomes more complex, interdependent and sensitive to a wide range of internal conditions and external forces like wrong and unbalanced equipment buying policy, non-availability of raw materials in time due to faulty order planning, fluctuating and unstable market trends and, above all, failure on the part of management to gear itself and the systems to suit these. Analytical mistakes are more costly in a competitive economy where profit margins tend to narrow down. Complacency as well as wishful evaluation lead to potential perplexities.

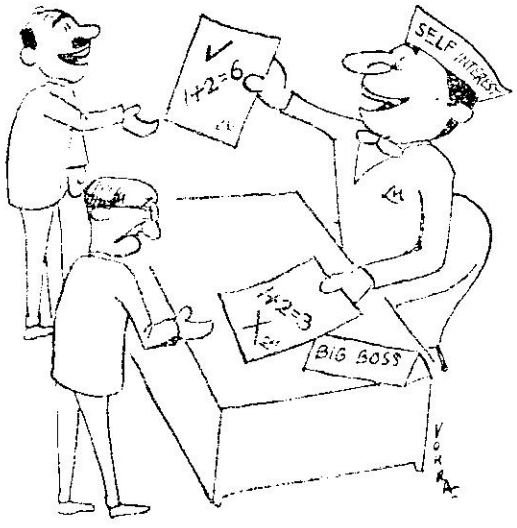
A correct analytical appraisal and scientific recommendation demands considerable management compatibility, imagination and accomplishments.

If the county is to be spared from economic woes, spiraling inflation and economic distress that accompanies low industrial productivity, a sense of service, mutual respect and consideration has to be created between labour and management.

There could be other reasons like ineffective preventive maintenance programmes, sales turnover, inadequate inventory maintained for toolings and other accessories for which management bears a direct responsibility and the operator is made to suffer his daily earnings.

Wage Increases

The industries, today, are faced with the critical problem of material-wage cost spiral. Earnings per manhour have been outpacing productivity gains. In 1969, productivity in manufacturing industries rose by 2.9%. During the same period, wages soared 5.8%. This widening gap between productivity and compensation led to inflation, dwindling profit-margins and falling "real" take-home pay increases. The imbalance between lagging productivity and booming labour costs also manifests itself into



spiral price increases, leading to decreasing ability to compete in the international market. We can compensate for at least a portion of our increased labour costs by stressing increased productivity. But raw materials cost, which includes downstream producer's increased costs cannot be absorbed. And thus, the standard of living for the average worker is actually deteriorating because the cost of his necessities are increasing at a faster rate than his take-home pay. In the words of Mr Harold Wilson, former Prime Minister of Britain, "One man's wage increase is another man's price increase". The cost of living rises. The result is a wage-price spiral that appears to have no end. And after a worker retires on a fixed income, the trend he helped start will continue to deflate his fixed retirement benefit. The local unions, therefore, must be convinced that the magnitude of labour wage increases can only be a function of reduced operating costs and a comparable gain, at least, in labour productivity.

On the contrary, the strength and motives of Indian Trade Unions have been reflected in their overriding demands for increased wages for the same or even less effort. This apart, all attempts to link fall-back wages with some base productivity index have been turned down outright. The operating class, by now, has reached a safe subsistence wage level without, of course, assuring management any production level in return. This has not only resulted in growing indiscipline among them but the whole factory atmosphere is being vitiated to meet political ends. In this context, let us not forget that a staggering 19 million mandays were lost last year in this country. The Indian Trade Unions should not act more as political institutions to meet political objectives, but should engage themselves in educating workers and serve the national tasks.

The Government and the managements on their part must emphasise the growing need to link guaranteed wages with some minimum productivity index, failing which it might become difficult to put the already sick industries into gear. For favourable productivity, machines must run for a higher percentage of the time. Idle machines do not stop the cost of ownership, obsolescence, taxes, insurance etc.

Many companies are also stripped bare by the overtime racket. The maintenance department puts in more overtime than practically any other section. And this occurs even though the average maintenance department is only 40% efficient. It may, however, be understandable to give maintenance departments some overtime but our industries have to comply with labour demands even in production shops in spite of the fact that the achievable capacities in these work centres are 2 to 3 times that already tapped. The managements must not resort to overtime practice to meet production schedules unless machines have been worked to their full capacities.

It is true that the capacity of the industries to absorb demands for higher wages has been responsible for initial labour wage rises. But it is difficult to sustain these through long periods. Workers/Unions should not be let to think that they can get their demands for higher wages met, without any increase in productivity on one pretext or the other.

A company can gauge its performance—

(i) by comparing the increase it has been able to make on its sales per average employee against the increase achieved by all national manufacturing concerns (if selling prices have not changed much, an increase should show progress);

(ii) by analysing average cost of employing each person (wages plus benefits).

If employment costs are not rising at a faster pace than sales generated per employee, the company should be in good shape. Actually, a 50% gap between these two ratios is desirable. Value added by manufacture (VABM) per production worker manhour, or per rupee of wages, is, however, the best method of measuring a plant's productivity. This ratio also helps in comparing the productivity of different plants making the same type of product.

But unless the present recalcitrant attitude of working class changes to more constructive outlook and a sense of belongingness and responsibility comes to prevail, there seems to be no escape from the existing employer-employee impasse. Today, no country seems to be immune from strikes. Of all industrial nations, only Japan could be said to be free of costly strikes.

Working Conditions and Employee Welfare

A company that does not sprue up its plant and offices and make them attractive work places is going to pay a price. For a higher rate of productivity, absenteeism should be below 3%, tardiness below 2%, and turnover below 19% annually. To accomplish this, the management must feel concerned about occupational facilities, living conditions and cater to the psychological needs of workers by finding ways of instilling a sense of skill, variety, responsibility and achievement in what are now tedious, boring and mundane jobs. Setting up work involvement programmes will help. There is a definite correlation between the physical well-being of employees and how much they produce. It does not cost much to provide good lighting, ventillation, noise control, pollution control, wisely and attractively painted walls, machinery, floors, etc. Employees usually work best when the temperature ranges between 68° and 70 F with 50% relative humidity. Figures show that a productivity rise of only 4.5% during summer will pay for providing air-conditioning. The usual gain in efficiency is 15%, besides other benefits such as less rejects, lower absenteeism and reduced labour turnover.

Also, ordinary employees have very little understanding of business life. Explaining the various economic factors and concepts will aid in gaining employee cooperation. Profit sharing is an excellent way to encourage employees to be time conscious and efficiency minded. The profit-sharing Research Foundation of London found in one of its studies that firms with profit-sharing programmes outstripped those that did not have them in terms of rate of profit earned on sales, sales growth, and the profit earned per average employee. Job-security and safety of work are other important factors. Complimenting, recognising and praising employees for their good work will motivate them further, boosting productivity.

An award-giving programme e.g. for best attendance, best discipline, highest incentive earnings over a period, consistently high quality production, least overtime, etc. will create competitiveness among employees and stimulate and encourage them to produce more. The awards should be such as to raise the standard of living of the workers or their social status and be directly visible.

If the country is to be spared from economic woes, spiraling inflation, and economic distress that accompanies low industrial productivity, a sense of service, mutual respect and consideration has to be created between labour-management relationship which can best be expressed in just wages (freely offered), hard work (happily supplied), and mutual sharing of the company's prosperity. □

Non-Programmed Decision-Making

Dr P Chattopadhyay*

There is a growing recognition that under systems of professional management some of the premises such as profit maximisation or cost minimisation are under check. Decision theory as yet has not been able to transcend the barriers of individual motivation. Non-programmed decision-making is essentially a concern of top level and middle level management which handle problems of decisional phenomena of the unique type. In this respect, the recent developments in the field of econometrics, heuristic decision making analyses, the Bayesian approach have a high degree of potency.

"An individual makes a decision when at a point of time he selects from several mutually exclusive courses of action which appear to be available to him." Actually, this forms the core matter of what Simon calls *The New Science of Management Decision* or Kaufman nicknames as *Praxeology*.[1]

Decision-making is thus a selection from alternatives which are mutually exclusive in character. Traditionally, such selection has been taken on the basis of the desires and motivations of the individuals choosing from the alternatives. The primary force behind formulation of the desires to be satisfied and also the act of choosing did not respond to any method which is even broadly scientific. One's own experience in such conditions appears to have taken the upper hand. The whole process was subjective, differing from person to person, from situation to situation and from time to time. The qualities of intuition and judgment essentially depended on the person, his background, his education and experience.

Ownership Motivation

The majority of enterprises in any country over a period of time would be primarily ownership motivated. The conditions in such enterprises are essentially geared to the satisfaction of the desires of the owners. Maximisation of profit has been one of the recognised courses conditioning the motivations of such owners in most cases. However, even in ownership-motivated enterprises one has started seeing the application of scientific techniques in much larger doses than ever before. This is because of the distinct advantages known to have been derived from the application of scientific techniques in larger organisations, particularly corporate organisations, in which the ownership motivation has been rather insignificant. The scientificity of the techniques applied was more underlined in the hands of professional managers.

Banishing of the ownership motivation in the large corporations has been initiated by several factors as noticed in the empirical study of Berle and Means followed by James Burnham, Wheelwright and Peter Drucker in different contexts as also in respect of different countries. Divesting ownership from control has been one of the major developments of the twentieth century corporations. In many cases, even the corporate legislation has accommodated this phenomena of divesting ownership from control. Curiously, Marx anticipated this in *Capital*. For a long time, ownership-motivated enterprises were subject to decision-making processes under the rule of thumb which respected only the desires of the owners or their

*Director (Research), Institute of Cost & Works Accountants of India, Calcutta.

1. Both of these are titles of fairly well-known books by the authors.

close representatives. In the wake of professional management, rule of thumb was found to be inadequate. Though the process started with the growing size of organisations, even in smaller-size organisations one now notices larger and larger play of scientific techniques.

Executive Training

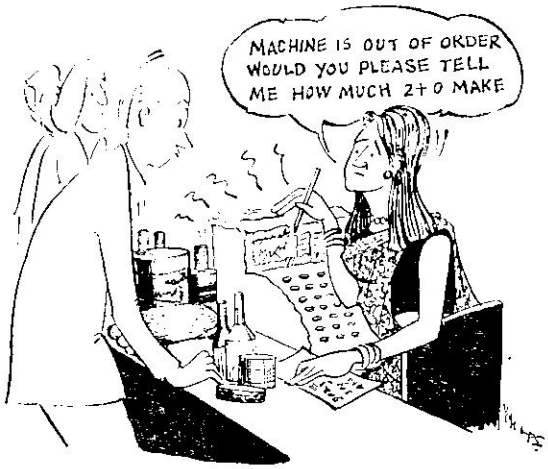
Executive training in most organisations has been designed mainly with respect to greater and greater orientation towards the adoption of the changing technologies of production and distribution. Exposure to keenly-competitive markets required that the executives exercised decision-making powers and they had to be trained with respect to what has been going on around. Primary emphasis of such training has been on the changing environment of business and industry, not as much on the rapid changes that have been experienced in the phenomena of decision-making. In the process, the evolution of the science of decision-making has taken a much longer time than noticed in other spheres in most countries. Such training sought to crystallise experience accumulated from various spheres of activities with which business and industry were concerned. The process of generalisation on this basis has taken a long time. Practical particularism has restricted the development of professionalism in our country as also in the U. K. Conscious attention towards the decision-making processes has been a feature of the last twenty years or so. The scale of education for management decision-making has expanded tremendously.

A particular feature of the traditional enterprise has been that education and training as also knowledgeability were supposed to be meant only for people at the level of the departmental managers or below, not so much for the top management. Part of this trend was because of the fact that some of the available and rapidly-developing techniques demonstrated their effectiveness in repetitive types of problems. The application of such techniques was also found much easier. These techniques were more objective and scientific than those with which managements at still higher levels would find themselves concerned. The techniques were of course inter-disciplinary, drawing, in the process, on mathematics, behavioural sciences, economics, technology and engineering. Gradually, the area of application of these techniques is being extended along with a much larger degree of formalisation of the problems and also of their solutions in conditions of risk and uncertainty with regard to outcome.

Hierarchical Positions

From the point of view of the different hierarchical positions within the organisation and spread of the centres of decision-making power, different types of decision-making techniques have been found relevant with respect to the nature of the decisional problems encountered in practice. The advent of the computer has done almost the impossible in quickly finding out the solutions or alternative approaches to problems and analyses once the primary data have been fed into it. All this would have taken a much longer time, if at all otherwise possible. One of the impacts of the computer has been that it has taken over some of the day-to-day worries of the executives, particularly of the middle and lower levels. Feeding information to the computer, which would be available from both external and internal sources, would be a fairly easy job in the context of the new conditions that have been prevailing in modern large-scale organisations. Information technology and cybernetics have already found out solutions to a large number of problems that were considered not susceptible to rigorous analysis unless at a tremendous cost.

As one goes higher and higher up the levels of the hierarchy, the nature of the problems, the alternatives posed and the inadequacy of information have required that subjective judgments were infused into the otherwise rigorous analyses made for the purpose of choosing between alternatives. In many cases, even the evolution of these techniques was on the basis of situations which were structured in the sense that some of the real-life problems were sorted out. The



techniques once evolved in a controlled situation were given a try in open conditions on the basis of releasing some of the constraints assumed in the structured situations. Such releases also required that a larger number of real-life problems were accommodated in the formal framework of analysis for decision-making purposes.

THE TECHNIQUES

Econometrics

In the light of the foregoing discussion, we may consider the case of econometric models concerned with the whole organisation. According to Professor Klein,[2] econometrics is primarily concerned with giving empirical content to *a priori* reasoning in economics. The *a priori* reasoning is derived from economic theory. In the context of management decision-making, econometrics has a good ground in view of the fairly rich and potent economic theory of the firm. The different factors and forces sought to be organised in an organisation have between them certain relationships which are known from observations. It is assumed in business that, essentially, profits or losses are made in the market place. Taking this as the phenomenon in reality, different variables have been thought of in different kinds of models and their relationships found out. The variables and the constraints to which they are subjected to have varied from situation to situation but their essential characteristics have remained more or less the same, so that such relationships would be predictable with certain degree of confidence. The prediction would, however, depend on how the variables have reacted in the actual situations faced over a period of time.

The econometric models, first of all, help management in its comprehension of the highly complex problems and in improving the quality of the value judgments that management must make. Secondly, the models help management in interpreting how much difference an alteration in the assumptions would make in the answers that the models give in different situations. Business use of such models has been somewhat limited so far except in large organisations because of the fact that the level of intelligent appreciation has been low as regards (i) the value of such models; (ii) the variables used; and (iii) the assumptions made in the models. A model is a mathematical description of an economic entity[3]. It yields the best results in conditions where management is aware of the various assumptions and of the mathematical relationships involved in the models. Such knowledgeability is reflected in practice in the following ways:

(a) what to expect from a model;

(b) what kind of information is necessary for fitting into the model;

(c) how to organise such information from internal and external sources; and

(d) what changes are required in the model.

Though management use of these models in our country has been rare in some enterprises,

2. See *Introduction to Econometrics* and *Text Book on Econometrics*, Indian Edition, Published by Prentice Hall (India).

3. Cf. Bursk & Champan (Ed.), *New Decision Making Tools for Managers*.

they have been found useful. However, the use of econometric models at the macro-economic levels has been fairly sophisticated and systematic. Many of these models have been in use since the First Five Year Plan. For instance, the Mahalanobis model for the Second Five Year Plan has evoked worldwide attention. Improvements in this model have also been indicated by the subsequent Raj-Sen model. Indeed, growth models formulated by several Indian economists have already attained a high degree of technical perfection. At the level of the enterprise, the econometric model has been a rarity in India mainly because of the absence of professionalism in the cadre of top management. The econometric model involves determination of parameters, choosing criteria for accepting or rejecting the results obtained on the basis of the statements of theory or observations from experience and prediction of the future behaviour on the strength of the analysis made. While the econometric models are no substitute for sound judgment in making decisions, they help considerably in developing the management insights into the nature of the problems, the way they behave, the changes that are necessary in defining the problems over a period of time and the solutions sought.

Heuristic Models

Heuristic decision models are based on the premise that a good proportion of management's problems are related to those with elusive patterns. The heuristic approach owes much for its origin to Professor Herbert Simon's analysis of the process of human problem solving. The basic idea here that the human being decides between alternatives under various limitations of size of alternatives, lack of information and so on, which have to be recognised as real life constraints. They relate to the top and middle management. Such problems are much too complex for being successfully handled by the presently-developed operations research techniques. They are unique and non-recurring types of problems with which some levels of middle management and the top management would be concerned. The theory and technique of heuristic programming is one of the answers for filling the gap.

Heuristic programming has been defined as an attempt to incorporate in the theoretical structure of a model the selective rule of thumb processes which humans employ in solving complex problems[4]. It is a technique that has been used to reproduce parts of the thinking or problems solving process. Its use as an aid in management decision-making, has been somewhat recent. The development of the heuristic techniques makes a departure from the extant concepts of rational behaviour of the economic man. In determining the content of rationality in rational behaviour, some of the actual constraints or limitations faced by the individual decision maker in practice could not be fully accommodated. The heuristic method makes it possible to accommodate the subjective elements into the mathematically formulated decision models or computer programmes. It has been found that in this way the selection processes generally applied by an individual can be broadly approximated in the models themselves.

Even though the behaviour of an individual has been uncertain insofar as the ways in which he reacts in selecting from alternative courses of action and the objectives that he seeks to satisfy from time to time and from situation to situation, the broad approximation attained in predicting the behaviour of the individual has helped management from several points of view.

1. In spite of the content of irrationality present in the individual's behaviour, it has broadly conformed to predictable courses of action.

2. At the levels of higher management, since information gap is there, heuristic method has been able to bring management much closer to reality than in other ways.

3. The method has helped building up the management's degree of confidence in selecting from alternative courses of action.

4. Cf Clarkson (Ed.), *Managerial Economics.*

4. It has helped the synthesis of several other management concepts into the frame of analysis for decision-making purposes such as, Maslow's scheme of need-hierarchy, organisation goals vis-a-vis individual goals, classification and delimitation of the nature of problems in the context of application of different methods for decision-making purposes, etc.

5. The method has to some extent solved the difficulty created by the fact that the different kinds of problems faced in the process of management decision-making, though not completely subject to grasp in mathematical terms, have been to a great extent brought within the purview of such models.

Since of its own no model will deliver the goods, a very cautious approach is necessary in this context. Sizing up the practicalities and fitting them into the model are problems of considerable magnitude. Experience has shown that the success of these models would depend on conscious application.

Bayesian Theorem

Bayes's theorem[5] is not a new discovery, in view of the fact that Thomas Bayes wrote his "An Eassy Toward Solving a Problem in the Doctrine of Chances" which was published in the philosophical transactions, Volume LIII, 1773. For a long time, the Bayesian approach was almost forgotten. In the context of management decision, the theorem has been found to be of great value. The acceptance of the idea of a probability distribution for the unknown parameter, though gradual, is now firmly based and one hears of Bayes's statistics a good lot more than one used to, say twenty years earlier. Various refinements and elaborations have been effected by various authorities which now go by the brand name of Bayesian approach. The classical statistical analysis has generally required a direct, intuitive fixing up of the determinant of the decision rule. The Bayesian approach, on the other hand, builds up a simple and elegant structure for its determination by way of indicating how a specified prior probability distribution, when combined with sample evidence, leads to a unique posterior distribution for the unknown parameter. This approach has helped to solve the fundamental weaknesses of the classical position as to what criteria to use in estimation problems and how to specify the tolerable risks of error in testing problems. In each case, the solution falls naturally into place, once the two essential ideas of the Bayesian approach are incorporated, namely, (1) explicit and systematic use of the economic concept of opportunity cost for evaluating the world of actions in comparison with the best possible action for the given states of the world: and (2) use of subjective probabilities to assign weights to the different possible states of the world. In this way, the process permits determination of a definite best procedure for any situation. Even in the assignment of subjective probabilities, the Bayesian approach makes for analysis on the basis of evaluating the alternatives not selected and incorporation of the opportunity cost for testing the value of the alternative selected. It has thus made management decisions, involving assignment of subjective probabilities, much more realistic than before.

ILLUSTRATIONS

Bayesian Theorem

Illustrating the Bayesian approach, it is convenient to state what Schlaifer has mentioned as an example in his book 'Probability and Statistics for Business Decision."[6]

A decision maker is confronted with the choice as to whether to purchase the one lakh flash bulbs per year of the traditional variety or to go in for a new type bulb manufactured for the first time. The usual bulbs have a known reliability of 99.0%. The decision maker assigns the following probabilities of reliability of the new type in the following manner.

5. Cf. Hayel (Ed.) Encyclopedia of Management.

6. This has also been dealt with in Hayel (Ed.), *Loc Cit.*

Reliability of new bulbs	*Defective bulbs*	*Probability*
0.995	0.005	$\frac{1}{3}$
0.990	0.010	$\frac{1}{3}$
0.980	0.020	$\frac{1}{3}$
		1.00

Since the new bulb is being marketed for the first time, the decision maker does not know about it and so assigns equal probabilities to the likelihood of new bulb, either matching the old bulb or varying slightly from it, one way or the other. The problem for the decision maker would be primarily whether to choose the old bulb or the new one. A traditional manager would consider the bird in hand as more valuable than beating about the bush. But when such bush beating is worth the exercise, the modern manager would go in for it in specific conditions, that is, he will choose the act for which the expected cost is lowest or the expected net revenue, or utility, is highest. The decision maker, therefore, decides to try a small lot of 500 bulbs on the basis of which he can form an opinion.

Pay-Off Table

State of Nature	*Conditional Cost*	
P	Old	New
0.005	2500	1250
0.010	2500	2500
0.020	2500	5000

'b' for the old bulb is 0.01

(Each time, a bulb fails to fire, the company's loss in film and labour averages 2.50)

Example: Conditional cost for p .005 =100.000 × .005 × 2.50 = 1250

Terminal Action Before Sampling

State of Nature 'p'	*Prior Probabilities*	*Cost of old bulb*		*Cost of new bulb*	
		conditional	*expected*	*conditional*	*expected*
.005	$\frac{1}{3}$	2500	833.33	1260	416.67
.010	$\frac{1}{3}$	2500	833.33	2500	833.33
.020	$\frac{1}{3}$	2500	833.33	5000	1666.67
			2500		2916.67

Example :
Expected cost of new bulb at p=.005
= 1250 X 3 = 416.67

Revision of Prior Probabilities

(1) *State of Nature*	(2) *Prior Probability*	(3) *Likelihood (From Poisson distribution table)*	(4)=(2)X(3) *Joint Probability*	(5) *Posteriori Probability*
.005	$\frac{1}{3}$	.2138	0.0713	.0591
.010	$\frac{1}{3}$	.1404	0.0468	0.388
.020	$\frac{1}{3}$	.0076	0.0025	0.021
		Marginal probability	0.1206	1.000

How does he now revise his original assignment of probabilities and what, if any different action should be taken?

He is now armed with experimental data gained from a sample. Recognizing that he is dealing with a very small fraction defective, he assumes that a poisson distribution applies and, by reference to the appropriate table, determines the probability of three defective bulbs in a sample of 500 to be .2138 when p=.005. Such a probability is called a likelihood.

Example :

$$\text{Posteriori Probability for } p=.005 = \frac{\text{Joint Probability}}{\text{Marginal Probability}} = \frac{.0713}{.1206} = 0.591$$

CONCLUSIONS

We started with the position that as yet the premise of decision-making is individual oriented —in the traditional ownership—motivated enterprise it is the owner: in the conditions of ownership divested from control, it is still the individual but with motivations other than of ownership. There is a growing recognition that under systems of professional management some of the premises such as profit maximisation or cost minimisation are under check. Decision theory as yet has not been able to transcend the barrier of individual motivation. In developing the theories of heuristic decision-making, greater recognition has been given to the practical constraints and limitations under which an individual decides. But even in this context, theorists like Professor Herbert Simon have not underscored the point that a corporate organisation may have goals that are distinct from the sum total of the goals of all the individuals comprising it. In fact, Professor Simon is positively against reification of the organisation. This paper submits that this is a weakness of decision theory. This is, however, not to deny or even undermine the tremendous advances made in the context of decisional analyses by various connected intellectual disciplines.

It is submited here that non-programmed decision-making is essentially a concern of top level and middle level management which handle problems or decisional phenomena of the unique non-repetitive type. In this respect the recent developments in the fields of econometrics, heuristic decision-making analyses and the Bayesian approach have a high degree of potency. The problems that have been handled by these approaches are those that are common in their characteristics in all industries. Indian enterprises can greatly benefit from a judicious application of these techniques in both private and public sector units. The Indian enterprises of 1975, let us say, will have to deal with a larger number of uncertainties than ever before. For instance, the advent of petro-chemicals with capability of replacing every type of commodity now in use, including steel. Our insulated economy of today will be a matter of the past very soon and survival of the fittest will require application of highly sophisticated techniques. The computer has already made its mark in many large units in our country. The best uses of the computer will require greater application of techniques in areas almost unconceivable now. In conditions in which knowledge is business, the future of our enterprises will lie in accumulating such knowledge from all possible sources. □

The wait-and-see gap is the lag in productivity, profit, and progress that results every time plant management decides to "wait and see", instead of acting, when a new idea of proven merit is up for consideration.

—Gerald C Quinn in *Modern Manufacturing*

Increasing Productivity Through Management Reporting

BK Mukherjee*

The term 'Productivity' may be defined differently when considered from macro or micro concepts. In this article, the author stresses as to how a particular unit of an industry can increase productivity through the management reporting system. Although the need for improving productivity in all kinds of enterprises is widely recognised, the question is whether enough attention is being given to proper management reporting system from which the different management levels can obtain productivity characters and attributes, its signs and signals from time to time.

IN any management the right communication of information is important as it should not be a symbolic routine but substantive in its value with the principal objective to serve the needs of the different management levels and to enable managers to think of improving productivity. A report is not only the primary channel and record of information but also a powerful instrument for inducing its readers to act. Reporting to management should be done on the basis of what information the managemennt can use rather than how much data the reporting department can compile. When a team of Indian experts visited USA under the auspices of the National Productivity Council, they wrote:[1]

"The striking features in the provision and use of accounting information in the USA are:

(i) The controllers realise that they have perpetually to be doing a selling and training job among management. Great efforts are, therefore, made to make the accounting reports as short as possible and to present them in an attractive and easily readable form. By eliminating unnecessary details and explaining the significance of the figures and their relevance to the subject matter, management's interest in the reports is thus created.

(ii) By virtue of their training at such business schools or at such institutes as the Massachusettes Institute of Technology, many managers have learnt the value and utility of accounting statements and what can be inferred from them. Even among foremen and chargehands there is little fear of figures and there is a marked ability to absorb information from tabular or graphical form as quickly as from a written text."

It goes without saying that in solving the productivity problem any management must take four basic steps:

—Get in facts
—Analyse the facts
—Arrive at a decision
—Act on that decision.

*Deputy Finance Manager, Planning & Development, Fertilizer Corporation of India, Sindri.

1. *Cost Accounting and Financial Control in USA, UK & W. Germany*, published by National Productivity Council of India, New Delhi.

The first two steps come under 'Management Reporting.' Responsibility for such reports usually lies with the Finance and Accounts Manager or the Managementant Accountant in a particular organisation.

Mechanics of Reporting

The report writer should always project himself into the reader's position by crystallising in his own mind what the intended report should accomplish and develop a logical answer to questions, such as:

How should it be presented?
What information should it contain?
How much details are needed?
Whether the data are trustworthy?
Whether the reader will be motivated to act?

Reporting conventions change and develop with the attitude of the readers and with time. The media of reporting are:

—Tables with proper classification
—Written comments
—Graphs to show comparisons or trends
—Flow sheets to indicate relationships
—Charts and sketches.

Different Productivity Concepts

When the final output is the result of the integrated management contributions through material inputs, labour efforts or machine efficiencies, it is imperative to detect the right causes of increased or decreased productivity trends. Therefore, the term 'Productivity' has three broad sectors, such as, Material productivity, Labour productivity and Capital productivity. Recognising the difference, the momentous question is how to locate the real cause in a particular period. Indeed, the proper accounting as well as recording of information help in dissecting different elements and ultimately the facts are communicated through management reporting.

Incidentally, we may also distinguish the productivity of the administrative function of a business from other productivity concepts mnetioned above. This may be termed Management productivity or Entrepreneur productivity for utilising other resources in the most efficient manner. Effective utilisation of the management reports may also be purviewed under this concept towards a perfect harmonisation of the conflicting claims of individual concepts.

Material Productivity

With this perspective in view, the term 'Productivity' is precisely the ratio between the output or the finished production and intake of the raw material. Here, the term 'yield' is a best synonym for expressing 'material productivity'. Higher yields indicate lesser visible or invisible losses in weights or other specified units. Indeed, measurement of such yields is very important in textile, chemical, and metal industries. When different kinds of materials are merged or blended together, it is important to devise the best "mixes" for obtaining the highest yields at the lowest costs with a lesser loss in scraps and other wastes at various stages of production. Let us illustrate with certain specific examples:

(a) A batching oil is necessary to soften a mixture, constituting various grades of raw materials. The price of this oil is one-tenth of the average price of the raw materials and hence there is a tendency to add as much oil as possible for adding weight. But, after a certain stage the extra oil in the mould causes more wastages and defectives in output, affecting productivity. The optimum quantum of oil to result the highest productivity at a least cost can be obtained through proper management reporting system.

(b) Circles of different diametres are cut from a large stainless steel sheet for making various sizes of utensils and the remnants of the sheet is a scrap. It is an art to yield the maximum number of circles from the sheets and to reduce the scrap to as least as possible. The management reporting section can calculate all sorts of alternatives and find the best combination.

(c) In a diffusion battery or a circulating chamber of a sugar mill, water is used during extraction of sugar for lessening loss of sugar in the pulp and pulp water. *vis-a-vis* more steam is required for operating the evaporators. More steam means high costs in coal consumption, but on the contrary it reduces the sugar loss. Because of two variables, the management reporting helps to find the optimum relation of cost and productivity.

(d) Two fuels, bituminous coal, 13,000 BTU per lb. and anthracite slush, 11,300 BTU per lb. are blended in a boiler house. The second one is cheaper in price, but more use of the same blend affects productivity of steam. The management reporting helps in finding the best combination correlating cost and productivity of the steam generation.

The report writer should always project himself into the readers' position by crystallising in his own mind what the intended report should accomplish.

Losses, we all know, are distinguished as physical and non-physical. The scrap in melting or rolling in a foundry, trimmings in a textile mill and things of the sort are physical losses properly weighed or measured. Although in some industries the physical wastages are reused but it is imperative to control such losses for the sake of maintaining costs as well as productivity. In fact, however, the weight of the input may not always be equal to the weight of the output *plus* the physical loss because of the moisture content in the process or other reasons. Such invisible losses have values from the productivity angle and should, therefore, emanate from the nadir. The proper reports from the management accountant are bound to reveal the relative position from time to time for appropriate action. As for illustration, a report is cited below:

Output of Cupro-Aluminium Sheets

Melting Input	*This month*		*Last month*	*Norms*
	Tons	%	%	%
Magnesium	0.50	5.0	5.0	5.0
Copper	1.25	12.5	12.5	12.5
Aluminium	8.25	82.5	82.5	82.5
	10.00	100.0	100.0	100.0
Output : Slabs	7.50	75.0	74.0	76.0
Scrap	2.00	20.0	21.0	21.0
Loss	0.50	5.0	5.0	3.0
Rolling Output				
Sheets	5.85	78.0	77.7	79.0
Scrap	1.50	20.0	20.3	19.5
Loss	0.15	2.0	2.0	1.5
	7.50	100.0	100.0	100.0

In addition to the quantitative statements, an effective management report warrants further analysis to show the effect of changes in productivity from time to time on periodical costs and profits. Under the historical costing system, lower yields and higher losses or defectives result in higher costs. Comparisons of costs from time to time indicate the trend of events. Under the standard costing system the quantum value of the "Yield Variance" indicates the extent of profit diminution in monetary terms. This may be illustrated with a single example.

Example: A chemical of 10 Kg is made up of three constituents, the standards of which are as follows:

Constituents	*Kg*	*Rate per Kg (Rs)*
A	8	5
B	4	4
C	3	3

In a batch one tonne of the chemical is actually produced from a mix of the following:

Constituents	*Kg*
A	850
B	460
C	290

We are to find out the yield and mix variances from the standard expected. (See Table Below)

Labour Productivity

The term 'productivity' was essentially and predominantly used in the past to mean only 'labour productivity' when the manual labour was the only important production resource and the manual work the only real effort. Speaking retrospectively, all human achievement can only be measured in units of muscle effort. Thus, this is the ratio of the units of production related to the manhour involved in connection therewith. While comparing with the productivity of the previous period, higher productivity means either more units of production during a period or lesser time to produce a particular unit of production.

The report to the management may be quantitative or translated in monetary terms. The quantitative report should include units of output separately for each item, in terms of machine-hours during a period and compared with the norms or standards. This may be illustrated as in the Table on next page.

When the actual output per machine-hour for a particular item is not satisfactory, it is necessary to analyse such information *de profundis* for each machine separately to locate the particular operator responsible for lowering the average. Take the item C, for example, which is an aggregate of six similar machines, each working 48 hours.

		Standard		*Actual*	
Constituents	*Rate (Rs.)*	*Kg.*	*Rs.*	*Kg.*	*Rs.*
A	5	800	4,000	850	4,250
B	4	400	1,600	460	1,840
C	3	300	900	290	870
		1,500	6,500	1,600	6,960
Wastage		500		600	
Output		1,000		1,000	

The actual cost is higher by Rs. 460.

Yield variance, 100 Kg. = Rs. 6,500/1,500 Kg. i.e. Rs. 433.

Mixture Variance, 1,600 Kg. = (Rs. 6,960/1,600 Kg. *minus* Rs. 6,500/1,500 Kg.) or Rs. 27.

DEPARTMENT X
Actual Production for the Week Ending

Items	*Output*	*Machine hour*	*Output per machine hour*		
			Actual this week	*Actual last week*	*Norms*
	Kg.		*Kg.*	*Kg.*	*Kg.*
A	16,856	1,536	10.98	10.80	11.00
B	21,543	1,824	11.81	11.90	12.00
C	5,409	288	18.78	19.02	20.00
D	12,934	528	24.50	24.00	26.00
and so on					

Machine No.	*Output kg.*	*Hours*	*Per hour kg.*
1	1,010	48	21.42
2	950	48	19.79
3	936	48	19.50
4	920	48	19.17
5	850	48	17.71
6	743	48	16.50
	5,409	288	18.78

Assuming an operator for each machine separately, the above result depicts very high efficiency for the operator No. 1, *vis-a-vis*, very poor performance for operators Nos. 5 and 6.

It may not be difficult to calculate the quantitative norms at a specified efficiency. Even when qualities of production vary from time to time there may be a mathematical formula to fix the norms *mutatis mutandis* according to the sizes and different specifications of the output possible to operate from the same machines. Take, for example, the textile industry where the weaving output varies from one fabric to another according to the width of cloth, porter, shot, weight of yarns and the type of weaving. Assuming the constant efficiency of the machine irrespective of the fabrics to be woven, it is possible *pari passu* to calculate the norms achievable for each quality.

Apart from the quantitative statements, the monetary statements are very helpful to the shop foremen for controlling inefficiencies. Such statements generally emanate from the costing department and flow to other concerned departments after processing through Management Reporting Department. When costs are based on actuals only, actual costs per unit may be compared from time to time as well as from the estimate. If the operators are paid on the job-basis, i.e. at the piece-work rates, higher piece-work payments during a particular period reveal higher productivities. We may illustrate with a single report as shown below :

Units of Output	*Labour cost per unit*			*Piece-work payments*	
	This month Rs.	*Last month* Rs.	*Estimate* Rs.	*This Month* Rs.	*Last Month* Rs.
A	1.24	1.16	1.00	1,20,530	1,29,320
B	7.20	8.00	7.00	20,390	18,230
C	5.34	5.10	5.00	40,670	42,600
D	10.20	10.51	10.00	70,910	68,830

(*Note* : The unit labour-costs, mentioned above, include other charges also in addition to the piece-work wages).

The Standard Costing System is a very effective tool in measuring the impact of labour productivity variance from month to month and from the standard expected under normal conditions. Such variance may be analysed separately for each group of machines or each block of hand labour. The following case-study will illustrate.

Case-Study

The standard output per spindle hour is 0.15 Kg. and an operator is supposed to operate one frame of 150 spindles. Assuming 120 effective hours per week of three shifts, the expected output per operator/frame per week is 150 spindles × 120 hours × 0.15 Kg. i.e. 2.70 tonnes. There are 10 similar frames and so the expected output is 27 tonnes per week. The basic pay is one rupee per hour and the total attendance time is 48 hours per week. Therefore, the total wages cost per frame is Re 1×48 hrs. ×3 shifts or Rs. 144, aggregating to Rs. 1,440 per week. Thus, the Sandard Wages Cost is Rs. 1,440/27 tonnes, i.e. Rs. 53.33 per tonne. In a particular week the total wages bill was Rs. 1,400; because of absenteeism, production was 25 tonnes only and thus the actual cost per tonne is Rs. 56.

For a production of 25 tonnes, the wage bill should have been 25 tonnes×Rs. 53.33 or Rs. 1,333 only. Hence the extra cost of Rs. 67 (Rs. 1,400—Rs. 1,333) is due to lower productivity.

While introducing the standard costing system and reporting the effects of productivity variances, it is important to distinguish between controllable and uncontrollable factors. Controllable factors include those attributable to the workers and the supervisors. Uncontrollable factors include product variety, raw material supplies, reliability of plant, new labour, defective design, power interruptions, etc. for which the shop people may not be responsible.

Incentives for Higher Productivity: A premium bonus or a piece-work system may induce an individual worker to raise productivity. A gang rate collectively for a group of workers may foster better team-spirit, leading to higher productivity. In addition to such an incentive, it may be necessary to introduce production bonus for obtaining higher productivity. A piece-work rate may be fixed by proper work-study which is entirely distinct from the task of management reporting. But, fixation of any production bonus may be a task of the latter as to the quantum of bonus in relation to the size of productivity rise. Let us assume the monetary effect of the higher productivity as follows:

	Conditions		
	(1) *Rs. (lakh)*	(2) *Rs. (lakh)*	(3) *Rs. (lakh)*
Piecework wage	10	11	12
Other wages & costs	90	94	98
Total cost	100	105	110
Sales price	150	165	180
Profit	50	60	70
Net gain		10	20

Assuming the net gain to be shared equally by the employers and the employees, not only by the piece-workers but also by other workers as well, a formula can be devised. Let us further elaborate:

	(1)	(2)	(3)
Productivity percentage	100	110	120
Total Wages bill :	(Rs. lakhs)	(Rs. lakhs)	(Rs. lakhs)
Piece-workers	10	11	12
Other workers	20	21	22
	30	32	34
Share of profit, 50%	—	5	10
Percentage on wage bill	—	15%	30%

For each 10 % increase in efficieney, the bonus is 15%. The formula may be that after achieving a particular target any increased efficieney should be rewarded. For each one per cent increase in productivity, each worker will be paid a bonus of 1.5% of his wages. Suppose, during a period the productivity increase is 7% more than the norm at a lower limit. At this point, each worker should get a bonus of 10.5% of his wages.

In the above case we have assumed a direct relationship of the piece-work payment with the productivity. But when such condition may not be feasible, efficiency can be measured in average through some norms, as illustrated below:

Items	*Output*	*Norms per unit*	*Total hours expected*
	Units	hrs.	
A	510	1.22	622.20
B	215	7.40	1,591.00
C	720	3.92	2,822.40
D	327	4.27	1,396.29
Standard hours			6,431.89
Actual manhours			6,500.00
Efficiency			98.95%

When it is possible to find a relation of efficiency variation with profit variation, it will not be difficult to formulate a production bonus. In any case, the management reporting section of the organisation will indicate the bonus payable to the workers.

Labour Turnover: The labour turnover is the ratio of the number of those who leave the organisation during a period to the average number of persons employed during the same period. We know that labour turnover affects productivity and adds to high production costs. Unfortunately, the effect of the labour turnover does not appear in the periodical cost or financial accounts, being completely concealed therein. Therefore, it is imperative that a suitable report should be compiled for the information of the management which may include the following information:

A. Lost profit resulting from lost output.
B. Replacement Costs:

Variable:—Advertising
—Training of new workers and induction
—Overtime worked
—Redeployment
—Tool and machine breakages
—Scrap and defective work
—Accident frequency and severity.

While introducing standard costing system and reporting the effects of productivity variances, it is important to between distinguish controllable and uncontrollable factors.

Fixed:

Part of the cost of personnel department
—medical department
—training centres

C. Presentive Costs
—Labour Welfare
—Medical Services
—Amenities
—Better working atmosphere

Absenteeism—Similar to labour turnover, absenteeism affects productivity. Even when replacement is possible, inefficiency of new labour causes loss of output and loss of profit. This fact also remains concealed in the periodical financial and cost reports. But assessment may be possible similar to the labour turnover so that the management becomes aware of the effect of absenteeism from time to time. Absenteeism cannot be avoided upto a certain extent because of the leave rules. But it may be possible to stagger the regular leaves in a planned manner in order to maintain the desired output.

Accidents—Accidents affect productivity not only from the worker involved in the accident but also from the fellow workers carrying the

Capital productivity may be considered from the angle of a correct balance in the productive capacities of different inter-related processes or departments.

person to the hospital, stopping the power line and discussing failures and lapses. Similar to reports on labour turnover or absenteeism it is possible to report monetary effect on productivity losses for accidents.

Capital Productivity

Normally the output per machine operator and the output per machine indicate the same information under the usual circumstances when the operator is using the same machine continuously or the group of operators using the same type of machines of the same efficiencies. But the machine productivity may be distinguished from the labour productivity for the following factors:

(1) Quantity, size, type and efficiency of the machines involved.

(2) Maintenance, lubrication etc.

(3) Fluctuations in power voltage, steam, heat and water requirements, effluent treatment etc.

(4) Natural conditions like variations in temperature, humidity etc.

(5) Imbalances in certain sections of the process industry.

(6) Fluctuations in the quantum and quality of the input material. For example, fluctuations in the quality of the coking coal used in the blend sometimes result in production of coke unsuitable for gas generation. Again, for another example, the quality of the rock phosphate such as grindability, purity and filtration characteristics and the P_2O_5 content have definite bearing on the plant performance.

Capital productivity may be considered from the angle of a correct balance in the productive capacities of different inter-related processes or departments. A certain imbalance of capacities affects over-all factory-wise productivity of the finished output.

Output-Capital Ratio: When the output is related to capital employed and that ratio is compared from time to time, it provides an excellent guide to measure the productivity trend. This may be done for the factory as a whole, for individual departments or even for individual machines. Again, the same ratio can be dissected into two segments, the average output and the average capital per person, after taking the number of operators into consideration.

For compiling such data, the question is how to evaluate the output and the capital. The output may be taken in cost or sales values. The capital may be the original or the replacement cost of the assets. Whatever bases may be adopted for evaluation, it is necessary to maintain the same consistently at different periods for the purpose of comparison.

Long-Term Productivity Drive

So far, the productivity question was considered under the existing conditions. Productivity can also increase through various endeavours such as:

Short-term: Work-studies for improving operation methods, improving and simplifying the product, reducing and standardising range or any other method.

Long-term: Research and value analysis for improving basic processes and optimal utilisation of resources.

Such techniques are conducted by specialists who may demand non-routine reports from time to time. □

A Philosophy of Industrial Relations

T.A. Acharya*

In this thought-provoking article the author highlights what he prefers to call 'my industrial relations philosophic Credo.' The crux of his Industrial Relations Philosophy is that for the enrichment of democracy, the state as such must develop into a friendly and interested mentor, staying in the background and eschewing its present near-total interventionism. The trade unions and the employers must be treated as equals and both should be amenable to 'the rule of law'. This social balancing demands that productivity cannot remain the sole business or responsibility of the employer. There cannot be a legal substitute for purposeful bilateral understanding in the field of industrial relations. To prove his philosophy, the author lists out three international examples of what he chooses to describe as 'creative bilateralism'.

FOR its very sustenance any worth while human activity must necessarily be buttressed by a philosophy. Industrial Relations cannot be an exception. Their social importance is such that if we did not have a philosophic credo our efforts would be patently barren.

Constructive Confrontation

I shall endeavour to set out my Industrial Relations philosophic credo. Industry is, understandably, a house divided. Because of the differing—even conflicting—attitudes and approaches of the two sides there will always be a gulf, say, hiatus, if you like, between the two and all that earnestness could hope to achieve is to put a bridge across and vigilantly keep it in good repair. Conflict there will be and the challenge in this field is one of discovering the mechanics of converting conflict into one of constructive and non-combative confrontation. The injection of philosophy renders—should render—that confrontation progressively creative and, because of creativeness, dynamic.

This philosophic credo shares W.H. Auden's (the British poet who is now an American citizen) thought: "*We must love one another or die*". (italics mine). Possibly, with agonising slowness and with a bullock-cartish speed, the world is turning away from the technique of war to solve real or imaginary international disputes. What applies to the international arena equally applies to industrial conflict. To be sure, men are getting impatient of conflict, wars and war-like postures, internationally and otherwise. In both cases, it is a matter of human survival. There is a fairly loud and insistent demand for more civilised ways and norms of social behaviour and fresh investments in social sanity. There is a perceptible Indianness in this thinking. Mahatma Gandhi once said: "The world of tomorrow will be, must be, a society based on non-violence. That is the first law. Out of it, all other blessings will flow."

State to Step Aside

Furthermore, this philosophic credo postulates that for the enrichment of Democracy, specially in the sphere of industrial relations, the State as such must develop into a friendly and interested mentor, staying in the background and eschewing its present near-total

*Labour Adviser, Mahindra Group of Companies, Bombay.

"The world of tomorrow will be, must be, a society based on non-violence. That is the first law. Out of it, all other blessings will flow."

—MAHATMA GANDHI

interventionism. If the democratic way of life is a fundamental condition of civilised existence and what matters is the quality of life, then, for a start, in the sphere of industrial relations, we must progressively learn to do without the State and State-provided machinery. The paradox or the dilemma of what is called the Welfare State is that it is only the State which has the resources to handle basic developmental areas of social life such as education, health, national highways, rail and air transport and the like and because of this advantage it possesses, it becomes powerful and insatiably and unquenchably power-thirsty, inevitably regulating the lives of the citizenry from the cradle to the grave. More power, less democratic. Both in the "capitalist" and "socialist" Welfare States, the State as such has emerged as the most potent of the anti-democratic pressure groups.

The State's sphere would be to assert itself when nationally vital issues spring up, like the one the late President Kennedy handled by ordering what has come to be known as the "roll-back" of steel prices in 1962. Because of his personal intervention, the trade unions accepted a limited settlement as steel was the basic product of economic strength and price rise would have inevitably worsened the inflationary spiral. Once the settlement was signed, the employers jacked up steel prices. The President ordered the roll-back as, according to him, it was a matter of "faith"—because of him the unions courted a modest deal and faith in the Presidency was sacrosanct. Other than in such great issues, the State should create the atmosphere for bilateral solution of problems. It is a choice between Democracy and Statism.

Fate of I.R.C.

By way of a meaningful illustration, the fate suffered by the key recommendation of the National Commission on Labour—I mean the Industrial Relations Commission—could be highlighted. At the meeting of the Standing Labour Committee — supposedly tripartite — held on 23rd and 24th July 1970, the concept of an *autonomous* Industrial Relations Commission, placed beyond the pale of governmental and other political influences, came up for consideration. The States' Ministers of Labour and, in some cases, officials, deputising for their ministers, stood as a solid phalanx against the recommendation. They did not want to let go the powers they had, under the Industrial Disputes Act, in respect of conciliation and the like. The employers' and the trade unions' representatives present were in favour—the A.I.T.U.C. (which had gone on record that it opposed all of the recommendations) being absent along with U.T.U.C. Mr. S. Venkatraman, a member of the Planning Commission at that time—despite his background as a Trade Unionist, a State Minister of Labour and subsequently a Minister of Industries of the same State—came out with a compromise formula: Conciliation to stay with the States and other functions, with the dismembered and truncated Industrial Relations Commission. The States jumped at this with understandable avidity. What shape the I.R.C. idea—if at all—finally takes is anybody's guess. This much is certain: The States as such would oppose any move to whittle down their power in this key sector. Here was a recommendation—the expenditure of Rs. 34 lakhs that the Commission incurred would have been socially justified if autonomous I.R.Cs at the Centre and in the States had come into being—that had emerged, for the first time in India's industrial relations history, representing the collective wisdom of the members of

National Commission on Labour and designed to revolutionise the approach to industrial relations.

The Legal Jungle

Law and legalism must be demoted. Law is the most perceptible manifestation of the State presence in industrial relations. That this presence is staggeringly obtrusive is evidenced by the listing by the proposed "Labour Code 1969"—"an act to consolidate and codify all existing legislation on employment, welfare, social security and insurance, industrial disputes and trade union organisation and other related matters" under "Section 207. Repeal of Acts"—of 90 different pieces of legislation, followed by a sub-section which reads "all other corresponding Central or State enactments, not enumerated above, and dealing with the subjects covered by the Code are also hereby repealed." In the prefatory note of the final report, submitted to the Chairman of the National Commission on Labour on 1.12.68, the Study Group on Labour Legislation spoke of there being "on the statute book about 108 enactments, both Central and State". Since then new laws have been placed by the Centre and the States on the statute book, making the corpus of labour laws Himalayan! The Common Labour Code concept lies buried, the National Commission on Labour having found facile and rather cheap excuses for such burial—the difficulty posed by definitions as there were different categories of employees and the possibility of hurting the sensibilities of the States of the Indian Union which possessed "concurrent" constitutional powers in the field of labour legislation. The inevitable result of this confusing jungle of law is an understandable field day for expert, pyro-technical practitioners of law, encouraging the two sides of industry, who should have themselves hammered out norms and codes of behaviour to be insufferably litigious and inveterate court-gazers. As there is no judicial body beyond the Supreme Court right from the commencement of a dispute, the thought of *fighting it out* and ending up before the Supreme Court is harboured by both the sides. The Law Commission has this to say in this context: "The graver aspect, however, of the matter is that labour matters are thrust on a court which has not the means or the materials for adequately informing itself about the different aspects of the questions which rise in those appeals and, therefore, finds it difficult to do adequate justice." Law, in a sphere where compromises must be born of bilateral understanding, must necessarily be said to be excess baggage. In the context of our colossal poverty, disease and hunger—it is known that one-third of the population is below the level of subsistence—a legalistic approach, which merely helps in circumventing the need for learning the art of living together, is grossly inadequate, patently barren and demonstrably obsolescent. A change of direction away from the State and State-provided machinery must progressively be engendered. All that is essential is one fundamental law in two parts—even two laws, if need be—the first relating to the whole gamut of industrial relations, with clear, simplified and uniform definitions, positively underscoring and giving the place of honour to bilateralism and, the second, setting out the whole range of well-knit social security and welfare provisions. This task would not be easy but, given earnestness and pragmatism, not, impossible.

A change of direction away from the State and the State-provided machinery must progressively be engendered.

Ethical Imperatives

This philosophic credo postulates certain ethical imperatives which, besides upgrading

The trade union and the employer must be treated as equal in the eyes of law and both of them rendered amenable to what is significantly described as the rule of law."

human effort in this essential sector, add new dimensions to industrial relations :

(a) *Balancing of social responsibility on the part of the two sides of industry :*

The trade union and the employer must be treated as equal in the eyes of law and both of them rendered equally amenable to what is significantly described as "the rule of law". For instance, if employer resistence to changing social trends is condemned as unsocial, unmodern and even reprehensible, the destruction of the country's property on ideological and other grounds by politically-motivated unions, by way of so-called protest, should be held to be equally, if not more, unsocial and reprehensible. If a bad employer is a drag on a forward-looking society, politically-oriented unionism, which breeds multiple and competitive unionism, is a curse. This social balancing demands that productivity cannot remain the sole business or responsibility of the employer. Addressing the Centre for Industrial Relations, University of Toronto, four years ago, Mr David Morse, the former Director-General of the I.L.O., significantly and rather prophetically remarked: "Trade Unions will, in the coming years, have to undergo a complete reappraisal of their role in society. In a sense they have become victims of their own success....I foresee as the second major issue in industrial relations over the next decade, an increasing tendency for governments to intervene in order to restore the balance in collective bargaining." What Mr Morse set out to emphasise was that if the two sides of industry failed to accept shared fifty-fifty responsibility for the maintenance of a high level of production by mutually-developed approaches and mechanics of understanding and if the trade unions did not go all out to make an ascending productivity also their sworn responsibility, governments would become openly more interventionist than they are now. That is because governments cannot remain uninterested when production suffers, the requirements of the "under-dogs" of the world being what they are and the elemant requirements of distributive justice being what they are known to be.

This balancing would also necessitate a change—it will be a veritable sea change—in nomenclature. One knows what happened when the first U.F. Government came on to the saddle in West Bengal. Mr. Subodh Banerji, the Minister of Labour, went on record that he was a *Labour* Minister not an *Employer* Minister! Obviously, we are still living with a dated, anachronistic and bloodless concept. There was a time, in the infancy of industrialism, when you needed a ministerial functionary to *protect* labour's interests. Not today! What you need, for impeccable social balancing, is a Ministry of Industrial Relations, a Minister of Industrial Relations, a Commissioner of Industrial Relations and so on down the line, all of them endeavouring to hold the scales even. We must insulate the ministries and ministers against Subodh Banerjis.

(b) *Power and responsibility are two sides of the same coin :*

There is no freedom to misbehave, to hurt and to arrest the even progress of socio-economic growth—today, economic growth must dovetail its demands with those of social welfare—more especially because the lives of millions hang on it. No group or section can claim immunity of any description. No longer will the world tolerate ignoring of the dictates of responsibility while exercising power. The employer and the trade union must accept the responsibility that goes with their power. So must the State. There is no *fundamental* right

strike: there is no *fundamental* right to lock-
.. They are eighteenth-nineteenth century
ncepts. If we demanded responsibility, as
must, these rights have little or no signi-
ance. There are civilised alternatives. We
ust look for a new ethic and help promote a
w spurt of civilisation. From this angle, the
its to strike and to lock-out carry with them
e responsibility not to strike or to lock-out.
is perfectly possible mutually to work out an
derstanding whereby all combative pos-
res and approaches could be eschewed, with
rantees and checks and balances, obviating,
the bargain, criminal waste of resources which
for careful and fruitful use for the good of
l. It is not beyond human capacity to think
it and do right—to work out a methodology
progressively reaching a dependable state of
utual acceptability as between the employer
the trade union. To continue to talk of
ndamental rights to hurt each other—not to
nk of hurting the community, at large—is
despair of man's infinite ability to move for-
ard into expanding areas of social decency.

reative Bilateralism

Last but not least, my philosophic credo
rs by the essentiality of creative bilateralism
industrial relations by means of reciprocal
ency and mutual respect. The President of
e Radio Corporation of America, while ex-
iating on the marvels that electronic techno-
gy had thrown up, observed that there could
"no electronic substitute for a man's private
science, his sense of compassion and human
ignity." Similarly, come to think of it, there
not be a legal substitute for purposeful bi-
eral understanding in the field of industrial
ations. While delivering an endowment
ure on "Search for Industrial Harmony—
Broad Outlines", last July, at Bangalore,
commemorate the Golden Jubilee of the
isvesvarayya College of Engineering, Mr
3 Gajendragadkar, envisaged the possibility
creating an "atmosphere" wherein the strike
nd the lock-out become "unnecessary". That
the sort of philosophy that I am talking
bout. It is only voluntaryism—not, certainly,
w or the State—that can foster a mutual

It is not beyond human capacity to think right and do right—to work out a methodology of progressively reaching a dependable state of mutual acceptability as between the employer and the trade union.

understanding to forsake the path of eternal baiting and the adoption of the high-road of creative bilateralism. But law can help by putting a social premium on bilateralism. The creativeness lies in the voluntary forsaking of the approaches inspired by combativeness. Ultimately, all effective and reasonable solutions must necessarily be bilateral—not imposed by a third party. This is so in any sphere of human activity. Instead of preaching homilies, the Central Minister of Industrial Relations, Mr Khadilkar, should have asked the employers and the trade unions to work out, for a start, mutually acceptable codes of industrial relations behaviour and the trade union organisations the mechanics of obviating inter-union rivalry, which, in its own right, is a drag on our economic-industrial society.

Combativeness Outmoded

The unreserved *acceptance* of the trade union by the employer as an accredited instrument of social justice could reasonably and hopefully be expected to chasten the union; the acceptance of the employer by the trade union as a prime mover of industry, willing to welcome the trade union as a catalysing and democratising agent, could help render the recalcitrant employer forward-looking. But the basic funda-

ment for this consummation is eschewal of combativeness, as an outmoded technique, on the basis of a written-down understanding that provides for "enforceable mutuality". The two sides must agree to tie themselves down to the unswervable path of civilised ways.

Three International Examples

There is the satisfying example of the agreement, originally mooted in 1937 and renewed every five years and preserved intact even today, between the Employers' Association of the Swiss Engineering and Metal Industries and the Union of Metallurgical Industrialists of the Canton of Geneva and five major trade unions, viz., the Swiss Union of Workers in Metal and Horology, the Christian Metal Workers' Union of Switzerland, the Swiss Union of Evangelical Workers, the National Union of Free Swiss Workers and the Union of Free Workers of the Canton of Solothurn. It provides for an obligation "to settle in all good faith, any major differences of opinion and other disputes and in endeavouring to settle such disputes within the terms of this agreement, to maintain absolute peace for its duration. In compliance with this, such combative measures as labour boycotts, strikes and lock-outs are to be regarded as inadmissible, likewise in the case of disputes concerning working conditions not specified in this agreement". The mechanics of resolution of disputes provides for Workers' Committees at the establishment level "appointed" by the workers. If the Committee does not succeed, the problems are submitted "to the executives of the respective parties for examination and settlement." Collective disputes go before a "conciliation board" with a chairman of "magisterial standing" and two "impartial persons", the chairman being named jointly and "the impartial persons" being drawn from separate lists submitted by the disputants. In the event of the Conciliation Board's "recommendations" not finding favour with one of the parties, the Board gives an "arbitration award", if, initially, the parties had so indicated. On the other hand, if the Conciliation Board cannot settle the issue or issues, an "Arbitration Board" comes into being, the composition of the Board being, besides a "Chairman of the magisterial standing", "two competent judges", selected similarly from among those listed by the two parties. There is a key article in the agreement stipulating penalties for the breach of an agreement. The initial deposit of caution-money of the order of 250,000 Swiss Francs each, in the Swiss National Bank, could be withdrawn by the "winning" party, if "a specially appointed court of arbitration" were to impose a "conventional fine", the size being determined by the gravity of the offence and the party on which the fine is levied does not pay it within a month.

Here is a unique and heart-warming example of what I have chosen to describe as creative bilateralism. Then there is the Dutch example of "Stichting Van de Erbeid"—translatable loosely as the Labour Foundation—which was conceived by the resistance movement and set up after the occupation by the Hitlerite Nazi hordes ceased to be. Ten men represented all the employers' associations and ten all the foundation workers union organisations, save the communist one. They had a chairman jointly named to help, guide and goad. They literally locked themselves up till they found a solution and the Foundation which helped in achieving the imposing Dutch economic recovery from the ashes of Nazi loot and destruction.

There is the outstanding example of the in built conciliation and arbitration machinery o the International Chamber of Commerce, i Paris, handling disputes as between national of two countries, with a record of having giv over two thousand awards, a few subsequentl fought in national courts and most of the having been sustained.

Clearly creative bilateralism shows the w to sublimate industrial conflict and channel into civilised ways.

If my approach is one of the ivory to I am content to stay in it.

Industrial Safety and Productivity

Brig GR Chainani*

Today, in India we are on the threshold of industrial uplift. If we have to survive as an independent and developing nation, we have to raise our level of productivity. This will be possible if the most precious resource --Man --is properly cared for and motivated. Industrial accidents prove very costly to the nation. Accident figures have risesn from 196,000 in 1967 to 272,000 in 1970. In terms of mandays, the loss of time due to reported accidents is in the region of 2.5 million. Safety is really a production tool. Research findings point conclusively that a safe plant is also an efficient plant. When management and workers accept safety as a way of life, they will move in the direction of optimum productivity.

EVERYONE accepts the urgent necessity for higher productivity and simultaneously aims for zero accidents in industry. In fact, these are two areas where there is full agreement between Government, Employers and Workers. As regards safety, Government always encourages schemes that help to cultivate and inculcate safety in work. It is realised that this social necessity is more likely to be attained by arousing safety consciousness amongst everyone than by legislation.

The position as existing can be gauged from a report of January 1971 about U.K. It states "More than 20 million mandays a year are lost through industrial injuries: death and injury benefit costs are approximately £ 50 million a year while loss in terms of productivity is annually about £ 250 million and the indirect cost to employers could be in the nature of £ 200 million. If all factors are taken into account including industrial fires and loss of production through those fires, the total cost of industrial accidents is estimated at over £ 600 million a year. The cost in pain and suffering to the injured, their families or relatives is incalculable."

* Director General, Factory Advice Service and Labour Institutes, Ministry of Labour, Employment & Rehabilitation, Central Labour Institute, Bombay.

Another authority in U.K. estimates that the cost to the country due to industrial accidents works out at £ 1000 per minute.

The position in India can be gauged from our accident figures which have risen from 1,96,000 in 1967 to 2,72,000 in 1970. The frequency rate of accidents in our country is 57 per 1000 as against 33 per 1000 in U.K.

In respect of accident costs, it has to be realised that these are like an iceberg where the major portion in the form of indirect costs is hidden. Quite often it is not realised by managements that they are spending a lot due to accidents, as the costs are not directly visible or compiled.

In terms of mandays, it is estimated that loss of time due to reported accidents is in the region of 2.5 million. This represents only the time of the injured and it is generally accepted that the time lost by others is at least 5 to 8 times, i.e. the total loss works out to between 17 to 18 million mandays. As against this the loss due to strikes and lockouts in 1970 was 17.2 million mandays. Whereas there is a dispute in case of strikes or lockouts, as regards accidents there is unanimity that these must be controlled and prevented to avoid human suffering apart from other factors.

Of all the Ms—Money, Materials, Methods, Machines and Men—it has always been accepted that Man is the most important.

Accidents are responsible for:

(1) Loss of limb or life resulting in cripples or human wrecks as well as human suffering
(2) Loss of production
(3) Upsetting all plant schedules
(4) Damage to plant and equipment
(5) Financial or economic loss
(6) Lower morale of workers.

Human suffering alone demands urgent action, as no one will accept cripples and wrecks as byproducts of industry. This is particularly so when it is known and accepted that 85% to 95% of the accidents are caused due to human failure. A little care or timely precaution can prevent many an accident.

Man—the Most Precious Resource

Of all the Ms—Money, Materials, Methods, Machines and Men—it has always been accepted that Man is the most important. But do we pay adequate attention to this most important resource? When we buy a new car or a new machine, we train operators to use them. Is the same attention bestowed on a new recruit when he joins a new plant? Is he inducted in safety?

To answer this it would be worthwhile asking as to what is the function of industry. It is accepted that industry has to produce or provide goods and services which the society requires, with the minimum waste of resources. Industries all possible measures to increase the supply goods and services so as to improve the standa of living and create a fuller and more satisfyi life. In doing this, its prime duty to the nati is not to squander the most precious of t resources—Man. Any failure on this account a failure on its part to fulfil its prime obligat to the society.

It is the aim of every management to obtai optimum production. But when is this possibl It is only when the worker is satisfied and pr perly motivated. In some cases, industries f that once they provide a job and pay the worke their obligation is over. But Maslow has prov that this is not enough because man is alwa aspiring and he is not satisfied merely by prov sion of his basic needs of food, shelter and clotl ing. His second requirement is security, incl ing safety at work.

Behavioural scientists believe that the key motivation is man's creative abilityand his stro desire to influence his own destiny, specially h work. He does not object to efficiency and con genial surroundings so long as he is not exploited He does not want to be treated as a 'productio machine'. He wants to play a part in the enti activity.

Safety Motivation

As regards safety motivation, most of us see to believe that little training, clever posters photographs exhorting employees to be safe a adequate. But can motivation be different fo safety which is essentialiy a human problem The truth is that whatever motivation is necess to influence or inspire a worker to optimu productivity, will be equally essential to motiva him to work without accidents.

Unless management realises this and creates sense of safety and a feeling of security amongs workers that it is taking effective steps to com hazards and that it is interested in preventin accidents, it is unlikely to secure full cooperatio of workers and achieve optimum productivity.

The Indian Scene

Today in India we are in the threshold of industrial uplift. It is worth remembering in this context the conditions that existed in U.K. at the time of industrial revolution, which in the words of Dr Donald Hunter, were as under:

"The industrial revolution gave rise to these discomforts and diseases which did not affect the privileged classes of society but only those who laboured in the workshop, factory or mine. For a long time the work of these men, who were indispensable for the prosperity of the community, brought them nothing but physical, intellectual and moral poverty.... As regards factory owners, so long as they professed to fear God and attended morning prayers and Church on Sunday, they felt their duty to workers was over."

It will be a great pity if we accept these conditions in our country.

The prevailing conditions in India and the factors influencing workers, managements and trade unions need to be briefly summarised.

Workers

(1) Till recently India was essentially an agricultural country. It is only in the last two decades or so that it has made great strides in industrialisation. The resultant rapid changes have brought forth several problems relating to the adjustment of man to the changed conditions. Indian workers with primarily rural background have been slow to realise the latent dangers in various industrial processes and operations. For them life in the industrial environment is new and it has also added psychological stresses.

(2) Deep-rooted faith that any event including a calamity or accident is an act of God accentuates the problem. This fatalistic outlook towards accidents and events over which they have little or no control, though on the decline, is a serious impediment in any effort for accident prevention.

Behavioural scientists believe that the key to motivation is man's creative ability and his strong desire to influence his own destiny, specially his work.

(3) Workers are available in plenty and there is fairly high level of unemployment. Because of this, managements are prone to exploit temporary and casual workers with very little job training and with hardly any safety indoctrination.

(4) In a tropical country personal protective equipment is not comfortable due to heat and humidity. The available equipment is often not suitable and hence there is reluctance to use it. Designs to suit local conditions have yet to be fully developed.

(5) Indian workers also loathe protective equipment as they consider it unnecessary or unworthy of experienced or skilled workers. They also are optimistic that accidents won't happen to them, particularly when they have not been involved for sometime.

(6) To improve their prospects and earnings, low-skilled workers try to learn better trades on their own and in this process get involved in accidents.

(7) Many a worker is the sole wage earner in his family and in his anxiety to maintain his family he takes risks by trying to do more work than his physical capabilities can permit, in order that he can earn a little more. At times his eagerness for higher emoluments tempts him to forget safety and either work without guards or adopt short-cuts.

A safety-conscious union has long been accepted as the most effective weapon against worker injuries.

Management

(1) Except for a few enlightened employers, their attitude in providing healthy and safe working environment has been more to comply with the letter of the law rather than the spirit underlying it.

(2) Due to State insurance against accidents employers pay their contribution irrespective of their accident rate and there is no direct incentive for safety activities.

(3) The rate of compensation for industrial injuries is not high and labour is easily available. Hence there is little motivation or pressure on management for vigorous safety programmes.

(4) There is little knowledge about accident costs, as only direct costs are known and even their impact is not felt due to State Insurance and easy availability of labour.

(5) Some industrial managements seem to believe that their primary job is to keep the wheels of production going and they need not waste their time and effort on safety. They have not realised that production can be violently disturbed by one single accident and that hazards on the job provide one of the biggest impediments in the fulfilment of their production responsibilities.

(6) In general, the top man does not run the same risk of accident as the worker. Therefore he does not seem to realise the necessity for safety.

(7) Penalties imposed for violation of Factories Act are not heavy and do not serve as a deterrent for the managements.

Trade Unions

(1) Industrial accidents and unsafe working conditions have not attracted the attention of the Unions to the same extent as claims for higher wages or cash benefits.

(2) Although they place lot of stress on fringe benefits like extra milk and better quality of food, they have not so far vigorously clamoured for accident prevention and improvement of working environments.

(3) Trade Unions have yet to really feel the involvement in safety movement and appreciate that one of their important tasks is ensuring workers' safety. This is particularly so, as by virtue of their position they can play an effective role in safety propagation. They can provide the biggest fillip in accident prevention activities.

(4) A safety-conscious union has long been accepted as the most lethal weapon against worker injuries. In certain advanced countries unions have established specialised safety programmes and campaigns for improvement of working conditions. Their activities have yielded very promising results.

Plant and Equipment

(1) Although there has been rapid growth of industries—many with modern plant, machinery and equipment - yet there are a number of factories with old machinery, inadequate safety arrangements and environments not compatible to modern requirements. Their layouts and design features are far behind the present expectations. As such there is comparatively greater proneness for accidents and occupational hazards in these factories. Economic and other reasons do not permit their quick modernisation.

(2) In certain cases even new plants and machinery do not conform to the safety requirements either due to initial investment or other reasons.

(3) There is no legal ban on procurement of hazardous machinery without proper guards.

(4) Although certain ISI standards exist for safety of plant and equipment, there is no restriction on procurement of non-standard plants and machinery by industry.

Everyone accepts and cannot dispute that if we have to survive as an independent and developing nation, we have to increase our tempo and raise our level of productivity. But it has to be accepted that this will only be possible if the most important resource - Man is properly cared for and motivated. Robert Owen, a champion of workers' safety remarked in 1815 "If, then, due care as to the state of your inanimate machines can produce such beneficial results, what may not be expected if you devote equal care to your vital machines which are far more wonderfully constructed." This is particularly so as industry of the future electronics, chemical, nuclear—may introduce numerous physiologic, pathologic and psychologic health problems not only for workers but electro-magnetic radiation may affect those yet unborn.

Safety Measures Bring Rich Dividends

Many factories have achieved higher productivity and improved their performance. But records of successful enterprises reveal that those particular factories have paid lot of attention to safety, because safety and productivity are in harmony. In many cases it has been ascertained that areas requiring improvement in respect of productivity are invariably common in so far as safety is concerned. In many cases efforts to prevent accidents have revealed areas of inefficiency in production and hence improvements bring a boost both in productivity as well as safety.

Safety is really a production tool. A poor accident record is an indication of inadequate attention. In such cases investigations have revealed many other mistakes in production practices. Consequently a good safety programme and production go hand in hand, as such managements have realised that even one accident can disrupt the entire production.

This has been amply demonstrated by Tata Iron and Steel Co. who undertook a study on productivity and safety in their plant. It was found that those departments which had paid considerable attention to safety were the ones which gave high productivity.

Correlation Between Safety and Productivity

In analysing the influence of safety on productivity several research findings point conclusively that a safe plant is also an efficient plant. A survey was undertaken by the American Engineers' Council to examine whether a positive correlation between safety performance and efficiency of production existed and also whether a safe factory is an efficient factory. Their findings were (1) Experience of a large group of companies shows that material reduction in accident rate can be secured simultaneously with increase in production rate; (2) Efforts to improve safety performance do not interfere with production processes; (3) Maximum productivity is generally secured only when the accident performance tends towards the irreducible minimum; (4) Improvements can be achieved by a majority of plants in respect of both production and accidents; (5) Industrial accidents can be controlled under modern conditions of highly efficient production.

In another survey carried out in the United States it was found that in the highly productive plants, the employees' attitude was positively safety-oriented and hence better performance was attained not only as regards accident prevention but also in respect of productivity.

These studies clearly prove that where managements have taken genuine interest in the safety of workers and not only because of production, they have achieved higher standards of both safety and productivity. This is in line with the philosophy of organisations with a very high

safety achievement like the I.C.I. and Du Pont, who have adopted the motto "Production with Safety".

Advanced countries have accepted as their objective "Make living safe by improving environment and conferring optimum health, safety and comfort and to protect the present generation and those yet unborn".

National Commission on Labour has remarked: "In a country as populous as ours there may be danger of a tendency to discount the value of human life. Loss due to accidents and through the slow and agonising processes of occupational diseases may not stir the community as much as it does in advanced countries with chronic shortage of labour. Although relief gets organised after the event, prevention does not attract the same vigour and enthusiasm".

Efforts by Safety Organisations

This seems to imply that no effort is being made to promote safety. But some personnel and organisations are hard at work doing everything to eliminate or reduce the loss of lives and limb and stall the increasing number of accidents. These are the State Chief Inspectors of Factories, the Central and Regional Labour Institutes and the National Safety Council. They all propagate safety and improvement in working conditions to attain betterment of workers' performance. The approach of the Central Labour Institute to safety is multidisciplinary in that the subject is viewed not only from mechanical hazards but also from the human research, productivity and psychology angle. Study of the man is done in toto, because it is not mere guards or machinery but other conditions like his outlook, working environment, ergonomics, etc. which are contributors to his satisfaction at work. A number of studies, surveys and seminars are undertaken to create interest in the subject and to guide industries on steps necessary to bring about reduction in accidents. Training programmes are organised for trade unions and workers—in case of workers, at the moment, these are conducted in seven regional languages.

To arouse the interest of managements the Government has constituted National Safety Awards to reward those industries whose performance in this field is outstanding. The schemes have been extended to cover a lot more factories as well as ports and docks.

Life is full of hazards—economic, political, social, occupational and domestic, but man has always overcome them by his inventiveness, ingenuity, determination and innovation. As new hazards come with new products he finds means to combat them.

It is necessary that interest in safety is maintained because even if the workplace has been engineered for safety, even if work procedures have been made as safe as possible and even if supervisors train their men and continue to enforce safe work procedures, it is not possible always to anticipate all the hazards, all the unsafe acts and other conditions and hence interest must be maintained so that workers employ imagination, common sense and self-discipline to protect themselves. Each worker must be stimulated to think beyond his immediate workplace in order to act safely in situations not originally visualised.

Industrial safety and productivity are human problems. Unless managements create the confidence that they are genuinely interested in the worker they cannot motivate him. They will neither achieve higher standards of safety nor higher level of productivity. When managements and workers accept safety as a way of life and not as a super-imposed factor, they will move in the direction of optimum productivity which is vital for the progress of our country. □

The man with a new idea is a crank until the idea succeeds.
— Mark Twain

Impact of Overtime on Operator Performance

Ravi Sharma*

The technique of overtime operation is normally resorted to by the industry when a sudden extra demand is felt on the system. The fundamental idea is based on economic considerations and infrequent shortlived overtime operation is not an unhealthy sign. Due to some psychological and social reasons, normally, the poison, which was originally intended to act as a medicine for the sudden demand problem, concentrates and inhibits the production system. It hampers the operator performance and the production process is rendered uneconomic. This tends to paralyse the system and must be treated first. Attempts to implement econcmising techniques at micro level ignoring this malady are like trying to treat an ordinary skin disease first when the human body is suffering from Leukemia.

The operator's total earnings are analysed as a function of his efficiency of performance and it has been revealed how at a certain point the motivation due to incentive wage ceases to be effective. The figures have been computed from actual paysheet analysis of a production shop. Remedies have been suggested and their applicability to different situations has been discussed.

NORMALLY it is taken to overtime operation when a production group fails to achieve the scheduled target for some reasons. The intention is to make up for the lag without incurring permanent investments in machines and manpower capacity. It gets introduced into a system mostly after strikes and lockouts whether they be in the system or in a competing system. However, there are many other reasons which are responsible for sudden positive fluctuation in demand.

Social Aspect

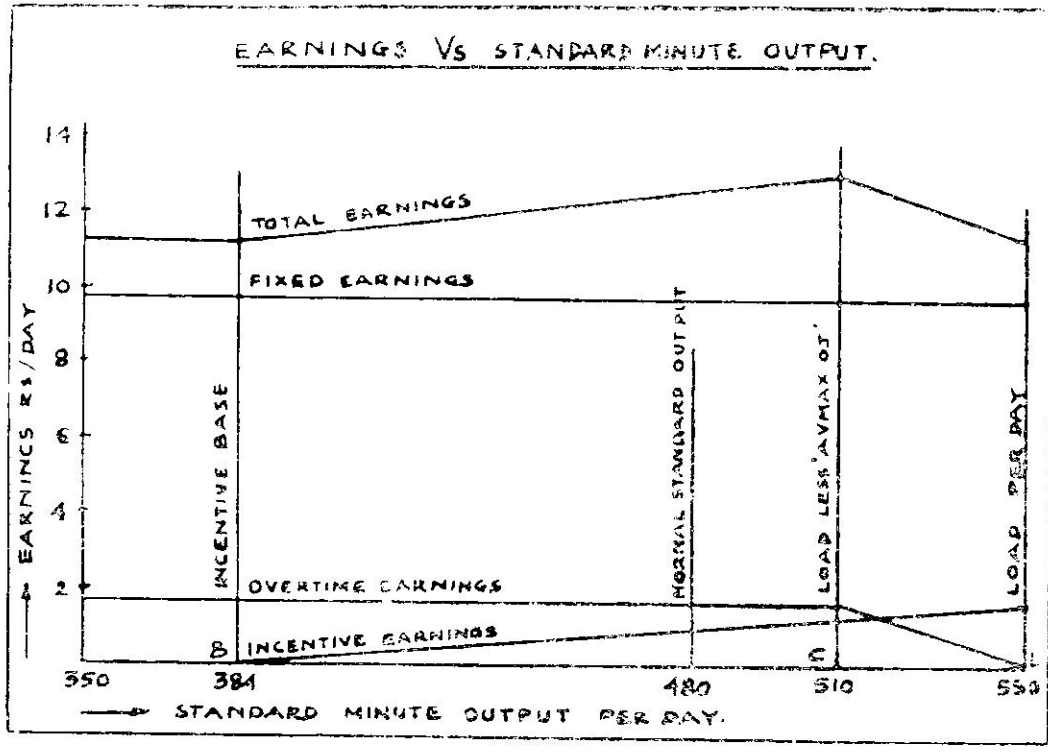
The labour in a country like India where the labour wages are not at par with the living costs and sources of entertainment are scarce, an average operator is attracted to spend some extra time in the Factory and supplement his income. As a result of interviews with the operators of different age groups it was discovered that in most of the cases, the operators welcomed overtime operation.

Parkinson's contention that 'expenditure increases proportionately to the income' works and operator increases his standard of living: The standard of living is a function with bias towards positive movement and the operator finds it difficult to live if the increase in earnings is not sustained.

Psychological Aspect

The overtime operation thus assumes the status of a privilege given to the operator and any man with least reason will like to utilise it to the maximum possible extent. The management misconceives that it is cheaper for them to allow overtime to existing manpower rather than employ more men and many a times it becomes a regular technique to cope with sustained increase in load. Also, the management feels that by this process of giving extra money they are

* Systems Analyst, Alembic Chemicals, Baroda.



keeping the employees happier. It is not rare to find organisations overshooting the government specified limits by large amounts.

Break-up of Earnings of Operator

An Operator gets a basic wage and some allowances which go into the making of his fixed earnings. These fixed earnings may not be constant from time to time but the term 'fixed' implies that they are independent of his efficiency of performance. In most of the industries the system of incentive wages is welcome and operators are paid money which by some relationship is linked to his efficiency of performance. If overtime operation exists, then the opearator has this third component of his total emoluments.

A Case Study

The following analysis of operators' total earnings is based on a case that existed in a manufacturing industry.

Fixed Wages: With the cost of living index the fixed rates of payment have been revised and increased time and again, in the Indian Industry. In the case under consideration the average fixed earnings of an operator were Rs. 9.71 per day.

Incentives Wages: There are various designs of linking the incentive wage with the operator performance. Normally the measure of performance is the standard minute output and if it exceeds a certain base value money is paid to the operator for every added standard minute output. The case under consideration had an incentive wage rate of 1 Paisa per extra standard minute produced over that corresponding to 80% of the working minutes. This rate was constant for all efficiencies of performance

and for all machine operators irrespective of the differences in fixed wages. Also, a ceiling was provided at 160% efficiency, beyond which the incentive was not paid. This corresponds to a maximum of Rs. 3.84 per day.

The Graph: The total earnings in rupees per day and its components have been displayed against the standard minute output of an operator per day. The abscissa has point B at 384 at which the incentive earnings commence. The terminal point L is chosen arbitrarily here and it indicates the standard minute load per day which is exerted on an operator by virtue of the planned rate of production. The maximum allowable overtime when distributed on all the working days in a quarter gives an average of 40 minutes per day. Let us call it 'Avmax Overtime'. The point C is at Load Less the 'Avmax Overtime'.

The graph before B is not included in entirety to magnify the Zone which is under analysis.

If an operator is loaded by L standard minutes per day and he knows that company can allow overtime upto a maximum of AVMAX OT per day he will pile up work at least as much as it corresponds to AVMAX OT standard minutes. This will enable him to earn maximum permissible overtime. A performance beyond C will increase his incentive earnings at 1 Paisa per standard minute output but his overtime earnings will reduce at 4 Paise per minute. The slope of the total earning curve is the slope of incentive curve plus the negative slope of the overtime curve.

An attempt to perform beyond point C, when such arrangement of operation exists, will be a burning example of quixotic chivalry.

The Paradox: The case wherefrom the earning figures were picked up was extraordinary, yet it is not very difficult to find more of the kind. Here, the company allowed 140 minutes of AVMAX OT against 40 minutes specified by the Government. People at the helm of affairs thought that they are violating the Law for the better.

The Effects: The operator performance dropped down considerably and there was a continuous lag between the targetted load and the output.

The operators at key posts where they alone could work started absenting. On absenting an overage operator lost Rs. 9.71 + Rs. 3.84 = Rs. 13.55 at the most, while he earned Rs. 9.71 × 2 = Rs. 19.42 if he did the same work in overtime operation. The high absenteeism made the planning and scheduling ineffective and the system performance deteriorated further.

These effects lead to operation which is wasteful to a high degree. Also the performance became inelastic. In attempting to stretch it beyond the existing level the industrial engineer will waste his efforts.

The Remedy: Prevention is better than cure and it is best not to resort to overtime operation. At least it should not become a method of dealing with sustained increase in demand. It may be permitted if there is some sound reason for loss of production, and that too for short periods.

The rate of incentive is not impressive compared to the rate of overtime payment. The incentive rate should be so increased that it may, combined with the attraction to reach home earlier, overweigh the overtime rate. The labour with high fixed wage is immune to this remedy.

The incentive should be differential in at least two planes, along the efficiency of performance and along the basic wage rate. A skilled operator should have a higher rate than an unskilled one.

The ratio of overtime payment to fixed wages by the government is a bit too high. It may have been justified when it was established years back but since then the fixed wage rate has increased considerably to render it a bit high.

Handling Labour for Better Productivity: "You are Right" Approach

Vijai Shanker*

President Theodore Roosevelt once said, "If I could be right seventy-five per cent of the time, I would reach the highest measure of my expectations". If that was the highest limit President Roosevelt could hope to achieve, what about us? If we could not be confident of being right even on fifty per cent of occasions, should we outright condemn people that they are wrong? It is quite possible that the other man may be totally wrong. But the important point for consideration is, does he think so? Probably not. There might be several underlying reasons why he thinks, acts in that manner. If you endeavour to analyse his actions and try to understand him you may develop interest in the cause and ultimately may not totally disapprove of his actions.

Trying to figure out why people act the way they do is a lot more enlightening. People may develop sober and sympathetic attitude after knowing the reasons. This may save them a lot of unnecessary irritation. A manager may feel that the employee's action is wrong while in certain cases and circumstances his action actually might not be so. When this attitude is developed, he may proceed to approach the problem in a more objective manner.

We quite often see, hear and read in papers about deteriorating employer-employee relations, falling production, suffering productivity and mounting inefficiency and idleness. Why is it so? In this article, the author attempts to analyse the problem to know the causes with a view to finding satisfactory solutions.

IT is no doubt recognised that man is by and large the most important factor with which the management has to deal. Materials and machines are inert factors, but man with his ability to feel, to think, to conceive and to plan is the most valuable and at the same time the most difficult element to handle, to inspire and to control.

Out of the many causes of industrial strife, problems of wages and human relations are perhaps the most important. Wages are only occasional problems and once certain basic level is achieved they do not trouble much, since the employees then try to seek other satisfactions. As human beings behave in a familiar pattern almost everywhere, employees anywhere want such things as personal dignity, security, recognition and participation besides adequate wages. Peter F Drucker, a well-known American Management Consultant, says in his book 'The New Society': "Every study of industrial workers has shown that wage rates are not uppermost in their mind."

Human relations problem is perennial and adjustment and re-adjustment has to remain in constant play for maintaining a congenial climate. Robert W Johnson, an American pioneer in 'human relations in industry' movement has stated: "The most vital rewards, however, are those of appreciative recognition: if they are adequate, money becomes secondary." Considering the importance of good human relations as a factor for improving day-to-day relations

* Assistant Director, Indian Institute of Labour Studies, New Delhi.

and climate in an organisation, some approaches to tackle the human relations problems are discussed here. If practised intelligently, they would enable the men to work more efficiently and productively.

Human Relations Problem

Twentieth Century has been the era of dynamic change; colonialism has almost disappeared; racialism is at its last; man is completely free and is treated equal irrespective of his birth, money and position. There has been vast explosion of knowledge almost in every field. There is no doubt that in good many ways, today's labour force too is a lot better than some three or four decades ago. The present workers are better-educated and better-informed about the world and have broader outlook. Most of them have fine motives and contemporary moral attitude. This has given them new horizons of thinking, new ambitions and new aspirations. New tools and techniques have been given in the hands of the new generation. The development of modern labour has brought about a revolt against things as they are since they feel there are ways of doing things better.

The new outlook suggests that managers and supervisors instead of being concerned mainly with production and enforcing discipline should take due interest in their workers as human beings and should try to understand their problems and help them solve them. The workers must be given opportunity for showing initiative. The emphasis needs to shift from production-orientation to employee-orientation. It is thus not unnatural that the new generation of working people who were perhaps born in Independent India, have revolted against the old domination and conservatism. While the revolution in thinking and consciousness has grown all round, vandalism, violence and indiscipline is at the hands of only a few, who constitute just a nominal minority. According to an American Judge, 97 per cent of the labour force is as good as those of any generation but the 3 per cent who are hoodlums are worse. Not more than that would be the percentage of hoodlums in our country too. Unfortunately, however, many people now-a-days have become so obsessed with the excesses of this small minority that they forget to note the decency, service and intelligence of the overwhelming majority.

Human relations is a perennial problem and adjustments and readjustments have to remain in constant play for maintaining a congenial climate.

The problem is certainly not as bad as is more often projected. Yet, it needs adequate awareness, participation and proper tackling. Majority of the labour do not approve of violent methods. Neither do they condone excessive drinking and experimentation with narcotics, outbreaks of vandalism and crime which are indulged by the headless few. To face the consequences of the actions of this irresponsible minority, mere passive disapproval on the part of the majority is not enough. The conscientious people among them should be more active in denouncing and in actively helping to curb the unjustified strikes and use of violence. The newspapers report alarmingly on labour unrest, demonstrations, vandalism and arrests etc, while activities like labour's decision to donate blood to save the lives of needy patients, their raising money for helping the widow of the deceased worker do not get enough publicity. The sacrifices made by the labour during aggression by China and Pakistan in both putting in extra-hours of work as well as donating liberally out of their hard-earned wages belie the all-too-common view that the workers are only evaders and idlers. These are only few of the innumerable instances where workers' contributions have been commendable.

The new outlook suggests that managers and supervisors instead of being concerned mainly with production and enforcing discipline should take due interest in their workers as human beings.

Sympathetic Consideration of Grievances

When the whole problem is limited to a small number of people it should not be very difficult to be tackled provided concerted effort is made by others. It is the individual grievances and frustrations that provide fuel to the ignition caused by a few. It is, therefore, necessary that individual grievances should be solved quickly and dissatisfactions should not be allowed to accumulate.

While dealing with people, we must understand that they have emotions, prejudices, pride and vanity. People normally do not own that they commit mistakes. Even the wrong-doer blames everybody but himself. He more often justifies his action by saying: 'I don't see how I could have done otherwise under the circumstances.' When this is the general mechanism, how should the problem be handled? Severe criticism only annoys the other man, puts him in the defensive. It ends in futility. Criticism is the potent source of generating misunderstanding. The employers must bear in mind and be careful not to chill workers' lives by fault-finding. It is not tactful to directly tell the worker that he is wrong. It defeats the purpse. It makes employees so tense and insecure that they make even more mistakes. It motivates them to cover up errors and spend their time trying to avoid looking wrong. The upward communication is impaired and higher management can never get a clear picture of what is really happening down the line. In an effort to uncover the faults, and deceptions management sets up inspections while the employees become adept in hiding mistakes. The enlightened managements, however, will try to learn rather than try to fix responsibility. They look upon mistakes as an opportunity to introduce reforms. They recognise that people, under stress of anxiety, may become suspicious or resentful or downright hostile which may prove sometimes explosive.

Need for Positive Approach

It is necessary to tackle the problem in a positive way. The main source of discontent and conflict between employers and employees appears to be the misunderstanding and mistrust. Misunderstanding leads to mistrust and ultimately to conflict. It should, therefore, be the foremost duty of the employer to remove these from the minds of the workers before they could expect development of a happy relationship. Employees have their own prejudices, emotions and weaknesses. It is really a tough job to understand them and find out the reasons behind the indiscipline, fault or negligence and make them unburden their pent-up feelings. When the employee gives out emotions he becomes a more reasonable person. But how can we do this more successfully? Should we start by pointing out his faults or weaknesses, by criticism or by threats of punishment. Quite the contrary. An employee preoccupied with his problems cannot be expected to shift focus instantly and respond the way the employer wants. It should be found out what is on the employee's mind. To achieve this he should first be made to feel at home. The approach should be friendly and should give due recognition and appreciation to the employee, his qualities and achievements which should make him feel important. Every employee needs to feel that he is good and acceptable. I would call this "you are right" approach. This approach does not antagonise the employee, does not make him reassert or tend to develop hostile attitude at the very outset. On the contrary, he will respond favourably. This is the stage when step by step counselling and other remedial measures can be adopted.

The employee should be made to feel that any average man under the same circumstances would have done the same thing. He should be given ample opportunity to rationalise or save his face if he so chooses. Protecting the other person's pride is a vital part for eliciting information. This, however, does not mean that management should sit idly by when employees violate rules, turn out slopy work or fail to do their job. Such laxity is not only bad for production, it is also unfair to the conscientious worker who carries out assignments effectively and even serves to encourage the 'culprit' in his bad work-habits. The employer cannot ignore faults. But the way he handles them may determine whether his subordinates will resent his use of authority or will come to look upon him as a source of help.

"You are right" approach though not a panacea for the conflicts, grievances and problems, can help successfully resolve many a problem and avert many a situation taking ugly turn.

Every situation we have to deal with is mixed. It is mixed from within and without. We should, therefore, recognise that two or even more apparently contradictory viewpoints may be true, or partially true of a particular situation. Basic to communication is the act of helping the labour to give expression to their feelings. It seldom pays to condemn or reason with an angry labour: strong feelings vanish not by threat but rather by clarification of the problems that occur in his mind. While talking about problems the aim should always be the action and not the man. It should be remembered that behind all these efforts and enquiry the purpose is to correct and discipline the employee and not to punish him. To say "I dislike you" is to store up his frustrations that will augment future misbehaviour. The fault you want to correct should seem easy to correct. The thing you want the other person to do should seem easy to do. Reassurance and encouragement rather than reprimand are often the best medicine for employees' frustrations or failure. A manager should not forget that he is supervising human beings and not just workers.

Sometimes a manager may have to deal with a crook or a deliberate mischief-monger in his establishment. In such a circumstance he should apply measures against him, prejudging the pros and cons and the extent of the success. He may need a different type of treatment. Hasty action should absolutely be avoided. However, so long as his relationship with the employer is tolerated and he is maintained on roll one possible way of getting the better out of him is to treat him as if he were a respectable and responsible man. Subtle appeal to his sense of responsibility towards the establishment, the society and the nation may also do good sometimes.

Arguments to defeat or convince the other should be avoided as often as possible since it is difficult to win an argument. More so, once struck he will never repose confidence in you. Confidence should be invited, not demanded.

'You are right approach', though not a panacea for all the conflicts, grievances and problems, can help successfully resolve many a problem and avert many a situation taking ugly turn. "You are right" is a subtle and individualistic approach. It needs self-training, practice and skilful application. A word of caution, however, is that this approach will work effectively so long as the other party does not know that it is being applied. Someone has rightly said, 'art lies in concealing art'. □

Quality and Reliability Through Standardisation†

PKS Menon*

The main problem which the consumer more often faces is that of reliability of what he buys. The consumer may be a common man or an industry. Quality is the foundation stone for reliability and both are complimentary to each other. Reliability of a product reflects the consumer's confidence in its performance and its lasting trouble-free service. In this paper, the author attempts to highlight the role of standardisation the vital link between the manufacturer and the consumer in providing satisfaction to both.

THE other day, a housewife went to a grocer's shop and asked for a packet of her favourite brand of soap powder. That particular brand being out of stock, the grocer offered packets of several other manufacturers for the lady to choose from. She was bewildered to find an enormous number of nice packets all claiming to be the best in the market! Suddenly she remembered the gossip going round about the spurious products in circulation. She was in a fix what to do? Which one to take home? Conscious of her tight family budget, she did not want to take any chances. She thought it wise not to buy then, and returned home empty handed, all the time thinking on her way back which one would have been her best buy.

Next day, she appeared on the scene, this time accompanied by the versatile 'Know-all', her own husband. He had a quick glance on the packets presented and his watchful eyes spotted a particular 'not so nice looking' packet. He turned to his better half and said, "well, this is the packet you should take. You see this mark here. This is the standardisation mark. It is the guarantee for a quality stuff. You can rely on it."

Such little instances do happen in our day to day life. This is the present market situation. Often helped by our long experience, we develop a certain kind of reliability with a product and its brand name becomes a favourite with us. At the same time we are not sure of the quality of similar products available in the market. And we do not want to take any chances with an unknown quality. If somebody is there to help us with the advice that "this is good", then perhaps we may venture to make a fair trial. This somebody is the 'Standard'. It is this confidence and faith that can be put in the standard which came in handy for our versatile man to pick out a reliable stuff.

Another trend among the customers is to rely on the so-called "foreign quality". Anything available in the market claiming to be foreign made, is blindly accepted to be much superior and more reliable than our indigenous manufacture, the latter being frowned upon as *Desi* Quality. Admitting the fact that there are some plus points in some of the imported items, which have been evolved after long years

*Quality Control Manager, Alembic Glass Industries Ltd., Baroda.

†This paper won the first prize in the Essay contest organised by the Indian Standards Institution, in collaboration with National Productivity Council as part of APY-1970.

of research and painstaking labour, the blind faith in their quality and performance leads to so many pitfalls. The trade, aware of this susceptibility of the customer, easily passes off some fake and clever imitiations. Though our government has come with a heavy hand in banning the import of all the non-essential items and imposing heavy import duties on several others, with an eye to boost up the indigenous quality, the easily-gullible customer falls a prey to smugglers and their associates. Unwittingly he is encouraging the smuggling trade and comes in the clutches of the law.

The main problem that faces the common man today is that he cannot rely on what he buys. Or, for that matter, he is not sure about the quality of the products available in the market. Quality is the foundation stone for reliability and both are inter-related. As nothing lasting can come up without a solid foundation, let us understand what quality is.

Quality, Reliability and Standardisation

The word 'Quality' appears to cover a wide notion for the best in everything. Some connote the word with perfection or an ideal state of affairs. And some are more liberal to identify it as the best available in a given situation. From an industrial point of view, quality covers those attributes of a product which make it suitable for its proper end-use at the prevailing cost. Here, a balance is struck on the utility and the cost. This being the concept of quality and the manufacturer assures of the same, let us see how we can instill in the customer, the reliability aspect of the product.

Reliability of a product is the customer's confidence in its performance and its lasting trouble-free service, when put to use. Say, G.S.L. bulb should give a fixed number of hours of light of a particular intensity under specified conditions before it gets fused. Similarly, any medicinal preparation should give the indicated potency during its shelf life. Once these requirements are complied with, the customer feels a kind of confidence in the product that it will faithfully serve his purpose. And this is the reliability aspect of the product.

Between two strangers, always a common friend is required to instil mutual confidence in them. When one is not sure about the bonafides of the other, a third man should be in the picture to assure the same. And this is what standardisation hopes to do. So three parties are involved in the affair: the one who makes and puts the product in the market, the manufacturer, the one who goes in for purchasing the product, the customer, and the third one, who assures the quality and reliability of the manuacturer's product to the cutsomer. Let us visualise this third one as the 'standardsman'.

A vital link is thus established in the marketing of a product. The standards or standardisation gives the much-needed satisfaction to the customer which is a number one asset to the manufacturer at any time. An atmosphere of complete satisfaction prevails at all stages. The manufacturer is satisfied, he is giving the correct product. The standardsman is assured of its qualities and the customer is fully satisfied that he is getting a reliable stuff. It is this atmosphere that helps for the healthy growth of the industry, and let us see how each one takes care of his own problems to achieve his objective.

Industry and Standardisation

The manufacturer's headache starts from the incoming raw materials. The age-old saying of the farmer that 'better seeds lead to a better crop', holds equally good in the industry as well. An uninterrupted supply of raw materials of the required specifications (standard) to the industry, solves half the problem. For this, the supplier of the raw materials and the manufacturer has to sit together and find the most suitable solution. Now, this supplier may be supplying the same raw materials for the same industry elsewhere in the country, also.

Hence, it is a better practice to bring together all the manufacturers and suppliers of a particular industry on a national level, come to a sort of understanding or agreement as to the best available quality of suitable raw materials which can be supplied. Once this is done it is the responsibility of the supplier to see that all his supplies to the same industry conform to the quality

requirements jointly arrived at, and the manufacturer has no reasons to grumble about the incoming quality. In other words, there should not be any deviation from the set standards in any lot supplied at any time. Thus the standardisation of the raw materials solves the problem of the quality and the reliability of the incoming materials to the mutual satisfaction of the manufacturer and the supplier.

It is easier said than done. Now, the crux of the problem is how to know that the supplier is adhering to the standards in each lot supplied and the manufacturer at his end really gets the required quality. Here the standardsman is of mutual help. He can test random samples from each lot at either end and certify whether the requisite standards are adhered to. This is a relief for both the parties. They save money, time and labour. They need not keep and maintain elaborate equipments and staff for this purpose. An impartial authority certifying the quality will increase the mutual confidence. The same certified lot, the supplier can confidently send to any other part of the country for the industry's use.

Now comes the manufacturer's arena where he has to strain every nerve to see that the end-products are of the specified quality. He has to put in action, all the management tools at his command like zero defects, process control, planning and co-ordination, inspection, etc. for an efficient and smooth running of his plant. He comes out with a product that speaks of the hard and sustaining work behind the scene. This finished product is subjected to regular routine tests of quality control for conformity with the standard specification.

Here again comes the standardsman with his inspection system. He collects random samples from the lots of the finished product and satisfies himself whether they conform to the set standards. In case they are, and the standardsman is fully satisfied with the performance, he allows the manufacturer to put the finished product in the market with his certificate of guarantee that these products do conform to the set standards and will undoubtedly serve the purpose for which they are meant.

This guarantee serves as an eye-opener for the customer and he need not have any apprehensions in accepting the product. He is more confident that he is getting a stuff which will definitely serve his purpose. He can rely on the quality of the product, once he sees that it has passed certain standards passed by an independent third party—the standardsman.

The responsibility of the standardsman does not stop here, once he approves the product and gives the green signal for the free flow of the product into the market. There is a follow up action. He collects random samples of these products (which he has earlier approved) from different markets and re-tests them to confirm his old findings. In case of doubt or in case the market samples do not conform to the standards, the standardsman *withdraws* the consent already given to the manufacturer and this fact is notified to the trade and the customer. So the action of the standardsman acts as a deterrent to the manufacturer from making any lapses and a warning to the customer about a faulty or defective product. Other manufacturers take a lesson from this and become more cautious about themselves. Meanwhile, if the first manufacturer whose products have been found sub-standard, does not improve his performance, this situation is taken advantage of by the competitors in the field and probably the former may be slowly pushed out. So this constant fear keeps every manufacturer on the alert to jealously safeguard his reputation and produce only reliable stuff acceptable to the customer. Here we see how the standardsman is helping to guarantee the customer the quality and reliability of the products.

Eventually the quality-conscious customer will become standard-conscious. He will be ready to accept any product in the market which has passed the requisite standards. And this consciousness develops into a confidence in the standardisation itself.

To safeguard the interests of the customers and to advise the latter on the reliability of

any products available in the market, some kind of association of the traders like the "Fair Trade Practices Association" and one for the customers like "Consumer Guidance Society" can be formed, dedicated solely for the customer benefit. They can as well represent customers' view points and requirements to the manufacturers. Any discrepancy in the adherance of the set standards noted by the standardsman can be intimated to this body for guidance to the customers.

Now, how to evolve this standard acceptable to both the customer and the manufacturer? There will be other manufacturers in the same industry. If everybody is to adhere to his own standard and claims that his products do pass his standards, customers are at a loss to compare and evaluate the quality and reliability of their individual products, a situation which the housewife had to face. Hence, in the interests of the customer it is advisable to have a common standard acceptable to both. For this purpose all the leading manufacturers of the same industry meet together on a national level, work out a uniform attainable standard in consultation with the body representing consumer interests. As mentioned earlier, the third party, the standardsman acts as a mutual friend to help each other.

Institutional Customers and Standardisation

So far we have dealt with consumer goods industry where the customer is generally the public. Now there are other industries where the products of one manufacturer goes for further processing, assembling, filling, etc. Industries engaged in yarn production, making of engineering accessories, container manufacture, fall in this group. These customers are institutional customers and naturally their requirements will be in bulk quantities. The products may be required all at a time or may be spread throughout the year. These products form, in a sense, the raw materials for the other.

As dealt with earlier, the same principle of standardised raw materials holds good here also. The responsibility of the first manufacturer is all the more greater as the smooth functioning of the production line of the second manufacturer depends entirely on the reliability of the products that are coming in for processing. The whole bottling plant in an aerated water factory has to be stopped if the bottles that are coming in, gives way while filling. The production line in a pharmaceutical plant will be definitely affected if the hollow closures, that are supplied, are not upto the standard. Weaving department in a textile mill can stop functioning due to the supply of sub-standard yarn. A slight deviation in the dimensions of a specific shaft may throw out of gear the whole assembly line in an engineering workshop. Here we see a crucial necessity for the supply of the products of the first manufacturer (raw materials for the second manufacturer) to be of the standard quality.

With the advent of automation and the high speed of working machines, this adherence to specific standards of the raw materials has assumed a strategic importance. Not only the manufacturer loses his product, but considerable time is lost on the production line for repairing damages caused due to the sub-standard material coming in. A telling illustration of this is the supply of standard bottles to the pharmaceutical industry. Here, bottles are made on automatic machines to rigid dimensional specifications and supplied in bulk to the pharmaceutical industry for their filling operations. Costly medicines are filled in these bottles at high speeds by automatic machines and simultaneously capped. If for any reason, the mouth diameter of these bottles happens to be slightly lower than that of the filling tube, the bottles go on breaking, spilling the medicines on the floor and damaging the filling tube. The whole filling line has to be stopped, defects rectified and restarted. But, if the supply of the bottles would have been standard, the production would have continued smooth and uninterrupted. The same kind of situation arises in other industries also if the supply of the incoming materials is non-standard.

Again, the end-products of this second manufacturer also have the same hurdles to pass as described earlier in the case of consumer indus-

try. In this context, some factors are worthy of consideration. The institutional customers are in a position to have their own arrangement for prescribing a standard, testing with their own equipments and ultimate checking of their own finished products. They can arrive at their own standards in consultation with their customers also. Quite true. But if everybody insists on his own standard at every stage from the supply of materials to the finished product, everything will end in confusion. The supplier of the raw materials for the same industry has to satisfy each one according to his individual whims. While one party is satisfied in accepting the materials as such, the other party in the same industry wants it to be further processed before accepting. This entails more delay and labour, unnecessarily increasing the cost. Hence, as in the case of consumer industry, a uniform standard for the supply of these materials for any particular industry should be evolved, taking into account the limitations of the plant and machinery of the second manufacturer.

One important aspect of the product can also be taken into consideration at this juncture. Complicated designs and shapes of products which hamper the smooth running of the production line and which also affect the efficiency can even be standardised, thus ensuring more productivity at a lower cost. Nobody bothers whether he gets the medicines (pharmaceutical products) in a round bottle, rectangular bottle or in a bottle of any other shape. Only the effectiveness of the medicine is the important factor.

Once these standards are fixed, it becomes the responsibility of each to scrupulously adhere to a common standard. The supplier of standard raw materials can cater for the requirements in any part of the country. The manufacturer is assured of a uniform standard in the quality of the incoming raw materials. He need not have to equip himself for testing the incoming materials which will definitely save his time, money and labour. The simplicity of designs adopted, the effective changes done in the equipment and machinery will enable him to undertake a mass scale production of any item without frequent stopovers, ensuring higher productivity, uniform quality throughout, better keeping of the delivery schedules, reduced costs and higher profits in the long run. Now he is bold enough to face any customer and assure him of the quality of his product which is in accordance with the set standard.

Just as in the case of testing the raw materials, he can pass over the testing of the finished product, to see whether his products are passing the requisite standards to the standardsman. This will save him the investment on elaborate equipments required for the testing and also time and labour involved.

It is now the responsibility of the standardsman to assure the customer that he gets the right quality. As dealt with earlier, the initial tests confirmed by further follow-up tests, on market samples will definitely achieve the objective.

Meanwhile, the customer is quite happy that he is getting what he wants – products that are top in quality and reliable in their performance. So allaround there is an atmosphere of goodwill, confidence and mutual satisfaction. See the miracle of standardisation!

Small Scale Industry and Standardisation

This type of standardised proceduure is of much help to small scale industries where they are in a position to give a quality product at par with those made by large scale units. The entire responsibility for testing and passing being given to the Standards Organisation, both of the raw materials and of the finished products, they can well concentrate on their manufacuring activities with their meagre funds. Quality of the finished products being quite comparable with those of the large scale units, they need not be afraid of the market also.

Here is the schematic approach for the successful implementation of the quality and reliability aspects of a finished product through standardisation.

RAW MATERIALS

(Certified as passing the requisite standards by an independent national body)

MANUFACTURING STAGE

(Entirely under the complete control of the manufacturer and employs all the latest management techniques such as process control, inspection, co-ordination and quality control for geting a uniform and standard quality)

FINISHED PRODUCT

(Approved as passing the requisite standards by the independent national body after tests at the manufacturer's end from his production)

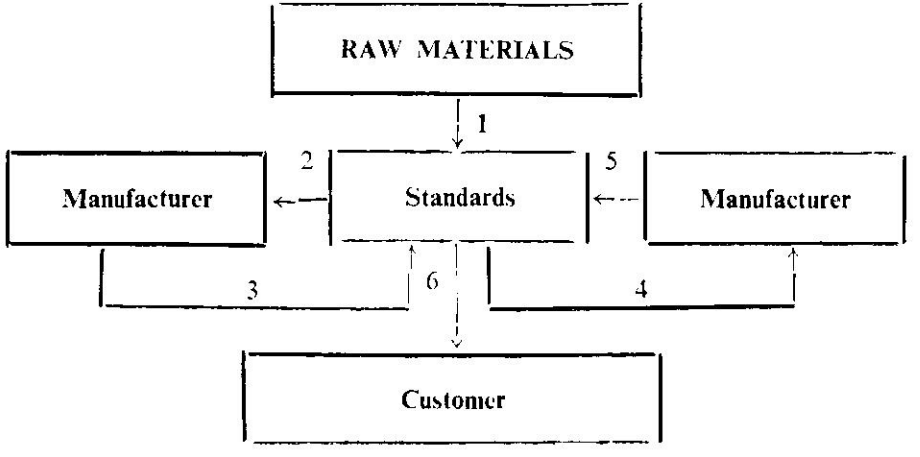
Quality evaluation of random samples collected from the market in case of a consumer products industry

Quality evaluation of random samples of the product suppplied to other industries for further processing

Information of the test results to such societies as the consumer guidance society and fair trade practices association for customer benefit.

Feedback of the test results to the first manufacturer for information.

Given below is the procedural flow chart showing the strategic importance of the standards in the manufacture and marketing of a product:



An 'OR' Approach to Production Control in Batch Production Industry

TR Pattabi Raman*

OR is a powerful management tool for achieving results. In this paper three intermediate problem links in, a possible OR chain in the batch production industry, are identified and analysed. Mathematical models for these production control problems are developed and solutions suggested.

RUSSEL Ackoff defines Operations Research (OR) as the application of scientific methods, techniques and tools to problems involving the operations of a system so as to provide those in control of the system with optimum solutions to the problems. The mundane, the obvious and the trivial problems of industry or business do not figure in the OR studies. OR has the total systems i.e., the universe, for its scope and, therefore, has a philosophical approach. It attempts to provide optimum solutions and therefore has a mathematical bias with multi-discipline participation.

In its meanderings through the global systems which is its purpose, OR may tackle many problems in a chain, the solutions of each in turn giving rise to other problems in its wake. Such a chain of problems, which can ultimately be grouped into OR, does exist in the batch production industry.

Production Control Problems in Batch Production

Ignoring for the present, problems in other areas of batch production industry like labour intensiveness, higher capital outlay and ever-changing technology, in the field of production control alone there are many areas meriting deeper analysis. Fluctuating demand, especially in a country like ours is one such menacing area. Product variety is another. Because of the high unit cost, peculiar customer requirements and the basic nature of machine tools, large product variety is a must to keep up in business. A natural corollary of the large product variety is small batch production of components and smaller batch still of finished products.

This also results in long production cycle times and relatively high inventories. The data to be handled by the production control department will be of the order of tens of thousands, which are to be properly recorded, analysed and synthesised for enabling intelligent action to be taken. In most cases, the text-book approach of production control will rarely be appropriate.

These are only some of the problems of production control facing the batch production industry such as a machine tool manufacturing set up. Out of the above, three areas have been chosen for further analysis in the following part of this article.

Product Mix

Given certain manufacturing facilities, products and their unit profits, how to juggle around the different products and to determine a production programme which will yield maximum profit

* Chief Engineer, Hindustan Machine Tools Ltd., Alwaye, Kerala.

or result in minimum production cost is the product mix problem. This is a typical linear programming situation and can be set up as follows:

Let Pj be the unit profit for product j and Xj, the quantity of product j in the mix.

Then the total profit Z will be

$= \Sigma\ Pj\ Xj$ where j=1,2....n products competing for a place in the programme.

Since the object of this exercise is to maximise profit, it is necessary for us to maximise the objective function.

$$Z = Max\ \Sigma\ Pj\ Xj$$

There will be several constraints to be applied on this function. They will be of the general nature

$$\Sigma\ aij\ Xj \geqslant bi$$

where i=1,2....m constraints and *aij* & *bi* are known constants.

Some of the constraints are described below:

(a) *Batch Quantity Restriction*

Because of the nature of machine tool manufacture, products are generally produced in conveniently-small but fixed batch quantities. Therefore any solution to the product mix problem should be in units that are multiples of these batch quantities. This restriction can, however, be reduced to one of choosing proper units for Xj.

(b) *Target Restriction*

The total quantity of all the products manufactured may have to exceed a predetermined target. This is expressed as

$$\Sigma\ a_1 j\ \ Xj \geqslant b_1$$

(c) *Programme Quantity Restriction*

One or more of the programme quantities (Xj) may have constraints on them because of guaranteed future sales commitments or of limited availability of certain critical components (like imported bearings of long procurement cycle) or raw materials (like special alloy steels).

$$\Sigma\ a_2 j\ Xj \geqslant b_2 \quad \text{(guaranteed sales)}$$

$$\Sigma\ a_3 j\ Xj \leqslant b_3 \quad \text{(limited availability of RM)}$$

where all a2j, a3j except one each will be 0.

(d) *Plant Capacity Restriction*

The machine loads projected by the mix should not exceed the machine capacities.

$$\Sigma\ a_4 j\ Xj \leqslant b_4$$

There may be several such load restrictions, in fact one for each machine group.

(e) The undesirability of overload on some machine groups and no load on some others imposes restrictions. Taking the difference in load between the busiest machine and the least busy machine as an index of the evenness of the load.

$$(a'_5 j - a''_5 j)\ Xj \leqslant b_5$$

where b5 will be the desired maximum permissible difference in load.

There may be other restrictions imposed in the system. However, once these expressions are set up numerically, the product mix problem can be solved by simplex or modified simplex routines as applied to linear programming.

The dual of the above problem is one of minimisation involving the same data. The dual can be interpreted as determining a set of unit costs of 'no activity', the least cost of 'no activity' being equal to the largest profit by taking maximal advantage of the opportunity to do some activity. In simpler words, this means that a search can be made for an optimal solution, possibly a better one than the primal, by exploring the possibility of a minor increase in one or two machine capacities whereby, production and profits could be substantially increased. Or, at the risk of not meeting some of the promised delivery schedules or postponing deliveries to customers, the possibility of readjusting some of the constants and thus increasing profits could be considered.

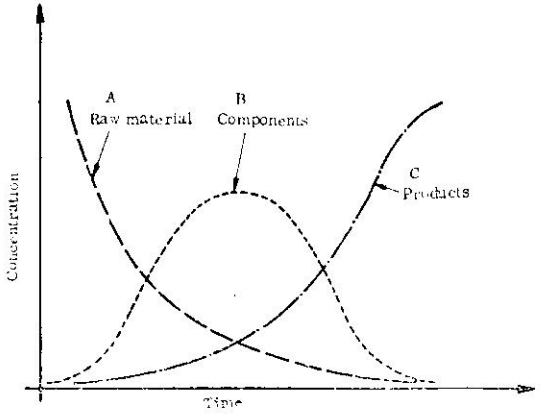


FIG. 1

Balancing Problem of Inventory Levels with Production Speed

Once the product mix problem is solved and an optimum production programme evolved, then solving the twin problem of in-process inventory levels and the production cycle becomes the next link in our problem chain.

It is common knowledge that the in-process inventory directly varies with the production cycle. Longer the production cycle, greater will be the in-process inventory. It is our objective to reduce the in-process inventory as much as possible and, therefore, the cycle time. However, taking other factors into consideration such as machine capacity bottlenecks, liquid capital available etc., a balance has to be struck. Consider our system as follows:

where k_1 =the production speed of manufacture, and

k_2 =the production speed of assembly.

Assuming the system relationships to be of the first order, then

$$\frac{dA}{dt}=-k_1A \qquad \frac{dB}{dt}=k_1A-k_2B \qquad \frac{dC}{dt}=k_2B$$

where t=elapsed time from start of process.

The graphical representation of the situation showing the concentration status of A, B & C with respect to the elapsed time t is as given in *Figure 1*.

The relationship of component store level B (which is the connecting link between raw materials and finished product levels) to the raw material level A and product level C can be expressed mathematically as follows:

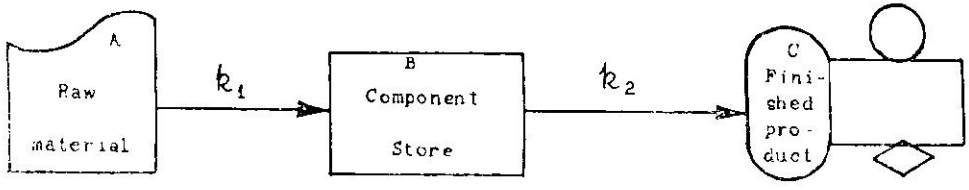
$$B=\frac{k_1}{k_1-k_2}\left[e^{-k_2t}-e^{-k_1t}\right]$$

where B=the dependent variable
t=the independent variable (time)

and k_1 & k_2 are the parameters to be estimated.

The equations can be solved explicitly in terms of the concentration of B relative to A and C.

A series of solutions to the above formulation will identify the levels of raw materials, component store and the products and the corresponding speeds K_1 and K_2. From these alternatives, the better solutions can be selected and further analysed along with other known limitations. This exercise will give the best



in-process inventory levels and the optimum production cycle time.

A Model for Monitoring Production

With the formation of the optimum production programme, in-process inventory levels and the production cycles, our next target is production control.

Monitoring production or controlling production basically, is the problem of fixing priorities for various jobs required for achieving the production plan. Because of long production cycles, several batches of components will be simultaneously processed in the shops. This, added with the number of products, throws in literally thousands of pieces of information which have to be carefully analysed and acted upon to achieve the plan. The only way to handle this complex situation is to recognise the pattern or the patterns of individual events contributing to the plan and to attempt to control the events in that pattern.

For those who are familiar with the batch production industry such as machine tools, three areas will be immediately apparent which will give rise to different patterns of behaviour. They are the small parts, the heavy parts and the assembly. Small parts are numerous in quantity. Heavy parts are few in number but constitute the basic structural elements of the machine tool. Assembly puts small parts and bought-out components onto the heavy parts and brings the final end-product, the machine tool, into being. Different approaches are required to deal with the three areas of control.

Since small parts are voluminous, they have to be controlled *en masse* i.e. in groups, or in series as we call it. Since the small parts is a random assortment of components, a few will require very few operations and a few will require a very large number of operations. A relatively-higher number of parts will require medium number of operations and so on.

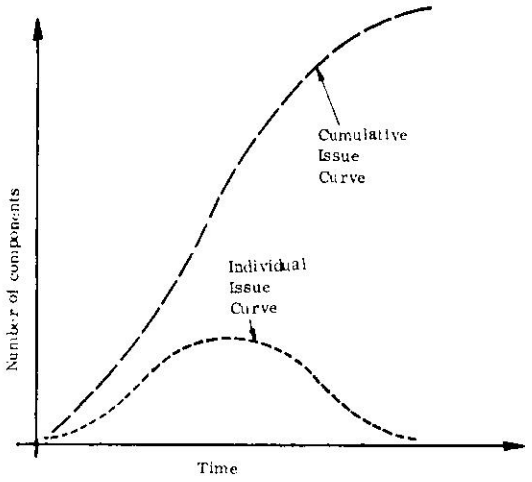


FIG. 2

Therefore, arranging them into different groups requiring varying time intervals for completion, we should expect to get a normal distribution as indicated in *Figure 2.*

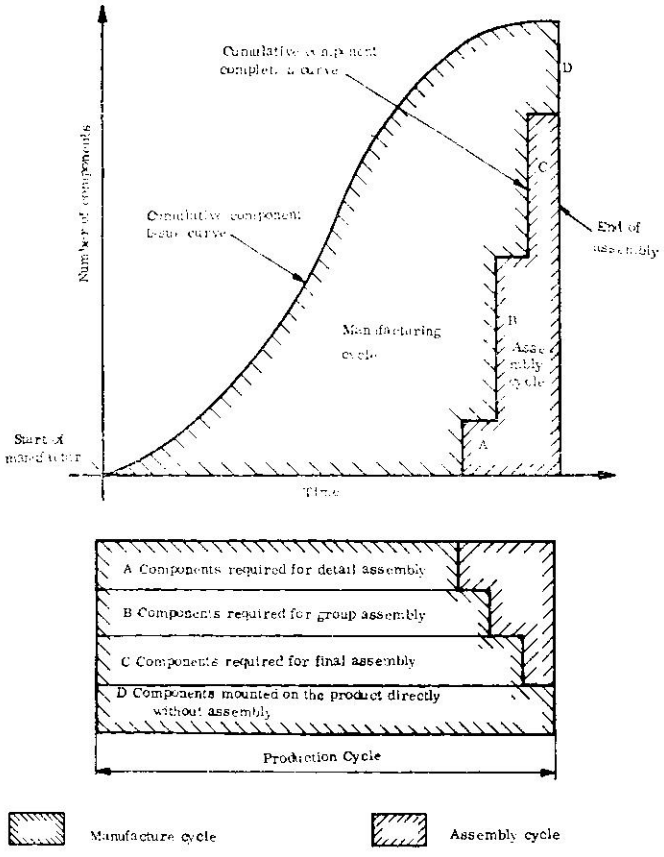
This is just another way of representing the pattern of SP manufacture using the well-known 'setback' method of scheduling. From this representation a pattern for control can be evolved since the cumulative distribution function will immediately give the progressive number of components to be issued for manufacture in the time scale. A similar pattern has to be worked out for the 'completion' events, since completion of components will be required in different stages matching the assembly requirements.

A representation of the above can be shown in *Figure 3.*

The cumulative component completion curve is obtained by plotting the components requirig maximum assembly cycle time (a), to the components requiring no assemby time at all (D—spare and other components supplied as such) in the appropriate time-scale.

From this analysis, we can immediately list the components to be progressively issued for manufacture against a given assembly completion time; also, a time-bound list of components to be progressively completed in the same scale. Among them, these two issue and completion lists with time-scales, will form the basis for monitoring production and regulating it.

Heavy parts are few in number and should be processed in smaller and odd batch quantities, supported by a strong machine-loading procedure. The inter-dependence of operations in assembly are so important that the only logical way of representing them for production control is by a PERT Network. The network should be designed for controlling the progress of each unit produced, since each unit (a lathe for example) is sufficiently big, warranting individual control.



PRODUCTION CYCLE REPRESENTATION IN BATCH PRODUCTION INDUSTRY

FIG. 3

Conclusion

In the wake of the second industrial revolution, organisations have grown from a mere one-man enterprise to multi-factory industrial corporations. One cannot expect different individuals to take decisions and act in unison to achieve the organisation's objectives as a single individual would. Nor can we assume that the limited objectives of one department may not conflict directly with the objectives of other departments. Scientific methods, techniques and tools are therefore to be applied in these growing problem areas, to provide an insight into the systems so that the organisational goals can be achieved. Trying, as it does, to solve the total system problems for optimum effectiveness, OR is a powerful management tool for achieving results, This is also one area where the industry with its problems and the educational institutions with their erudition and theoretical bias can collaborate effectively to mutual benefit. Let us, therefore, hope that the industry and the educational institutions will work together for the application of OR and other techniques for achieving higher productivity, which is the paramount concern of our nation today. □

Quantitative Analysis in Production

Dr Louis J Rago*

The computer is an intermediary. It merely carries out computations which would be too time-consuming to do by hand. However, what can be done by pencil and paper computations, can also be done by the computer—except much better and much faster.

A decision requires analysis of the underlying causes (and their effects). This, in turn, means gathering and evaluating of factual as well as probabilistic data. When organised in a model that predicts the consequences for several alternative decisions, the decision-maker has provided himself with guides to action. Although models give the consequence of any given action (what will happen if we cut the price of product A by 15%), the decision is still up to the individual manager. Occasionally, mathematical manipulations of the model make it possible to find out not only a series of alternatives, but also the optimum decision. Computer-aided decision-making has not advanced, however, to the point that all managerial decisions can rely on optimisation techniques.

Quantitative analysis will essentially formalise judgment and thus sharpen procedures used to plan, execute, measure, and control operations irrespective of the field (production, marketing or finance).

THE operations of an industrial plant require a never-ending series of decisions. Since things change all the time, each new situation creates new challenges as well as new opportunities. It is the function of management to make the best of every new situation. In this context, decision-making is a way of life in business and industry.

Every decision is predicated upon some kind of *analysis*. By analysis the consideration of the pros and cons of every contemplated action are meant. Thus, *analysis* and *decision-making* are inextricably interlaced. Many problems which arise in production can be solved with very little analysis, for the options are limited in number and scope; there are problems, however, which require not only a casual but a very elaborate research and analysis. Here, the gathering of data, evaluation of such facts and figures in the light of certain goals or predicaments, and the pre-auditing the outcome of contemplated actions are bound to be involved.

*University of Illinois, USA.

Decisions in the production area lend themselves to *quantitative analysis* primarily because the factors, upon which they are based, can be expressed in numbers. One relies, therefore, not on brain-power alone, but also on the power of mathematical computations, on figures, facts and importantly, on the relationship between such facts and figures. Such careful manipulation of quantitative data, tends to facilitate decision-making and improve the quality of the decision itself. It is a well-known adage that efficiency and profitability depend largely on the quality of decisions. Though everybody charged with some functional responsibility attempts to make good decisions, errors are inevitable. Nevertheless, the chances are good that well-run companies—where careful planning is the rule—make fewer mistakes than haphazardly-managed companies.

Decision-Making Process

How are these decisions made? Decisions can be made on the basis of experience. Although

such decisions may be made on the spot, they are not necessarily poor decisions. Here the decision-maker uses merely his own logic and reasoning power, relies on his past experiences and, what we call, seasoned judgment to select a reasonable course of action under the prevailing conditions. While these kinds of decisions are more prevalent than decisions based on the scientific approach, large corporations are apt to turn more and more to quantitative decision-making processes. Although in the latter, the calculations involved can be done with paper and pencil, as a rule computers handle the time-consuming computations.

What do we mean by *analysis*, and *quantitative analysis* in particular? Every decision requires consideration of all the options (alternative ways of solving problems) and the *selection* from among them the one which appears to serve the purpose best; considering, of course, always the prevailing circumstances (constraints). Although some problems do not, many other problems lend themselves to numerical analysis. In turn, the quantitative data—which represent different components of a problem—can be manipulated mathematically. Since some of the factors involved in each problem are subject to change, all data, to yield alternative answers to the problem, must be manipulated under the assumption of a number of predictable changes. A mathematical reshuffling of problem elements, with varying assumptions, will give several alternative solutions. This kind of planning is the so-called simulation. With such careful consideration of alternatives and the pros and cons involved in each, the *subjectivity* in decision-making can be minimised and the possible outcome of a number of selected courses of action pre-audited.

Limitations of Quantitative Analysis

Since quantitative analysis tends to minimise the area where judgment need be used, *objectivity is an obvious strength of quantitative analysis.* Therefore, such analysis should be used whenever it is feasible; however, not every problem lends itself to quantification. Hence, there are certain limitations to quantitative analysis. In the production field, between 30%—50% of the problem areas lend themselves to this kind of analysis.

Believing in quantitative analysis does not mean, however, that one can be absolutely certain that such a careful analysis actually brings the expected results. There are several reasons as to why quantitative analysis is not always foolproof. *One reason* is that it is not quite as simple to *model* problems as one wished. The mathematical formulation of a problem—any problem—requires that the relationship between the various elements of a "problem-complex" are known and that the model (the mathematical formula) faithfully represents such relationships. Evidently, if there is error in the model the formula itself may precipitate wrong answers. A *second reason* is that quantitative analysis requires numbers, and useful data are not always available. When, for sake of expediency, that is, in the absence of real data, the decision-maker relies on figures which were arrived at through some kind of guess-work, including the probability theory, the answer will be just as good as the guess *itself.* Thus, if the data used are false, then the answer will also be false, no matter how good the model. Since the time-consuming mathematical computations tend to be done by computers, it is apparent that "garbage *in* means garbage *out.*" It is not that the computer makes mistakes, but that people tend to feed wrong information to the computer. Wrong data will lead to wrong answers. A *third reason* for possible errors in quantitative analysis, and resulting decision, has something to do with oversimplification. Since real-life problems are extremely complex, there is a tendency to build models which contain *most* of the factors, but not *all of the factors.* And in most situations, some of the factors are not enough to get good results. Unless the model is *complete* in every respect, the factors overlooked may cause defective answers.

The foregoing remarks indicate that scientific decision-making relies on decisional aids (tools of decision-making), such as graphs, charts, scale models, templets and last, but not least, mathematical models. In using the latter, the computer is merely an intermediary.

Computer: An Aid to Decision-Making

While it is easy to use graphs and charts, mathematical models can be more difficult to use. Although the mathematics involved in quantitative analysis is not earthshakingly difficult, the many additions, divisions, multiplications and subtractions which must be performed may be confusing and cause arithmetic errors. A single error can easily be compounded and the outcome of a large number of computations may be defective. Besides arithmetic errors, mathematical analysis is very time-consuming. For this reason, a computer is warranted. Without the use of computers, *quantitative analysis is often not practical.* But computers are nowadays *universally** available, and therefore, quantitative analysis becomes more and more prevalent in industry.

Contrary to popular belief, *computers do not make decisions*! The computer merely takes over the tedious computations and prints out the answer to a problem. It does not make arithmetical errors and it performs the mathematical computations at a fast rate. In addition, the latest type of computers can work not only on one, but on several problems simultaneously.

In using a computer, the decision-maker must know three things: (1) how to express problems matematically and (2) how to feed information to the computer and (3) how to read the computer output. They can be learned relatively fast. Equipped with computer-aided informtion decision-making can be greatly facilitated.

Problems

The term "problem" connotes that something is wrong. Nothing can be farther from the truth. Any *change* creates problems, because new developments tend to make *old facts obsolete.* Thus, when a change effects one's decision, *the problem must be thought over* with the change, or probable changes in mind. In a fast changing world problems arise regularly. Thus, in *contemplating any action*, one is always faced with "problems". What should be done? How should a dilemma be resolved? The decision-maker is faced with a problem primarily because any "situation" can be handled in several different ways. The question is which *way is the best* under the circumstances.

Contrary to popular belief computers do not make decisions! The computer merely takes over the tedious computations and prints out the answer to a problem.

If there are a number of different ways to skin a cat, how do you find out which method is the most desirable one? Each alternative tends to bring different results. Thus, *one must pre-audit* the outcome of each contemplated action. Mathematical answers tend to facilitate decision-making, because numbers tend to make the picking and choosing among alternatives easier. Whichever alternative has the highest numerical value, it tends to indicate which solution is the most appropriate. It is still up to the decision-maker to *decide*, but the numbers speak for themselves. Although the decision-maker can still pick the *second* or *third* best alternative rather than the best one, *subjectivity* has largely been eliminated.

Most problems are "planning" rather than actual problems. In other words, it is not necessary that a production enterprise actually experiences a difficulty! A problem exists as soon as a *plan* is to be made and there are several alternative courses of action. For instance, a mass producer plans the yearly output volume. How much should be produced? The question itself poses several additional questions, namely: What is the demand? What is our normal share in industry? What is our output capacity? When must the first hundred pieces be ready? Many similar questions must be answered. Thus, a problem is not one thing, but a composite of many sub-problems. They must be looked upon individually as well as collectively.

*At least in the United States, Australia and Western Europe and to a lesser extent in Asia.

If there is only one solution (one alternative), then there is *no decisional problem*! A problem exists only when we must look at various alternatives and select from among them the one suitable from every point of view.

Life itself is a series of problems. Business life is no different. One barely finished solving a problem, when already a new one requires attention. In fact, hardly a day goes by in tranquility! The job of management is a never-ending series of problem-solving.

There are basically two ways to solve problems: 1. using judgment and 2. making a formal analysis. The latter is quite similar to the former, except that it is highly formalised and one relies on the power of numbers in which the area where judgment is needed is much narrower. When numbers are involved, the analysis becomes "quantitative" in nature.

Although it is difficult to reconstruct how one makes decisions, experience with computer-based solutions indicates that the nature of *judgment*—where random bits of information are pieced together in one's mind—used in arriving at a production decision, is not entirely different from the computer-aided decision-making. The technical capacity of a computer to arrive at *programmed decisions* is, of course, greater! Nevertheless, decisions based on experience and judgment are not necessarily worse. Computer-based decisions merely foster objectivity whereas, in decisions made by management personnel, subjectivity is an integral part of the decision.

No matter what kind of decision, certain mental steps must be taken, namely:

1. problem recognition
   a. assembling the *symptoms* indicating the existence of a problem
   b determining the factors *causing* these symptoms,
2. determination of *cause* and *effect* (i.e. what causes the symptoms); this can be thought of as the *model building*.
3. formation of *alternative solutions* either to eliminate cause or causes or to counterbalance them
4. selection of the *best* solution (decision).

Although only the latter (4) is *decision-making per se*, it is apparent that the choice of the appropriate alternative is just one of the many steps involved in decision-making.

Problem Recognition

In industry, like in the medical profession, something is considered a problem when the natural, *expected performance* does not occur. The human body operates in a certain normal way. Physicians expect it that way. In the same manner managerial actions are expected to bring predictable results. When the results turn out to be different, we speak *of a problem*. One expects for instance a normal blood pressure. However, when the blood pressure is either too high or too low, the physician begins to look for certain additional symptoms to determine as to *why* the blood pressure deviates from the expected norm. In industry similar things happen. For instance, it is expected that introduction of a wage incentive system will assure 100% efficiency. When this does not occur, it must be assumed that something went wrong and the situation must be investigated.

A deviation from norm in itself is a *symptom* and an investigation will reveal that there are several other supporting symptoms pointing to the fact that something is wrong. The *investigation* is aimed at discovering other supporting evidences and raises questions such as why does the wage incentive system not work? Is the time study upon which the incentive system is based incorrect? Is the percentage of income-increment too high or too low? Just what is considered by people as too low? Are quality specifications too high? What should then be the right quality? Is supervision bad? Bad in which sense? Is the inflow of materials used in the production process irregular? If so, why? Questions of this kind will sooner or later give additional clues (symptoms) pointing up the *causing factors* and permit analysis and lead to a decision—to the solution of the problem.

Determination of Cause and Effect

Earlier, mention was made of the necessity to determine the *relationship* between certain interrelated factors. When the various relationships between elements of a *problem-complex* are known it is possible to determine which factor counteracts which other factors and to what extent (this is called *sensitivity analysis*). How does factor A affect factors B and C or *vice-versa*? When one discovers the existence of such relationships, it is possible to express a problem in mathematical terms.

For instance, if profitability is falling, it is possible to determine where the knob lies by simply *modelling* the situation. A model is the replica of the "situation" on paper or in form of a scale model. Let's look upon the various components of the problem-complex to see how they influence *profits*.
Thus,

P = R—C and
R = Q×A

where: P = profit
R = revenue
C = cost
Q = output quantity
A = price per unit

The model can be refined by building more and more details into it. Among others, the *cost* can be subdivided into L = total labor cost, M = total material cost and O = overhead cost (fixed cost). With this addition, the model reads: P=(Q×A)—(M+L+O). Since M., L, and O refer to *total* material, labour and overhead cost based on a fixed output, additional refinement calls for a breakdown of total costs into unit labor and unit material cost. With this refinement, the model is written:

P=(Q×A)—(Q×m)—(Q×l)—O, where
m = unit material cost and
l = unit labour cost

Computer-based decisions merely foster objectivity whereas, in decisions made by management personnel subjectivity is an integral part of the decision.

On the basis of such a model, the decision-maker could try out several contemplated alternative actions by simply assuming different numerical values for Q. It is apparent that total cost in respect of labour and material will depend on the quantity. Further refinement is necessitated by the fact that larger quantity of raw materials used calls for quantity discounts. Thus, the material cost should be further broken up into m_1 and m_2. In this case m_1 = unit cost for materials up to a certain minimum quantity; m_2 = material cost per unit beyond m_1 quantity. By the same token, the unit labor cost could be called, l_1, l_2 and l_3 (any quantity produced with overtime work, would cost higher labour cost per unit, l_2, and yet higher unit labour cost (l_3) if produced on sundays or holidays.

Assuming that at lower prices *more* can be sold, by varying price and assuming corollary increases in sales, alternatives can be developed, which will be used in the decision-making process.

As seen, a simple model can be expanded to reflect more and more of the relationships between the various component factors and can, thus, be used as a means of planning. The decision-maker, by *assuming* certain output quantities, prices and costs, obtains information upon which to base his decision. Provided his assumptions are correct, the mathematical answer will also be correct.

To illustrate the planning process with above mathematical models, let us assume some "numbers" and substitute them into the *model.*

The use of quantitative data, *will yield answers* indicating some of the options to beef up profitability. Assumptions:

	M=$30,000 (total material cost on 10,000 units)
Revenue=90,000	L=$30,000 (total labor cost) (on 10,000 units)
	O=$20,000 (overhead cost)
	$80,000

1. Model: P=R - C

P=90,000 - 80,000
P=10,000

2. Model: P=(Q×A)−(M+L+O)

Under the assumption that Q=10,000 units and A=$9.

the answer can be computed as follows:

P=(10,000×9)−(30,000+30,000+20,000)
P=90,000−80,000
P=10,000

Let us, however change Q by assuming that at lower prices, the product sells better.

If A=$8 and
Q=15,000, then
P=(15,000×8)−C

Since we no longer can work with fixed total cost, C must be broken up into unit cost, both for material and labour. Let us, therefore, assume that unit labour cost as well as unit material cost are $3, respectively.

3. Model: P=(Q×A)—(Q×m)—(Q×l)—O

P=(15,000×8)—(15,000×3)—(15,000×3)—20,000
P=120,000—(45,000+45,000+20,000)
P=120,000—110,000
P=$10,000

Still more refinement is needed on assumption that larger-scale production improves labour efficiency and reduces unit material cost (due to quantity discount). Incorporating these assumptions into the model, the answer will most likely be a different one. Evidently, unless profits increase, it would not pay to produce 5,000 additional units than previously. By assuming that normal capacity of the plant is 12,000 units and that the added 3,000 units call for overtime work and pay (50% higher than normal wage rates), shifts in costs will take place.

With these new assumptions in mind, let us proceed as follows:

labour cost with the improved efficiency per unit	=$2
overtime labour cost per unit	=$3
material cost up to 12,000 unit per unit	=3
material cost in excess of 12,000 per unit	=2.5

4. Model: $P=(Q\times A)-(Q\times m_1)-(Q\times m_2)-(Q\times l_1)-(Q\times l_2)-0$
or $(Q\times A)-(Q\times m_1+Q\times m_2)-(Q\times l_1+Q\times l_2)-0$

P=(15,000×8)−(12,000×2+3,000×3)—(12,000×3+3,000×2.5)−20,000
P=120,000−(24,000+9,000)−(24,000+7,500)—20,000
P=120,000−(33,000+31,500+20,000)
P=120,000−84,500
P=35,500

By now it must be apparent that *cause and effect analysis* leads to *model construction.* The result, the model, depicts the relationship between various factors involved in a given problem. In turn, an integral part of model building is *sensitivity analysis*—a study revealing to what extent one factor influences or is influenced by another.

In decision-making, models are used in order to visualise the situation and to permit the decision-maker to toy with different ideas (that is, to come up with *alternative courses of action*).

Although here the construction of a mathematical model was used, *any* model, say a physical model, can be used by the planners to gain information about alternative solutions. A physical model would be, among others, a *scale model* of a plant. Here the planner could move little toy tracks in the isles to see the possible flow of goods; he could position the various machines in different angles to see how the job of machine attendants could be facilitated under assumption of various workplace arrangements. A scale model of a plant would also permit arrangements of the various departments in a number of different ways and show the planner the impact of various floor layouts on production flow, job performance, materials handling, etc.

Data, Model, and Computer

Data processing cannot begin unless the computer is provided with a *model* (that is, unless the computer is *programmed*) and subsequently with *data* which it can substitute into the formula. *Programmed* into the computer, the model is being stored in its memory unit.

Programming is, however, somewhat more complicated than writing a mathematical formula.[1] The model must be written in such a way that the computer can carry out the required computations step by step. In other words, the model becomes a set of *instructions* indicating how to solve a given application problem. Initially it takes the form of punched cards in a code language (FORmula TRANslation=FORTRAN). This is done electronically; hence, further explanation is unnecessary. It is sufficient for this purpose to understand that computers are programmed; hence, they know certain mathematical models and when required, a particular model is retrieved from its memory.

The *computer* must then be fed with *data* (pertinent information related to the problem at hand in the form of constants), on the basis of which it will produce a solution.

Model (from now on referred to as *programme*) is a twin sister of the hardware (the computer itself). In this sense, hardware and *software* (programme or model) make problem solving possible. The computer (hardware and software included) without *data* is like a car without petrol. Therefore, it must be remembered that problem-solving is possible only if the computer can be provided with pertinent data, which can be substituted into the formula.

Data can be *deterministic* (capacity, time standard, order quantity, labour and material costs per unit, inventory costs at given levels, interest charges, fixed cost, etc.) and *probabilistic* (estimates of sales, reject rates, economic factors, such as disposable income, gross national product, etc.). Computers could give precise answers if *all* data were deterministic (that is, if all data consisted solely of facts). As a rule, however, most companies, when *planning* any kind of action, deal with *estimates* (probabilistic data). If the estimate turns out to be wrong, the computer will give a wrong answer; not because of computational error, but because of incorrect data.

Computers will give excellent solutions to problems, provided that the data used represented the *realities of life*. In the planning work (simulation), companies will plug, say predicted sales figures into the computer. With *different sales figures* the answer to profitability and cost structure will be *different*. With different output levels and price assumptions the unit cost will be different and the sales volume will rise or fall.

Actually, computers will preaudit the outcome of contemplated actions under a number of assumptions. This will facilitate the task of the decision-maker in the sense that he has a series of answers depending on the action taken. He knows, for instance, what is *likely* to happen to profits, if he raises his price by X, Y or Z percentage under the assumption that he precisely predicts how sales will react to price changes.

Decision-making will be facilitated with the help of computer-aided analysis. What's important is that a problem is broken down into manageable segments (problem elements). For each segment an estimate is made and a model is constructed which relates each segment to the total, and *vice versa*. □

[1]The use of the term programming in conjunction with punched card accounting machines is quite different from its use in conjunction with electronic computers.

Management Accounting: Its Contribution to Productivity†

SD Sharma*

Prosperity of a nation depends to a very great extent on productivity. The need for Productivity is vital, if we desire to survive as a nation. Management Accounting can help in achieving higher productivity by identifying the factors which influence productivity and presenting to management vital financial and related data, which will provide the basis for the formulation of policies governing various phases of operations.

THE concept of 'productivity' is not new to many advanced countries, but the productivity movement in India is not very old. It was not until after independence that India thought of industrialisation on a large scale. Until then, the country's economy was mainly agro-oriented. Thus, the concept of productivity only became known after an industrial base had been set up.

Productivity Defined

'Productivity' is one of those words which have different meanings to different persons. Usually people consider productivity as 'Efficiency' or 'Efficient Production'. But efficient production does not necessarily amount to productivity because there may be operations carried out most efficiently, yet the end-products may not be useful or saleable.

Mr. Hiram S Davis in his treatise on Productivity Accounting has defined productivity as under:

"Productivity can be defined as the change in product obtained for resources expended. If any producing unit such as a department, plant, company or industry obtains more or better product than at some prior time for the aggregate materials, power facilities, labour and management resources used, its productivity has increased. Productivity falls if a smaller quantity or lower quality of product is obtained for the resources used than at some prior time". In the broadest sense, productivity is the change in results obtained for the resources expended. "It "is a ratio of return to input"."

Productivity postulates useful end-products resulting in progress, prosperity through increase in standard of living. To sum up succinctly, productivity aims at prosperity through increasing national wealth and providing higher standards of living to the nation as a whole.

Need for Productivity

There is no denying the fact that the prosperity of a nation depends to a very great extent on productivity. It is only through productivity that we can successfully compete in the foreign market and earn needed foreign exchange. A developing country like ours has to earn foreign exchange for establishing a favourable balance of trade in the international market. Therefore,

*Chartered Accountant, New Delhi.

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unless we improve our productivity the chances of raising the standard of living for the nation are remote. The need for productivity is vital if we desire to survive as a nation.

Management Accounting and Productivity

Concept of Management Accounting

'Management Accounting' may be described as a means of harnessing and using accounting information for discharging management functions. In the opinion of the Institute of Chartered Accountants of England and Wales, any form of accounting which enables a business to be conducted more efficiently can be regarded as management accounting. The Management Accounting Team of Anglo-American Council on Productivity described management accounting thus:

"Management Accounting is the presentation of accounting information in such a way as to assist the management in the creation of policy and the day-to-day operations of an undertaking."

Because of increasing complexities of industrial management, mass production, huge capital outlay, sophisticated technology, and employment of large labour force, accounting services in industrial enterprises are not merely for bookkeeping, but are being used to provide management information for:

Decision making
Planning
Control, and
Measuring Performance.

Needless to say, these management functions have a great bearing on the productivity of any undertaking.

Management accounting does not supplant but supplements financial accounting. Accounting techniques which would assist the management in increasing the productivity of their enterprise can be reckoned as management accounting's contribution towards productivity. Let us now consider the techniques available to the management for increasing productivity and the contribution of management accounting in implementing these techniques.

Some of the significant management techniques which help to increase productivity are enumerated below:

I. **General Management and Administration**

—Organisation Structure and Policy
—Planning

II. **Finance**

—Budgetary Control
—Standard Costing
—Ratio Analysis

III. **Production**

—Operation Research and Development
—Standardisation and Simplification
—Quality Control
—Inventory and Production Control
—Preventive Maintenance

IV. **Purchase and Sales**

—Materials Management
—Market Research

V. **Other Areas**

—Work Study

—Incentive Schemes and Labour Relations

In this paper it is not possible to describe all the above techniques and their impact on productivity. The scope of this paper is, therefore, restricted to those techniques where management accounting has a significant contribution to make.

The main functions of the management and the techniques employed by accountants to assist management in the above functions are discussed below:

Management Function	*Accounting Techniques*
I. Decision—making	
A. Capital Budgeting	a. Pay back Method b. Accounting Method c. Discounted Cash Flow Method
B. Product Planning	a. 'Direct' Costing b. Break-even analysis
II. Long Range Planning	a. Budgeting and Forecasting
III. Controlling	a. Standard Costing b. Budgetary Controls c. Management Information System d. Management by Exception
IV. Performance Evaluation	a. Ratios Measuring Liquidity and Indebtedness b. Ratios Appraising Funds Management c. Ratios Referring to Profitability

I. Decision-making

A. Capital Investments (Capital Budgeting)

The accountant plays an important role in the decision-making process, not as decision-makers themselves but as collectors and reporters of relevant data to the management. His reports provide valid data pertinent to the decision. His approach in discovering and weighing of alternatives after evaluation of various aspects helps the management in making proper decisions. Special decisions requiring the accountant's expertise are measuring of the profit potential of long-range investment proposals such as:

—Modernisation of existing plant
—Introduction of new product line
—Choice between two or more machines
—Opening of new sales offices etc.

In recommending decisions on project proposals, the accountant has be to extremely cautious because such decisions involve considerable capital outlay and a decision once implemented would be difficult to reverse or correct.

To enable management to take decision, the accountant, keeping in view the constraints imposed by the management on the total volume of investment to be made: (a) ranks various proposals indicating their profitability in descending order, and (b) uses a minimum desired rate of return as the cut-off point for determining whether the projects be accepted or rejected.

Methods of Ranking Projects

Ranking procedure envisages relating of a stream of future earnings to the cost of obtaining these earnings. Some of the widely used approaches to determine the rate of return on the capital outlay are:

—Pay-back period Method
—Accounting Method
—Discounted Cash Flow Method

(a) *Pay back Method*: It is a rough and ready method to determine the number of years required to recover the original investments. It attempts to measure the period of time it will take for the original cost of a project to be recovered from the earnings of the project itself.

(b) *Accounting Method*: The accounting method considers adding all the expected earnings after providing for depreciation and dividing them by the project's economic life. The rate of return may be expressed as a percentage to the investment.

(c) *Discounted Cash Flow (DCF)* : This method of calculating profitability of a proposal is based on the theory that money has a time value and that its use has a cost. It considers that Re. 1 today is worth more than Re. 1 received at a future date. DCF technique considers the expected earnings (net cash flow) on a specified investment, as representing the recovery of original investment plus a return on capital invested.

The mechanics of the method consists essentially of finding the interest rate that discounts future earnings of a project to a present value equal to the project cost. This rate of interest may be obtained from special tables or it may be independently calculated.

B. Product Planning

(a) *Marginal Costing Technique*: Marginal or 'Direct' costing is a technique which presents management with information enabling it to measure the profitability of an undertaking by considering the behaviour of costs Marginal costing requires that only the variable manufacturing costs should be treated as product costs and fixed overheads charges are primarily concerned with the time rather than the volume of output. This technique helps the management to:

1. Decide on which products to concentrate, which ones to de-emphasize and which ones to drop.
2. Appraise alternatives which arise as a result of price reductions, special discounts and special advertisements to boost up sales. Decisions in such cases are made by making a comparison of the increased costs with the prospective additions in revenue due to increased sales.
3. Determine sales volume which would yield desired profits.
4. Ascertain contribution per product (in case of diversified product lines).

(b) *Break-even Analysis*: In the process of decision-making, management often has to consider:

1. What would be the cost of production under different circumstances?
2. What has to be the volume of production/sales?
2. How much profit can be earned?

Accountants can provide answers to these questions by preparing break-even analysis. Break-even analysis is based upon the interrelationship of sales, fixed and variable costs. Break-even point is that where there is neither a profit nor a loss. All sales beyond the break-even point would yield profits and below it would result in losses. Break-even analysis, therefore, provides helpful information for decisions as to pricing, sales mix, addition or deletion of a particular product line, acceptance of special orders and export promotion etc.

II. Long Range Planning

1. *Budgeting*:

Long-run profit maximisation is the primary goal of all managements. This is achieved through proper planning. It involves determination of future course of action based on the forecast of future events and conditions to achieve the set objectives. Budgets, therefore, are basically forecasted financial statements, formal expressions of managerial plans. They embrace all phases of operations such as sales, production, distribution and financing. With different objectives in view, budgets may be long run, annual or periodical.

In order to be useful and effective, budgets should be:

—timely, i.e. established in advance
—based on careful forecasts
—flexible for different levels of activity
—capable of being accomplished.

The accountant's role in the formulation, installation and administration of budgets can be explained as under:

1 Provide historical information to help management in forecasting.

2 Issue instructions regarding budget requirements, fix up deadlines for receipt of information from various sources.

3 Define the general policies of management in relation to budget.

4 Advise the staff in the preparation of budget inputs, and compilation thereof.

Management accounting does not supplant but supplements financial Accounting.

5 Review, revise, and consolidate budgets after functional budgets have been approved.

6 Compare actual results with the budget and recommend corrective action wherever necessary.

III. Controlling

A. *Standard Costing*

The concept of 'control', an important link, in the managerial process, means the process of ensuring the accomplishment of plans. Among the techniques developed, standard costing is an important one to control costs and other activities. Standard costs are carefully predetermined costs. They are target costs, which should be attained under efficient operations. Standard costs provide a framework for gauging performance.

The accountant's role in regard to determination and exercise of controls through standard casting are enumerated below:

1. Evaluation of physical standards which represent engineering estimates.
2. Determination of appropriate price factors i.e. predetermination of costs.
3. Determination of variances, i.e. comparison of actual results with standards.
4. Analysis of variances, and segregating them by department, by cost, elements of costs, price and quantity.
5. Investigation in the basic causes of variances and finding out improved methods of adhering to standards or accomplishments of the objectives.

B. *Budgetary Controls*

Both standard costing and budgetary control techniques have one common objective, i.e., improving managerial control by establishment of predetermined targets, measuring actual performance and comparing them with the targets for control purposes. However, there is a fundamental difference between the two. Budgetary control is concerned with comparison of estimated and actual results of a department or a company while standard costing has reference to the comparison of estimated and actual results of manufacturing a product or rendering of a service.

C. *Management Information System*

There is no information technique so far developed which may be called ideal or considered best under all circumstances. A modern management information system, however, should provide management with the information it needs, and within time, to help it to plan, execute and control the operations of business. To fulfil management objectives the reporting technique should ensure that the management reports are:

1. Never a burden to those who receive them. A large number of detailed reports submitted periodically might defeat their very purpose as it may become difficult to pick up relevant information therefrom and more likely that important points remain buried.
2. Current. Problem areas are identified before they get beyond control. In times of financial difficulties even a day's delay may do a lot of harm to the organization.
3. Covering essential data. In order to make decisions, and to take specific action, the management must know precisely the factors which contributed to a given situation.

Possessed with background and professional competence, the accountant attempts to identify, observe, analyse, and specify the requirements for information. He makes this study so as to

determine the source of data, attempts to equate supply with needs by the use of techniques considered appropriate in a given situation. As a result of this, the accountant's role in the management information system as a systems analyst is gaining importance with various industrial and commercial organisations.

D. *Management by Exception*

This technique is applied to reduce paper work and highlight and report to the management with focus on exceptions only for appraisal and corrective action. Management need not concern itself about actual performance which is at or near standards. If, however, significant variances from standards appear in the periodic performance reports, management devotes time to analyse the variances and decides to take appropriate action. Thus management effort is expended only when exceptional items appear on the standard performance reports. Accountants assist management in identifying exceptions and suggesting course of corrective action.

Accountants play an important role in the decision-making process, not as decision makers themselves but as collectors and reporters of relevant data to the Management.

IV Performance Evaluation

Analysis and Interpretation of Financial Statements

This technique assists the management in measuring the financial condition, efficiency and profitability of a business. The accountant's role is considered most significant in this area because of his professional competence and expertise in interpreting the results of the business operations reflected in the financial statements. The specific areas in which management is interested deeply are:

—Liquidity and indebtedness of the Organisation

—Appraisal of Funds Management

—Profitability

1. *Liquidity and Indebtedness*

(a) *Current Ratio*: It is an indicator of the ability of the business to meet its current obligations. It gives a danger signal to the management in case they are overtrading. This ratio is arrived at by determining the relationship between current assets and current liabilities. If current assets are two times the current liabilities (2:1), the liquidity is generally considered adequate. However, a lot depends on the nature of current assets. If the major segment of the current assets is tied up in slow-moving inventories, even a ratio of 3:1 may not present a healthy liquidity status. This factor has given rise to another ratio commonly known as Quick Asset Ratio.

(b) *Quick Asset Ratio or Acid Test*: This ratio arises from the same basic desire to measure the company's ability to meet its current obligations through current assets. It is, however, a more severe test since it eliminates some of the disadvantages of current ratio by concentrating strictly on liquid assets whose realisation is fairly certain like cash, marketable securities and accounts receivables.

(c) *Debt Equity Ratio*: It relates to creditors' claims on the assets to funds provided by the owners (equity holders). The purpose of this ratio is to derive an idea of the capital supplied by the shareholders and the assets 'cushion' available to the creditors in case the company goes into liquidation. This technique helps to determine the relative position of the creditors and the owners.

2. *Funds Management*

Ratios appraising funds management or indicating 'Turnover' relationships.

(a) *Sundry Debtors*: This ratio is used to determine the collection period of sundry debtors. This is arrived at by dividing the trade debtors by the average credit sales per day. The quotient represents the number of days a sale is tied up in accounts receivables. This method can be used to compare credit terms granted to customers. A major deviation from the normal terms granted towards slower collections will be a warning signal. The promptness in collections will indicate the managerial effectiveness of the credit department.

(b) *Inventory Turnover*: This ratio establishes relationship between the cost of goods sold and the inventory. It is generally calculated by dividing the cost of goods sold by the average inventory at cost. This ratio indicates the velocity with which the inventory moves through the business and assists the management in determining investments in inventory to support a given level of sales and thus is useful both in judging current capital fund requirements as well as possible investment need for future sales.

(c) *Fixed Assets*: The turnover concept is also applied to gauge the level of investment in fixed assets to support a given sale. The management may compare the effectiveness of their assets with similar companies within the industry and make judgements on the efficiency of their assets.

3. *Profitability*

(a) *Profitability as related to Investment:* The relationship between the annual profits and the investment committed to earn those profits is one of the basic fundamentals of a business. This relationship is reflected by way of percentage of net profits (profits after taxes and financing charges) to Stockholder's Tangible Net Worth. This information provides a valid basis for inter-industry comparisons.

(b) *Profitability as to sales (Profit Margin) Gross/Net Profit Ratio*: It indicates the margin of profit on the product sold. When expressed as a percentage of sales, the margin serves as a guide to the operating efficiency of the business. Tax authorities lay great emphasis on this ratio while making assessments of a company. If a company manufactures several products, it would be worthwhile to analyse the gross profits productwise as the average percentage may be quite misleading and the margin on individual products may widely differ from the average.

Ratios by themselves are not absolute measures of gauging managerial efficiency. For deciding whether a ratio is favourable or not, it should be compared with norms and/or standards set for the business. Ratios for one year or so may also not indicate a general trend as they may get distorted due to some unusual items. It, therefore, becomes essential that the trend be indicated by way of comparative tables, charts, graphs, etc. for certain prior years. Of course, while making comparisons, due consideration should be given to the impact of change in economic policies and price level changes etc.

Conclusion

Higher productivity will mainly depend upon the quality and resourcefulness of management and its grasp of the factors which influence productivity. Management accounting helps in identifying these factors and presenting to management vital financial and related data which will provide the basis for the formulation of policies governing all phases of operation. Thus, in management's continuous quest for ways and means for increasing productivity, the accountant serves as a pathfinder and adviser. □

Role of Metal Fluids in Production Engineering Practices

RA Rao*

Metal-working fluids, known under various names depending on end-use, as cutting fluids, grinding fluids, drawing oils, rolling oils etc., form an essential element in modern production engineering practice. A wide variety of these fluids have come into use following developments in technology of materials, machine tools and metal forming techniques.

In this paper, the essential functions of metal-working fluids are outlined and the latest ASTM classification, which is based on fluid composition, is presented. General practices in the selection and use of various metal-working fluids are indicated. Some important aspects of efficient and economic handling and use of these fluids are discussed. Current practices in India are summarised and the need for evolving comprehensive standards and suitable guidelines for their correct implementation is stressed.

METAL-WORKING fluids which, depending on end-use, are commonly identified as cutting oils, grinding fluids, drawing oils, rolling oils etc., are used in most engineering process operations involved in the manufacture of metal parts. The variations in metallurgy of materials, metal forming techniques and machine tool technology have led to the development of a wide variety of metal-working fluids. It is, therefore, highly desirable for the user to become aware of the necessary performance features of the fluids suited to his operation, so as to be able to maximise his 'net' returns.

FUNCTIONS

Basically, the functions of a metal-working fluid are:

(i) Cooling : Dissipation of heat generated by friction and metal deformation so as to maintain job accuracy as well as extend tool life.

(ii) Lubrication: Reduction in friction and tool wear and prevention of metal adhesion and welding of job material to the tool.

(iii) Cleaning : Removal of swarf from the cutting zone so as to present a better surface finish.

Besides these, the fluid is expected to provide:

(i) Prevention of Corrosion/rust and work discoloration.

(ii) Resistance against rancidity, bacterial growth and odor formation.

(iii) No detrimental physical effects on the operator.

(iv) Resistance against foaming and instability which might lead to deposit formation.

CLASSIFICATION [1][2]

In view of the large variations involved in the metallurgy of job materials, tools, and machining operations, various types of metalworking fluids have come into wide-spread use. Based on their

* Lubrizol (India) Ltd., Bombay.

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end-use, these fluids are generally referred as neat cutting oils, soluble cutting oils, grinding fluids, drawing oils, rolling oils etc. However, a rational classification has lately been evolved by ASTM (American Society for Testing and Materials) and is designated as ASTM standard D2881. This classifies the fluids as below:

Oils and Oil Base Fluids

A. Mineral Oils—Uncompounded.

B. Fatty Oils.

1. Uncompounded
2. Fatty oils containing chlorinated compounds
3. Fatty oils containing sulphurized compounds
4. Fatty oils made by combining B_2 and B_3

C. *Mineral Oils Compounded*

1. Blends of mineral oil and fatty oil.
2. Sulphurized and/or chlorinated mineral oil.
3. Mineral oils containing sulphurized fatty compounds and/or sulphurized non-fatty compounds.
4. Mineral oils containing chlorinated fatty compounds and/or chlorinated non-fatty compounds.
5. Mineral oils containing sulpho-chlorinated fats or sulpho-chlorinated non-fatty compounds.
6. Mineral oils made by combining C_3 and C_4.
7. Mineral oils and/or fatty oils containing nitrogen or phosphorous compounds or solid lubricants etc. in addition to compounds from the groups described in C_5 through C_6.

II. *Aqueous Emulsions and Dispersions*

A. *Oil-in-Water Emulsions (soluble oils)*

1. Mineral oil-emulsions of class 1-A.
2. Blends of mineral oil and fatty oil — emulsions of class I-B1 or I-C1.
3. Heavy duty or extreme-pressure emulsions of class I-C2 through I-C7.

B. *Water-in-Oil Emulsions*

1. Mineral oil-emulsions of class I-A.
2. Blends of mineral oil and fatty oil-emulsions of class I-B1 or I-C1.
3. Heavy duty or extreme pressure—emulsions of class I-C2 through I-C7.

C. *Colloidal Emulsions*

1. Regular—emulsions of class I-A.
2. Fatty—emulsions of class I-B1 and I-C1.
3. Heavy duty or extreme pressure—emulsions of class I-C2 through I-C7

D. *Dispersions*

1. Physical dispersion of liquid (class I) materials.
2. Physical dispersions of solid (class IV) materials.

III. *Chemical Solutions*:

A. Organic
B. Inorganic
C. Mixtures

IV. *Solid Lubricants*

A. Powders
B. Vitreous materials
C. Greases and pastes
D. Dry films
E. Chemical conversion coatings.

V. *Miscellaneous*

A. Chlorinated non-oil type materials.
B. Sulphurized non-oil type materials.
C. Combination of A and B.
D. Organic materials not otherwise specified, such as alcohols, glycols, esters, phosphorous compounds etc.

Additives[3][4]

Sulphur and chlorine compounds and fatty oils are the most commonly used additives for imparting the extreme-pressure, anti-friction

and anti-wear characteristics to the metal-working fluids. These react chemically with the base metal, forming a new compound which shears preferentially, thus reducing friction and preventing welding or seizure of the contacting surfaces.

Sulphur compounds are more effective for heavy-duty, low-speed operation, while chlorine compounds, which tend to reduce friction to a greater extent, are useful in light-duty, high speed operations. Fatty oils form iron soaps which have low shear strengths but lower melting points than sulphides and chlorides, and are not so effective for heavy duty operations. These, however, serve as good 'wetting' and polar agents and are effective boundary lubricants.

Besides, there are various other additives such as corrosion/rust inhibitors, anti-oxidants' anti-foamants, emulsifiers, tackiness agents, bactericides, etc., for improving various performance aspects of metal-working fluids.

METAL-WORKING FLUID PRACTICES

Machining and Metal Cutting Fluids(5)

The metal-working fluids used for machining and metal cutting operations such as turning, drilling, boring, milling etc. are commonly known as cutting oils, which are subdivided as neat type and soluble type. The neat cutting oils are further broadly subdivided as active type and inactive type.

The active type neat cutting oils are sulphurized or sulpho-chlorinated mineral or fatty compounded according to the application required. These are used, principally in the machining of steels. The 'active' sulphur contained in the oil tends to form an iron sulphide film on the steel surface which because of its low shear strength, facilitates easier cutting action. High-carbon and hard-alloy steels are more-readily machined with active oils containing fatty oils. For machining low carbon steels, straight sulphurized type active mineral oils would be adequate.

The inactive oils are used to machine non-ferrous metals, primarily brass and copper alloys which are susceptible to staining and/or corrosion by active sulphur or chlorine compounds. These oils could be straight mineral oils, fatty oils, mineral-fatty oil blends and mineral oils containing mild sulphurised fatty-oil bases or compounds. The sulphur in the inactive sulphurized cutting oil is so chemically bonded that it is not released at operating temperatures to attack the job metals.

Soluble cutting oils, are mineral oils containing an emulsifier base and a coupling agent. For use as cutting fluids, they are emulsified with water. Thus they combine the cooling power of water with the lubricating properties of the oil. Some soluble oils contain fatty oils, fatty acids, wetting agents, water-softening agents and germicides. Heavy duty soluble oils contain active chemical compounds to provide extreme-pressure protection. These soluble oil emulsions are sometimes preferred to neat cutting oils as, in addition to good cutting action, they provide all the advantages of superior cooling(6). They are also low in first cost and their use offers more pleasant work surroundings to operators.

The soluble oil-water mixture concentration varies with application. It is generally betwen 1 in 20 to 1 in 30 for conventional emulsions and 1 in 10 for heavy duty emulsions. For making the emulsion, oil should be added to water, not the reverse, while the water is being agitated.

Cutting Fluid Practices

The selection of suitable cutting fluid depends on several factors such as materials and tools involved, surface finish desired, inventory and cost factors. However, as a rough guide, typical cutting fluid recommendations for a wide range of machining operations and types of work material, are presented in Appendix 1.(6).

Grinding Fluids

Grinding, though in many respects similar to metal cutting, involves a tool made of abrasive

APPENDIX—1

CUTTING FLUID RECOMMENDATIONS[5]

Operation	*Steel*			*Cast iron*	*Nickel and monel*	*Copper*	*Brass and Bronze*	*Aluminium*	*Magnesium*
	—Low Carbon	*High carbon and alloy*	*Stainless and high alloy*						
Broaching	F	F	H	D 10	F	B	C	C	B
Threading	E	F	H	D 10	F	B	C	C	B
Gear cutting	E	F	H	D 20	....	....	B		
Drilling and reaming	E	F	H	D 20	E	B	B	B	B
Boring and turning	D 20	J 10	J 5	....	E	D 30	D 30	D 30	B
Automatic screw machining	E	G	G.H	....	G	A	B	C	B
Milling	D 20	D 20	J 5	D 20	F	D 30	B	D 30	B
Thread rolling	F	F	F	....	....	A	C	B	A
Sawing	D 30	D 30	D 30	D 30	D 30	D 30	D 30	D 30	B

Key : Types of cutting Fluids Recommended
"Inactive" types :

A, straight mineral oil SSU 100 to 150 at 100F viscosity
B, mineral-fatty oil
C, mineral oil plus sulphurized fatty oil
D, soluble oil or aqueous solution (see Note)

"Active types :

E, sulphurized mineral oil
F, sulphurized mineral-fatty oil
G, sulphochlorinated mineral oil
H, sulphochlorinated mineral-fatty oil
J, heavy-duty soluble oil (see Note)

NOTE : Suffix number following designated soluble-oil or solution recommendation indicates water dilution to use. Thus D 20 signifies a 1-to-20 oil-water mixture.

grain of aluminium oxide, silicon carbide or diamond, all these dissimilar to the ground metal. Also, large frictional forces are involved in grinding operation. As such, the grinding fluid can influence the residual stress distribution and thereby the fatigue strength and service life of the finished parts.[5]

Grinding fluids, apart from their direct coolant effect, act by reducing chemical bonding or reaction between the grinding grits and the material being ground. The surface finish and the wheel life also depend to a significant extent on the type of grinding fluid used.

The influence of the grinding fluid on cylindrical grinding performance is illustrated in the following table. (7)

Fluid	*'G' ratio*	*Power-kw*	*Parts dress*
Water	7.5	6.0	2
Rust-inhibitor type	10.5	6.0	5
General purpose soluble oil	63	5.8	25
Heavy-duty soluble oil	153	5.3	50

Grinding Fluid Practices[5][8]

Both soluble oil emulsions and oil type fluids are widely used for grinding various classes of metals with exceptions of a few like magnesium, in which case aqueous emulsions are not used due to hazardous water-wet fines.

'Oil' type fluids are more generally used for grinding die-steels, high-strength and high-temperature alloys. These are also particularly favoured for finish grinding with dense, fine-grit wheels as in form grinding. The grinding oils are broadly referred to as soft and hard oils. The soft oils which contain fatty compounds are used for grinding very hard metals (R_c 45 and above). The hard oils, which are chemically most active and contain sulphur-chlorinated fatty combination, are used for grinding tough alloy steels in the R_c 20 to 30 hardness range and various other high-strength super alloy materials.

Soluble-oil emulsions are used for general categories of both rough and finish grinding, i.e., cut-off, cylindrical, centreless and surface grinding. These are of particular advantage, due predominantly to their better cooling effect, in applications where porous wheels of coarser grit are used. The soluble oil-water mixture for conventional emulsions is usually of the order 1 in 50.

Drawing Fluid Practices[5][9]

Most drawing operations are characterised by high unit pressures of the order of several hundred thousands of pounds per square inch and thereby necessitate the fluids to operate under boundary or elasto hydro-dynamic conditions of lubrication. Otherwise, the requirements of drawing fluids are basically similar to those ascribed to machining fluids.

The type of fluid used and the concentration of the emulsions used depend considerably on the material drawn (Steel), Aluminium, Copper etc.), the type of drawing operation (press drawing, bar and tube drawing, rod and wire drawing etc.) and the severity of the draw.

APPENDIX—2

DRAWING LUBRICANT RECOMMENDATIONS[6]

Drawing Operation	*Carbon steel*		*Alloy steel*		*Stainless steel*	*Aluminium*		*Copper and brass*		*Bronze alloys*	
Fine-wire draw	E	24	E	24	D	B		E	40	E	40
Intermediate wire	E	24	E	24	D	B		E	24	E	24
Rod breakdown	G		G		D	B		E	12	E	12
Bar draw	F	4	F	4	D, J	B		F	6	F	6
Tube draw	F	6	F	6	D, J	B		E	6	F	6
Blanking and stamping	A, E	6	B, E	6	D	E	6	A, E	6	F	6
Shallow press drawing	E	4	F	4	D	E	4	B, E	4	F	4
Deep draw (cold)	F	2	F	1	D	C, E	3	C, E	3	F	3
Deep draw (hot)						H*					
Heavy cupping	F	2	F	2	D	C, E	2	F	2	F	2

Key : Types of Drawing Lubricant Recommended

A, drawing oil, straight mineral, SSU 100 to 300 at 100 F
B, drawing oil, mineral, fatty-oil blend
C, drawing oil, straight fatty oil
D, drawing oil, sulphurized or chlorinated oil
E, emulsion, soap-fat compound (see Note)
F, emulsion, pigmented soap-fat compound (see Note)
G, solid, dry soap (sodium) or combination with dry lime
H, solid, graphite in light vehicle (either petroleum or aqueous)
J, solid, soft metal (such as lead coating)
Also applicable for hot draw of magnesium.

Note : Suffix number following recommendation indicates water dilution to be used. Thus E 4 is a mixture of 1 part compound to 4 parts of water for use.

APPENDIX 3

ROLLING FLUID RECOMMENDATIONS(6)

Metal rolled	*Hot rolling*	*Tandem Mill Cold Rolling*		*Sendzimir, cold rolling*
		Dual system	*Circulating*	*circulating*
Steel.....carbon and alloys.....	Water	A	B[a] C D[c]	B[a] C D
Copper, alloys.....	Waste oil	C D[c]	B[a]	C
Bronze alloys (also cupronickel and beryllium copper, alloys	Waste Oil	D	D	D
Aluminium alloys.....	B[a]	E	E G[d]	E
Magnesium alloys.....	B[e]		E[c]	
Zinc alloys.....	None	....	F[f]	
Other nonferrous.....	.....	....	(C (D	C

Key : Description of Lubricants
Type A, palm oil, fatty oil, or substitutes
Type B, soluble oil (petroleum-based)
Type C, mineral oil, SSU 100 to 150 at 100F
Type D, same as C except fatty compounding addition (about 1 to 10 per cent by volume)
Type E, light-viscosity, highly refined base mineral oil plus selected nonstaining compounding. Viscosity about SSU 40 to 50 at 100F
Type F, heavy-viscosity, EP compounded oil about SSU 100 at 210 F
Type G, light refined kerosene-type fluid, viscosity about SSU 35 at 100 F
aAbout 2 to 6 per cent by volume oil concentration in emulsion.
bUsing water flooded on rolls for cooling.
cUsed neat or cut back with kerosene for narrow strip rolling.
dFor foil finish rolling.
eAbout 20 per cent oil concentration (alternatively use synthetic aqueous solution).
fDrip or swab application to strip. No recirculation of oil.

Typical drawing lubricant recommendations for various materials and operations are shown in Appendix (2).(5)

Rolling Fluid Practices(5)

Selection of rolling fluids is based not only on the rolling process operation itself (metal strip involved, rolling speed etc.) but also on the special requirements of the mill rolls, bearings, coolant system required etc. Some typical rolling fluid recommendations are shown in Appendix 3.

IMPORTANT ASPECTS IN USE OF METAL-WORKING FLUIDS

Water for Soluble-Oil Emulsions(8)

Dissolved solids in water, particularly the "hardness" producing minerals and salts, can seriously impair the functioning of soluble-oil emulsions. They could upset the stability of the emulsion, cause corrosion of machine tools and machined parts, aggravate residues on machine tools, and increase the rate of bacterial and fungi growth in the emulsion.

The concentration of these solids, though initially low in the water, could rapidly build up in the emulsion due to evaporation of water and consequent top-up.

In the case of non-availability of naturally soft and clean water, it is most desirable, and even economical in the long run, to use water-softening plants to obtain the necessary water. Wherever available, boiler water condensate can also be safely used. Improving on the quality or richness of the soluble oil-water emulsion can also alleviate the problem of hard-water.

Corrosion and Rust Problems[8]

Corrosion is a form of metal degradation through chemical action and rust is one of its manifestations on ferrous metals as oxidation in presence of water. Various factors, some of which are discussed below, are responsible for corrosion and rust occurring on machined components.

Atmospheric Factors: Acid fumes in the atmosphere, salt content of air in areas near sea, moisture content—particularly high relative humidity and large variations of temperature between day and night, are factors most conducive to attack of corrosion and rust. Use of suitable rust-inhibitor type of oils and proper control over the richness of the emulsion can minimise the harmful effects.

Galvanic Action: Corrosion can occur from the flow of current generated by pairing of two dissimilar metals, as, for example, in long duration machining of large pieces of aluminium aircraft alloys. The corrosion of aluminium in this case could be prevented by using certain special inhibitor type of oils.

A similar phenomenon also occurs in aqueous emulsion spread between areas under 'mated' parts (two parts touching each other) and open areas where the water in the emulsion is evaporating. This happens because of difference in concentration of the liquid at the two places. In such a case, it is desirable not to allow any emulsion to reach between the mated parts, as for example fixtures or tail stock on a lathe bed, by using a water resistant grease or fluid on the surfaces of mating parts before assembling them together.

Bacterial Control [5] [8] [11]

Aqueous emulsions, unless properly controlled and maintained, can become good breeding ground for various forms of bacteria. One bacterium can multiply into over a billion bacteria in a matter of 12 hours. Bacterial growth produces acids which cause corrosion of machined and machine-tool components. The effectiveness of the emulsion is also gradually destroyed as the bacteria 'lives' on the cutting fluid concentrate of the emulsion. Also, foul odours and blackening of the fluid are produced by sustained bacterial growth.

Following are some of the steps that can effectively curb bacterial growth in aqueous emulsions.

i. Use of softened water is desirable as some of the minerals in the hard water serve as food for bacteria and fungi.

ii. Alkalinity in the water and pH controlled to 8.5 to 9 can also inhibit bacterial growth and contribute to emulsion stability. [11]

iii. Good house-keeping is essential. Periodic cleaning of the sump and entire machine with a germicidal cleaner and replacing with clean and fresh fluid can extend the fluid life by several times, apart from presenting pleasant and clean work surroundings.

iv. Contamination of the fluid with lubricating oils or hydraulic oils leaking from other systems of the machine, should be avoided as these tramp oils can serve as food for the bacteria. If contaminated, efforts should be made to skim off these oils through centrifuging or syphoning, etc.

v. Use of germicides can effectively help prevent or retard bacterial growth. However, care has to be taken in selecting the germicide and the concentration of its addition. Improper use of germicides can actually act as a stimulant for more rapid bacterial growth.

Operator Dermatitis[8]

Dermatitis, an inflammation of the skin is caused in some operators on prolonged contact with some cutting fluids. The human skin has a pH of 6.8 (on the acid side) and also a protective layer of natural oils to retard moisture evaporation and act as a mechanical shield. Therefore, chemical action leading to the removal of natural oils and neutralisation of the acidity is likely to cause dermatitis. Though human sensitivity to dermatitis varies considerably from person to person, the following aspects of cutting fluids are considered important.

1. Too high acidity or alkalinity.
2. Too 'rich' mixture.
3. Some metals and metal salts such as of Ca, Zn, Cd etc.
4. Breakdown of certain types of chlorinated-sulphurous cutting agents in water-miscible fluids (through liberation of chlorine and formation of hydrochloric acid).
5. Solvents.
6. Certain germicides.

Dermatitis is prevented by proper selection of cutting fluid, avoiding or minimising physical contact (through protective creams or gloves) and by overall clean atmosphere. Also, use of galvanised metal (zinc-plated steel) should be avoided in the storage and handling equipment, as the cutting fluid is likely to react and give rise to products that cause dermatitis in some operators.

Economic Implications of Proper Selection of Fluids [6][8][12]

To most users of cutting fluids, economics mean only the initial cost of the fluid and the fluid life period. There are, however, other major factors, tangible and intangible, which can affect the overall economic picture of operation. The other tangible cost factors are: production rate, tool/wheel life, part cleaning cost, scrap and rework costs arising out of rust/corrosion, total machining cost per piece etc. The intangible cost factors are: operator satisfaction and hygiene, cleanliness of machines and workshops, work accuracy, ease of handling and viewing parts, adaptability to different jobs, safety and fire hazards, disposability etc.

Careful analysis of all the various cost factors involved in two recent case studies[8][12] showed that very significant gains could be had by switching over to a superior fluid though it was almost 2 to 3 times costlier. The detailed cost calculations involved in one of the cases[12], are shown in Appendix 4. The total cost of production came down in this case by 20%.

Cutting Fluid Practices in India

Large-scale users in India often go by branded products of the oil companies which are supposed to market these conforming to their respective international brands. Apart from the consideration of first cost, there does not appear to be any serious awareness on the part of these users about the performance levels expected of these products or the implications of using different products. The concern of small-scale users being about first cost only, they look to some basic qualities like ability to form emulsions, etc., and as such get their supplies at lowest cost possible from small local blenders. The machine tool manufacturers, in general, render little help in assisting the user to select proper fluid for his operation.

The Indian Standards Institution has specifications[13][14] drawn up for soluble cutting oils (IS 1115:1957)and neat cutting oil (IS 3065:1970). While the soluble cutting oil specification

APPENDIX—4

COMPARATIVE CUTTING FLUID COST ANALYSIS[12]

	Cutting Fluid A Cost per piece	*Cutting Fluid B Cost per piece*
Cutting Fluid Costs		
Cutting fluid costs per gallon	5s	16.4s.
Dilution of cutting fluid	1:30	1:40
Tank capacity	120 gal.	120 gal.
Cost of cutting fluid to fill machine	20s	49s.
Production		
Average number of pieces produced/8-hr. day	120	140
Average number of pieces produced/40-hour week	600	700
Machine operator's rate	14s/h.	14s/h.
Burden rate	60s/h.	60s/h.
Production costs/40-hour week (labour + burden rate × 40 hours)	£148	£148
Production Costs Per Piece		
(Production costs divided by average number of pieces per 5-day week)	4.93s	4.22s.
Tool Costs		
Average number of pieces produced for each grind of set of tools	40	81
Average number of regrinds per set of tools/week	15	8.6
Time required to grind a set of tools	90 min	90 min.
Burden rate for changing tools	60s/h.	60s/h.
Length of time for changing tools	30 min.	30 min.
Total time per week for tool changes	7.5h.	4.3h.
Total cost of tool changes per week	22.5	12.9
Tool changing cost per piece (Total tool cost divided by average number of pieces produced per week)	0.75s.	0.378s.
Recharging Costs (coolant life)		
Length of time in machine	4 weeks	8 weeks
Cleaning time	1 hour	1 hour
Labour or clean (hourly rate)	10	10
Burden rate for machine	60s/h.	60s/h.
Total cost of filling machine one time	90s.	119s.
Recharging cost per week	22.5s.	14.875s.
Recharging cost per piece (Recharging cost per week divided by average number of pieces produced per week)	0.0375s.	0.02125s.
Yearly Costs		
Total cost of tool changes per week × 50	£1,125	£645
Total recharging costs per year (Number of cleanouts per year × cost of recharging)	£56.25	£37.1875
Total production costs per year (Production cost per 40-hr. week × 50)	£7,400	£7,400
Total yearly costs	£8,581.25 (for 30,000 parts)	£8,082.1875 for 35,000 parts)
Total Cost per Piece Produced	5.72s.	4.61s.
Total Cost of Pieces Produced per Week	£171.6	£161.35
Total Saving Realized with Cutting Fluid B over Cutting Fluid A per Year	£1,923.35	

preseribes certain performance tests like emulsion and frothing test and cast-iron corrosion test, the neat cutting oil specification merely classifies these oils in three categories and distinguishes them by physico-chemical analysis in terms of viscosity, saponification value, reactive sulphur content etc. The three categories specified are:

Neat cutting oil Type 1: mineral oil in two viscosity grades, the low-viscosity one having no fatty oil content. Both grades are without added sulphur and are meant for general machining of mild steel, brass and light alloys.

Neat cutting oil Type 2: mineral oil in two viscosity grades, blended with sulphurized fatty oils. It is meant for non-ferrous metals.

Neat cutting oil Type 3: Sulphurized mineral oil which is staining and intended for use with ferrous metals and alloys. Reactive sulphur at 100°C. is to be 0.5% minimum.

However, these specifications are hardly used or referred to by the industry and general trade. With the current and growing indigenous availability of additives and base oils and the rapid rate of industrialisation in the country, there is a strong need for concerted efforts by the machine-tool manufacturers, petroleum industry and independent bodies like Central Machine Tool Institute, Indian Institute of Petroleum and higher Technological Institutes of learning, to evolve comprehensive and appropriate standards and guidelines for their correct implementation. The engineering industry also must appreciate that the metal-working fluids are production items and not maintenance items and that the use of proper fluids can contribute directly to increased productivity and higher profitability.

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PREPARING FEASIBILITY STUDIES IN ASIA by John E Walsh Jr., Published by the Asian Productivity Organization, Tokyo; Pages i—x+168.

The later half of the 20th century may truly be named as a 'developmental era' for Afro-Asian countries. Due to the age-old political subjection to the foreign countries, the majority of the countries in the Afro-Asian region were deprived of making an organised effort to harness their natural and human resources to their best advantage. Thanks to the lead demonstrated by their erstwhile rulers, the newly-freed countries have adopted ambitious programmes to develop their economy with a view to increasing their Gross National Product (GNP) and making available to their population a multiple of products which were hitherto either not available to them or were beyond the purchasing power of a great majority of them. In this process, these developing countries have made abundant use of the techniques and strategies adopted by their erstwhile rulers in the field of economic development to their advantage. In doing so, however, the governments and the people in these countries have been obviously faced with the phenomenon of ignorance about the techniques of production, including the knowledge about the inputs and the turnover, their exactness, etc. The Asian Productivity Organization has, therefore, done a 'yeomen's' service to the people of these countries in encouraging Mr John E Walsh Jr. to bring out such a valuable book which unfolds in an interesting and effective manner the techniques of preparing feasibility studies.

Before starting the actual subject, i.e., the 'Discourse on Feasibility Stuides' the author has done well in dealing with the subject on 'Outlook and Philosophy of Planning'. In this process, he has not only described the importance and necessity of planning but also drawn the attention of the readers to the methodology adopted by some of the developing countries in the process of planning.

The guidelines given on the preparation of the feasibility reports are complete and precise and they have definitely been given, bearing in mind their practical utility. In this task, the wide experience of the author in Asian countries seems to have fully commanded the flow of his thinking. The economic, financial and technical aspects in the preparation of the feasibility report has been portrayed with vivid examples. Rightly, more space has been given to the discussion on various aspects of demand. The formulation for constructing

demand forecast, as mentioned in the book, will no doubt be very useful for not only those who have to prepare feasibility reports but also for others who deal with such subjects in a different context. It, therefore, goes to the credit of the author that demand analysis, financial viabilities and the like are brought up comparatively with less stress on econometrics which obviously is a domain of a few who specialise in this branch of knowledge.

A country like India, where functioning of public sector undertakings has become a controversial issue, has to gain more from this book as in Part IV of the book, the author has discussed in detail the feasibility exercises on these types of projects. The discussion here provides a refreshing analysis and also a guide for improving the working of such projects. The various appendices given at the end of the book are thorough guides. They are comprehensive and concise too. The book will, therefore, provide much more than a mere guideline. In fact, these appendices serve as base documents for a series of exercises, particularly to those who are actually on the job.

The presentation of the subject by the author bears testimony to his mastery over the brevity of expression. Though it is small for a handbook yet it is big enough as a reference book on feasibility studies. A large number of books used as bibliography by the author go to indicate the extensive study he has made of the various issues involved in the preparation of feasibility studies. The get-up and the presentation enable one to have an easy reading of such a technical subject. The book should, therefore, prove a treasure for those who are new to the subject and provide a working guideline to those who are on the job. To the extension service agencies, it has a greater usefulness as due to the rapidly changing attitudes of the people from traditional to modern technology there is a heavy demand on these agencies for detailed projects and feasibility reports, the preparation of which will, no doubt be facilitated by a thorough study of this book.

—DR JD VERMA

TECHNOLOGICAL CHANGE AND INDUSTRY: Edited by CP Thakur and GS Aurora, Published by Shri Ram Centre for Industrial Relations, New Delhi and Administrative Staff College of India, Hyderabad, 1971. Pages 336; Price Rs 40

The problem of technological change in relation to various aspects of industrial development was the subject of a Seminar organised in June 1970 at Hyderabad jointly by the Shri Ram Centre for Industrial Relations, Delhi and the Administrative Staff College of India, Hyderabad. About 60 participants drawn from a variety of disciplines presented a number of papers which are now compiled in the volume under review.

The importance of the problem needs hardly to be emphasised. Technology is now regarded as an instrument of development and as an agent of change. Most developing countries are undergoing a process of technological change with wide repercussions on various aspects of growth. It is, therefore, important for persons concerned with industrial growth to study the problem which such technological change would imply and to suggest various corrective measures for them.

Broadly, the papers included in the volume fall under three categories:

(i) those dealing with Organisation,
(ii) those dealing with Training, and
(iii) those dealing with Labour Relations.

Dr CP Thakur, one of the co-editors of the volume, in his Introductory piece sets out the broad implications of technological change. He rightly points out that the choice of technology in developing countries is often a matter of balancing the need for increased productivity and the equally important need for creating more employment. The problem of transfer of technology at an international level has been the subject matter of considerable thought as to how much to borrow and how far the indigenous research and development organisations

should be strengthened, to provide adequate absorptive capacity. Dr Thakur has suggested that at the applied level special attention should be paid to four aspects—human capital formation, organisational structure, management styles and Trade Union's response.

Prof Ward Morehouse, Visiting Professor of the Administrative Staff College, poses a novel (and in his own words a "perverse") view of technological change—"Is such change always desirable"? he asks. In his view, there should be a deliberate choice of technology and adoption of improved technology should not be left to chance or merely "to keep up with the Joneses". He makes concrete suggestions which Government might consider both in regard to fiscal incentives as well as in control over collaboration policies.

Specific case studies (five in number) of the complex relationships in introducing change are presented in a paper by Dr & Mrs Aurora and Mr Sivamohan. Each of these case studies highlights an important problem but all of them are woven around the theme that technological changes have, often, overtones, which are human and non-technological. It is only where one foresees the possible consequences of such changes that they are bound to be successful. Prof Mishra of the IIT, Kharagpur, deals with the impact of technological change on the organisational structure. The same theme is highlighted in a case study relating to the Fertilizers and Chemicals, Travancore Ltd., (FACT) in a paper by Dr Pylee and Mr Poduval; the main conclusion of the study are the need for major changes in organisation and personnel policies because of the adoption of a new technology and that the dislocations caused by such a technology are amenable to smooth handling by willing managers.

Two specific areas have been studied in detail in the next two papers—one on 'Railways' by Prof Mathias and the other on 'Science' by Dr. Jitendra Singh. The latter is of particular interest partly because of the fascinating content of the paper dealing with the organisational set-up by Dr Homi Bhabha at Trombay. (The paper also has a poignant interest because of the untimely demise of the author a few months back). What Dr Bhabha has achieved at Trombay is a model for scientific institutions elsewhere. Of course, one can say in reply that it is not often that a man of the stature of Bhabha is available to provide the leadership which he did in the Fifties in the field of nuclear technology. It is indeed fortunate for India that in that decade the man and the moment combined to produce an institution of outstanding merit.

The problems of computerisation (which is now a familiar technique in India) are dealt with in a paper by Shri Gidwani and his associates. Here, again, the main theme of the paper was the change in the decision making roles within the organisation because of the injection of a new technique into a management philosophy which was largely paternalistic till then. Mr Padmanabhan of the Asian Institute of Educational Planning examines in another paper the implications from the point of view of the educational planner of technological changes in economic development.

The next set of papers deal with responses of labour to the problems of technological change. Dr CP Thakur himself has a paper on the labour problems posed at the Heavy Engineering Corporation, Ranchi, through the introduction of new technology. The need for identifying changed training needs to maximise the effect of the improved technology was highlighted in a paper by Mr Dhingra. Dr Papola takes a close look at the problems of the Ahmedabad Cotton Textile Industry and comes to the conclusion that the success of introducing technological change depends largely on the willingness of labour and management to agree to such a change. In other words, harmonious labour-management relation is a pre-requisite for the successful impact of this change. The Ahmedabad experience has also been commented upon in a paper by Rev. Dawson of the Xavier Labour Relations Institute of Jamshedpur. Mr Bagaram Tulpule has an interesting paper on technological change and industrial relations, wherein he argues that although technological change has not been the cause of industrial conflicts in the past, it is likely to be so in future, unless an adequate framework of principles and procedures is deve-

loped for handling such problems. In his view, there is at present no forum available to the trade unions where they can raise questions regarding the desirability or otherwise of a proposed technological change on socio-economic considerations, while employers claim unrestricted prerogative of deciding upon and introducing such change. Unless this basic gap in the approaches of the two sides to the changes is bridged, the possibility of conflict is real. Mr Tulpule's views are of particular interest in view of his subsequent appointment as General Manager of the Durgapur Steel Plant.

Dr Suri examines the impact of office automation on the problems of clerical manpower while Dr Hem C Jain cites some case studies from United States and Canada on the way technological change has an impact on labour management relations.

The papers included in the volume all deal with matters of considerable interest. The quality of the papers is, however, somewhat uneven, but this is inevitable in a volume of this type. There is no doubt, however, that in the important field of technological change which is of great interest to all industrial managers, the present book provides a useful study, citing many specific situations from the Indian experience. Both the Shri Ram Centre for Industrial Relations and the Administrative Staff College of India, Hydrabad, deserve to be commended for holding the Seminar and for bringing out this handy volume which presents some of the important papers presented at the Seminar.

—Dr Ram K Vepa

MANUFACTURING ORGANIZATION AND MANAGEMENT (Second Edition) by Amrine, Ritchey, and Hulley, Published by Prentice-Hall of India (P) Ltd., Pages 568, Price Rs 19.50.

This is an improved edition by the authors and includes recent developments in manufacturing organisation concerning automation, operations research, value engineering, PERT, work sampling, and maintenance engineering. The contents of the book are divided into five major sections dealing in historical part, design of the manufacturing system with respect to physical facilities, the controlled mechanism to make the manufacture possible, the relationship to various sections of business to the main manufacturing organisation and lastly with the assessment of the results.

Section 1 dealing with the development of manufacturing management takes the reader through the developments of industry in the United States of America starting from Henry Ford, Andrew Carnegie and others. It stresses the development due to the competition as a key note among the American Businessmen. The authors also point out to the influence of the unions and high level of education on attainment of higher levels of productivity. While discussing the growth of management the authors have also laid stress on the evolution of the concept of modern management like specialisation, mechanisation, use of industrial engineering, use of computer and data processing equipment, use of scientific methods and systematic approach to solving problems and the use of operations research techniques as an aid in decision-making.

Section 2 which deals with the manufacturing system design is broken up into 8 chapters, namely Manufacturing Organisation, Plant location and Buildings, Design of Manufacturing Process, Industrial Equipment, Methods Engineering, Work Management, Material Handling, and Plan Lay-out. The authors discuss in this section the principles of developing an organisation suitable for any manufacturing business. In deciding the form of organisation the authors stress that the goals and objectives for the business should be first formulated and the functions necessary should be determined in order to achieve these goals and objectives. For a manufacturing organisation such goals would include production, distribution, finance procurement, employer-employeee relations, engineering and research, control, and general offices. The authors point out the need for grouping of functions in consonance with the principles of span of control and need for incorporating flexibility in organisation in order to

meet the changing need of business. The distinction between the various types of organisational structure like line structure, line and staff structure and use of committees has been brought out. The authors feel that to achieve coordinations, besides a proper organisation, manuals of standard practice should be developed by industries. This will enable the demarcation of responsibility and authority and will help in training new incumbents. These will also help to standardise procedure in an organisation to achieve the ultimate goal of "manufacturing standards". The organisational planning would also help to provide for manpower planning and also better understanding between different persons of the organisation, thus giving a long run strength to the business.

The chapter on plant location discusses the various standard factors which effect selection of locating the plant in a particular area and also in the selection of a particular site for a plant. The discussion on plant buildings is of a very general nature giving an idea of the overall requirements to the reader and to focus his attention on the fact that plant buildings are an important aspect in overall efficiency of the manufacturing unit. The authors discuss general problems concerned with continuous manufacture, intermittent manufacture and mixed type of manufacture, and selection and replacement of equipment. On method engineering and work measurement a general coverage of the techniques involved has been brought out briefly for the guidance of the readers. The tools for scientific analysis like operation chart, process chart, simo chart, work sampling techniques and determination of elementary motion times and principles of motion economy have been narrated in brief.

The material handling chapter brings out various types of equipment like conveyors, cranes and trucks generally used in industry along with the principles of equipment selection.

Under Section 3 the control activity concerned with manufacturing has been discussed. The authors have mentioned four basic control phases: (1) there must be a plan (2) there must be a record of actual performance (3) this actual performance should be compared and evaluated continuously with the plan and (4) there must be adequate provision for corrective action in manufacturing operations. These aspects have been dealt with at length. This section also deals with the management of inventory and the control thereof in order that the manufacturing activities may not suffer. Here again only the fundamentals have been discussed. Purchasing as a function of maintaining supplies of raw materials and purchased parts and controlling the incoming material has also been briefly dealt with. The authors discuss the fundamental principles of purchasing/procuring right material in the right quantity and quality from the right place and at the right time and at the right price. Importance of value analysis as a part of purchasing function has also been brought out.

The authors deal in general with the principles of Production Planning & Control and make brief mention of the PERT & CPM and operative research techniques utilised for an economical planning. Some aspects of quality control and cost control have been also discussed by the authors. The various methods of inspection like inspection of purchased materials, inspection in process, inspection of finished goods, inspection by attributes and use of control charts and sampling procedures have also been discussed. A brief reference also appears about elucidating maintenance engineering, corrective, preventive and predictive maintenance.

Section 4 deals with the departments related to the manufacturing department. The role of personnel management and responsibilities towards establishment, personnel policies including employment, training, health, safety benefits, services, labour relations and wage administration connected with personnel are brought out. The various methods of wage payment and wage fixation, job evaluation and merit-rating have been discussed. One chapter deals with the research and its importance in the manufacturing management connected with evaluation of product, developing of manufacturing process, use of proper materials and research on marketability as a goal towards increased productivity. The fundamentals of process development and

project development have also been briefly mentioned. The organisation required for such research development and planning engineering project and planned engineering has also been brought out. The financial management which is also another important link to sustain the manufacturing management has been discussed to give an idea to the reader regarding the various types of capital employed in the industries, the source from which these are made available and the significance of various financial statements like balance sheet, profit and loss statement and manufacturing cost statement. The organisation in the financial management and control has also been generally mentioned. In the chapter on marketing management the reader is told of the various marketing functions and organisation required to man these marketing functions. They include marketing, research project, planning, advertising, sales and services.

In the last section, the authors have very rightly laid stress on the appraisal of the manufacturing results. They lay stress on the functions of management as a process and responsibilities of management towards fulfilment of objectives. The functions of the Manager like planning, organising, staffing, direction, controlling and coordination as brought out by Henry Fayol and various principles of Management propagated by him have been enumerated.

In the last chapter, the proposals of the various functions performed by the Managers and the tools employed for such appraisal have been mentioned. The Management audit as proposed by the American Institute of Management to appraise the Management's success has been propagated. The 10 factors covered under this audit include economic function, corporate structure, health of earnings, services of stockholders, research and development directorate analysis, fiscal policies, production efficiency, sales vigour and executive evaluation.

In general, the book is meant, as rightly mentioned by the authors, for persons inexperienced in the field of manufacturing management and the material presented, therefore, is in a non-technical manner. The various functions involved in manufacturing industry have been mentioned with the proposed organisation patterns for every function. These are only indicative and, therefore, are useful to the reader as only the starting point in his attempt to solutions of any concrete problems.

The book is excellent in its services to the Manager who will get an opportunity to review various facets involved in developing and maintaining the manufacturing organisation. At the end of every chapter a number of case problems have been narrated pertaining to the topic in the chapter. These case problems and the questions give the reader an opportunity to think on the practical situations arising in the industry, thus giving him a scope to apply the information contained in the chapter in the form of mental exercises. In order to apply the knowledge, however, he will have no doubt to obtain the services of persons specialised in particular fields or to read deeper in books dealing with particular aspects of his interest. The book serves ably the purpose for which it is meant as it is not the purpose of this book to make an expert of the reader in planning and running a manufacturing organisation but to focus his attention and make him knowledgeable with the various aspects which are required to be considered for building up an efficient manufacturing organisation.

—KG SALVI

PURCHASING MANAGEMENT: MATERIALS IN MOTION (Third Edition) by JH Westing, IV Fine, and Gary Joseph Zenz, Published by Wiley Eastern Private Limited, New Delhi 1971; Pages 538; Price Rs 16.50.

The science of purchasing has attained ever-increasing importance with the recognition of the facts that mass production operations depend on a steady and reliable flow of materials and supplies and the cost of these purchased components constitute a major factor of product cost. With the rapid industrialisation of our country, scientific purchasing has

assumed a vital role because it is considered an important tool of cost reduction. The principles and techniques of sound purchasing that have taken shape as a result of the long experience are equally adaptable and profitable everywhere. It is only through the understanding and application of the basic principles and techniques that the purchasing executive can attain proficiency in fulfilling his responsibility for procuring the right material, in the right quantity, at the right time, from the right source and at the right price. Purchasing today is a creative task, geared into the overall plants and operation of the entire organisation.

The book under review highlights the basic principles and techniques of modern purchasing management. It has been broadly divided into two sections first dealing with the text on the subject while the second half providing cases emphasising the different aspects of purchasing. The text has been discussed in four parts under the heads Introduction, Purchasing Activities, Related Purchasing Activities and Control of Purchasing Activities.

The authors have done an excellent job in bringing out in a simple language the various facts of the purchasing function. There are special chapters which provide an understanding of PERT, CPM and value analysis, electronic data processing, internal auditing as well as special purchasing procedures such as systems contracting, blanket purchase orders, and stockless purchasing. Purchasing research has also been dealt with as a separate chapter. Most of the chapters are supplemented with summary and references. The purchasing cases given in the second half of the book provide an insight into the types of problems which a purchasing man can encounter.

This book is recommeded to be on the shelf of every purchasing executive, teacher and the taught.

—GK HANDA

MARKETING MANAGEMENT IN DEVELOPING COUNTRIES by TAA Latif; Published by Hemkunt Press, New Delhi, Pages 173, Price Rs. 20.

One thing that can be said about Mr Latif's book "Marketing Management in Developing Countries" without fear of contradiction is that it presents a lucid exposition of some of the facets of marketing management; a high degree of clarity of thought, and a treatment of the subject shorn of technicalities. And it is this third characteristic of the book which sets limits to the scope of the subject covered.

The book is not designed for the advanced student. It is primarily meant for those businessmen and industrialists who have tended to take marketing tools for granted, hitherto feeling secure in a sheltered economy. Equally useful will be this book for youngmen making their debut in the field of selling and marketing.

Mr Manubhai Shah rightly points out in the Foreword that "sustained economic growth depends to a large extent on marketing activities" and "it is of vital importance for all businessmen to understand the role of marketing in the economic development of a country and in raising the standard of living of the people". This must be unambiguously grasped not only by big but more so by small businesses and manufacturers. In their case, to quote Dr P C Alexander from the Introduction "the areas of ignorance are larger" and the competition is mounting.

The book is broadly divided into five parts: (i) marketing management—concept and strategy; (ii) marketing and small industry; (iii) marketing, advertising and personal selling; (iv) marketing and public relations; and (v) marketing and export management. While dealing with concept and strategy of marketing management, Mr Latif emphasises the importance of business schools; productivity in marketing and the need for value engineering. The two chapters dealing with marketing

trends in fertilisers and coal management are slightly out of context. Mr Latif has done real service to small businessmen by highlighting the importance of marketing techniques for the growth of small industry. Small entrepreneurs can with advantage go through the relevant chapters. The most outstanding contribution of the book is the author's emphasis on advertising and public relations as marketing tools. "More and more businesses and industrial undertakings both in the public and private sectors have to be aware of their role in Industrial and Business growth".

It is a useful book in spite of a little repetition here and there because the author uses some of his earlier contributions made in various journals. And this is a lapse which can be ignored.

—GC AWASTHY

CASES IN INDUSTRIAL RELATIONS: Edited by OP Dhingra and HVV Chellappa, Published by Shri Ram Centre for Industrial Relations, New Delhi, 1971, Pages 144, Price Rs/-25.

Twenty-two cases dealing with industrial relations problems such as multiplicity of union, jurisdiction of committees, management styles of handling workers, *gheraos* and violence, impact of technological change, reduction of manpower, promotion and upgrading, wages and incentives, modes of payment, labour laws, dismissals, rumours and joint management councils are collected from different small and medium scale industries in India. The industries covered in the cases include: textiles, cooking gas, cigarettes, autobulbs, surgical products, automobile and motor cycle parts, chemicals, plastics and other light engineering goods. The cases have been written in a lucid style and can be used effectively in syndicate discussion. Some of the cases can also be used for role playing and incidental process of teaching. The case abstract and index of the book is very useful. It would have been better if the names of the case writers were also mentioned on the book. The price of the book and for the additional copy of the case seems slightly on higher side.

—NR CHATTERJEE

PERT AND CPM: PRINCIPLES AND APPLICATIONS, by LS Srinath, Published by Affiliated East-West Press Pvt. Ltd., New Delhi-13, Pages 135, Price Rs 12.50.

The book on PERT and CPM—Principles and Applications—will prove equally useful to the beginners, practitioners and managers keen in making use of this technique for planning, scheduling and control of projects.

The author, in Chapter 1, briefly explains the technique of Bar or Gantt Chart in vogue before the advent of PERT/CPM and brings home its weaknesses. In subsequent chapters, the author gradually develops the Concept of PERT/CPM and explains logically the steps involved in the use of this technique. Each concept is demonstrated by an example, and at the end of each chapter a number of problems are given to provide adequate practice to the beginners. They can check their answers with the solutions to these problems given towards the end of the book.

This book is comprehensive in most aspects. Besides explaining the development of network, making time estimates, and calculation of critical path and slack or float, the author goes further to explain the very important concepts of Updating, PERT-Cost principles, Resource Allocation, Smoothing and Levelling.

The usefulness of this book, however, would have been greatly enhanced, if the author had provided guidelines for making single time estimates on the basis of quantum/norm analysis, developed a system of reporting for review and updating and given an introduction to the use of Computers in PERT/CPM. The absence of these, however, in no way undermines the usefulness of this book.

—RS GUPTA

AGRICULTURE PRODUCER'S RATIONALITY AND TECHNICAL CHANGE, by Dr Sipra Das Gupta, Published by Asia Publishing House, Bombay, 1970; Pages 184, Price Rs. 24.00.

In contrast with the economically-prosperous nations where agriculture is no longer the Achilles' heel, the economically poor nations generally find the supply of agricultural products trailing behind the demand with a growing stringency of food supply casting a dark shadow on their efforts for progress. In this context, the most important question to ask is: "What is it that makes development of agriculture more difficult in predominantly agricultural countries?" In other words, was it that the reforms of institutions were not enforced in the same earnestness in which they were introduced, or that the implementation faced real and unsurmountable difficulties or still further, were the reforms not of the right type?

These are very pertinent questions to be answered while analysing the ills that beset Indian agriculture. Quite competently, r Sipra Dasgupta has probed into an area where many would fear to tread. She analyses the elements that influence the cultivator's attitude to technical innovation and changes in cropping pattern. By collecting and collating the empirical data, the author explores the sources of the risk and uncertainty elements with special reference to Indian agriculture.

This publication is a doctoral dissertation that the author submitted to London University. Containing seven chapters, it gives a useful bibliography and ends up with an exhaustive index. The economic data have been scientifically interpreted to their logical conclusions. The hypothesis enunciated in the investigation is that the agricultural producers in India are guided by economic interests in their actions. The test revealed that the actual cropping patterns are not inconsistent with the hypothesis. Indian cultivators maximise a composite function of the expected income and the income variability, the latter arising from the presence of risk elements in the farm planning environment due to the role of natural factors.

A number of studies made on Indian agriculture assume, implicitly or otherwise, that the determining variables in agricultural development are "sociological" rather than economic in nature. Specifically, it is claimed that agricultural producers in India do not have any economic motivation and are incapable of behaving rationally within the given environmental constraints and that they are incapable of adapting to changes in environment i.e., they are change resistant. The author's analysis explodes such myths. "In India, the peasant producers have shown over time a positive preference for higher income and an inclination to face greater market uncertainties if there is a likelihood of greater income." This is revealed in their positive response to changes in price ratios of competing crops or in the spread of crops associated with greater price uncertainties than food crops. Such experiences contradict the notion of any peculiar peasant psychology as such.

The author rightly points out that technological innovations in agriculture are often complementary to each other; the use of one innovation creates the need for the use of another. Any possibility of introducing innovations in agriculture requires the growth of scientific knowledge in the country. The need for "package deal" in India arose largely from the complementarity among innovations. Dr Sipra's analysis suggests that agricultural producers in India may well respond to new opportunities in future, if such opportunities are created in such a way as to be consistent with their own requirements. However, the efforts at introducing innovations have so far been slow and rather sporadic.

The analysis of the land-labour ratio figures reveals that the amount of an input to be applied (i.e., labour) is determined by basic economic calculations of cost and return. The small producers apply more labour per unit of land since family labour is a free fixed factor in the short period. Given the low rate of substitute

between leisure and income of low income group farmers and the lack of alternative employment opportunities, family labour has no 'opportunity' cost. In such cases, the maximum utilisation of the available land coincides with the maximum of family income. On larger farms, the application of less labour could be explained in terms of the change of leisure-income preference of family members and the amount of hired labour being determined by cost and return calculations. In such cases, the point of the maximum family income does not necessarily imply the full utilisation of land as an input. There is, therefore, no reason to assume, *a priori*, that all agricultural producers in India would use their land fully in their own farm planning.

The book certainly makes a landmark in exploring a tedious and difficult terrain in Indian agriculture. But the journey must have been interesting as are the ultimate findings.

—NAVIN CHANDRA JOSHI

COMPUTER FOR ALL BASIC FORTRAN PROGRAMMING, by LL Bhirud, Published by Somaiya Publications, Bombay, Pages 80. Price Rs 5.00.

The book covers fundamentals of Basic Fortran, a programming language that can be used by students, engineers and scientists who without having to concern themselves much with the computer where their programme shall ultimately run, and without any knowledge of the machine language of the computer, can avail of the computer facilities for solving their scientific and mathematical problems.

The main merit of this book is that it specially addresses the Indian environment and discusses Fortran programming for computers in use in India. Also, this book is well-explained and is reasonably priced. Examples given, however, are too simple and may find only limited practical application as such. A couple of examples with real problems could have been included. There are quite a few typographical and other minor errors in this book.

The book should prove useful to the beginner in programming, who can supplement his knowledge with a regular classroom course or with actual programming on the computer with recourse to manuals put out by the manufacturers.

—AMRIT S CHOPRA

ECONOMICS OF TUBE WELL IRRIGATION, by SM Patel & KV Patel, Published by Indian Institute of Management, Ahmedabad Pages 100, Price Rs 8.00.

The Faculty for Management in Agriculture and Co-operatives of the Indian Institute of Management, Ahmedabad, under whose auspices this research project has been taken up by the authors needs a word of praise for the encouragement they have been giving for conducting studies in agricultural management. The need for such management-oriented studies based on scientific analysis cannot be over-emphasised.

Availability of the right and acceptable type of irrigational facilities is crucial for agricultural productivity. Their mere availability is just not enough. Conditioned by natural factors, the extent, nature and methods of availing and utilising irrigational facilities are not uniform all over India. As a single important source of minor irrigation, wells assume the predominent role. In this category, tube-well irrigation has its own characteristics—its economics, investment pattern and cost structure; its performance and acceptability. The authors have probed into all these aspects. Their's is the managerial approach to the subject, that is the one of most optimum utilisation of resources—a viewpoint which cannot afford to ignore, *inter alia*, the behavioural aspects of the consumer. In this context, it should be interesting to examine the

authors' finding that small farmers who used water from State tube wells were worse off as compared to owners of tube wells. Cheapness of water led to its non-judicious utilisation; uncertainty about its availability undermined the very objective of their existence.

The report has been neatly divided into six chapters. After discussing the problem and scope of the study in the first chapter the authors have discussed in detail the characteristics of sample farmers, their behaviour in respect to the lift irrigation equipment, the investment pattern and cost analysis, lift irrigation and farm business. In the last chapter their findings and recommendations have been very well summarised.

The report establishes that the acceptance of technological changes and adaptation to new levels of farm technology is different with different categories of farmers. Social circumstances educational standards and economic resources influence the levels of technology adopted by them. There is also a significant relationship between the educated farmers and higher levels of technology.

Realising that technological changes cannot be introduced from the top, and to be successful, should be acceptable to the farmer, the authors have taken pains to analyse the behavioural aspects of the consumer in the lift irrigation machinery market. It is significant to note that, motivated by economic considerations, the sample farmers have been more influenced by non-official agencies in selecting the irrigation equipment. Governmental agencies are relied upon more for credit facilities. The farmers somehow had the feeling that the opinions of Government agencies on equipment are not worth depending upon. They are feared to be prejudiced.

These findings and those brought out by study of the investment pattern and cost analysis of different sources of lift irrigation underscore the need for functional literacy. The authors found that the farmer does not have good knowledge about the market or the product, e.g., which type of motor starter he should buy, he does not know generally. On the other hand, there also seems to be a need for a fresh approach to tackling of this problem of tube-well irrigation by the Government. Establishment of state tube wells indiscriminately may not be the solution. Probably what is required is a marketing viewpoint—the chief aim being customer creating value satisfaction—a philosophy based on scientific analysis of need, costs, input-output relationships. Scientific management seems to be the only way to achieve better and increasing productivity in the field of tube well irrigation.

—GR KHANNA

BOOKS RECEIVED

The following technical publications of the Asian Productivity Organisation, Tokyo, have been received:

1. Guide to Quality Control Circle Activities
2. Managing the Japanese Factory
3. Technological Survey of Small Industry in Japan
4. Export Inspection Systems in Five Asian Countries
5. New Developments in Plating Technology
6. The Construction Base and Payment Base in Equipment Investments
7. Industrial Standardization in Japan
8. International Marketing of an Oriental Product
9. Summary of Agricultural White Paper of Japan for 1969
10. Industrial Relations and Productivity in Japan.

These publications are available in India from M/s JAICO Publishing House, 121 Agra Building, 125 Mahatma Gandhi Road, Bombay-1.

History of the Russian Non-Marxian Sacial Economic Thought: by Dr. Boris Ischboldin, Published by New Book Society of India, Post Box No. 250, New Delhi, Pages 328, Price Rs 30/- ($ 7.00 or Sh. 50/-).

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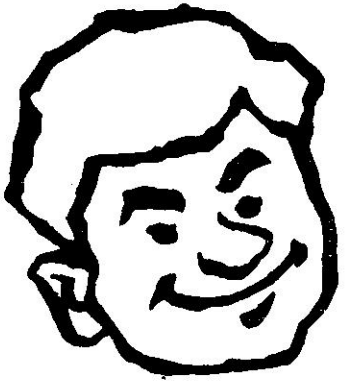

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Company Directors Handbook	Price : Rs. 5 or $ 1.50 (in Press)
Technological Education	Price Rs. 7 or sh. 15 or $ 2
Elements of Costing	Price : Re. 1
Directory of Directors	First Edition : Price : Rs. 30 or £ 3 or $ 9
	2nd Edition : Prepublication Price : Rs. 30 for Reservation (Out 1972)
Who's Who in India	Reservation Price : Rs. 30 or £ 3 or $ 9 (in Press)
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