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PRODUCTIVITY

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Industrial Relations and Productivity

Excerpts from the speech by Mr Varahagiri Venkata Giri, President of India, on the occasion of laying the foundation stone of the building of the National Productivity Council on 11th October 1972, at New Delhi.

SINCE Independence we have made impressive progress in generating productivity-consciousness in various sectors of the nation's economy. The productivity movement is gaining momentum now, and seeing the record of NPC's work, I may say that I am greatly impressed by the positive transformation which this public service organisation has been able to bring about in the outlook of managements and labour as well as of the public in general. By popularising the techniques of productivity through innumerable training programmes, seminars, symposia and other propagational measures, the NPC has made a valuable contribution to the creation of productivity consciousness amongst all those who are actively connected with industry. Today, there is a growing demand for NPC's application training programmes as well as its result-oriented consultancy services in the field of techno-managerial areas, not only within the country but in the developing countries of the Afro-Asian region as well.

There is no doubt that, whether in large scale or small scale economic operations, productivity plays an essential role in the efficient utilisation of resources. With the growing advance of science and technology, we have to endeavour constantly to adopt the most efficient methods of production which make the best use of the available resources, and achieve production at an economic cost. This, in fact, is the basic philosophy of productivity which needs to be stressed continuously. The use of scarce resources to the utmost advantage is important for the nation as a whole, and I am glad that this trend is being strengthened in our growing economy.

In the 25 years that have elapsed after Independence, we as a nation have faced great stresses and strains without losing sight of our major objective of providing productive employment for all the people in the working age group, raising the standard of living of the masses and designing for them a socialistic

"The time has come when there should be a healthy competition in increasing production and productivity rather than living in conflicts which would hit the labour class no less than the community as a whole. Labour must consider it its supreme duty to maintain production and productivity at a high level for they are the co-sharers and co-partners in progress."

pattern of society. While the Government is fully aware of its responsibilities and is taking necessary steps towards the achievement of this objective, every citizen of the country must also contribute his mite in the fulfilment of this task in the shortest possible time.

Optimal Use of Resources

What we need is inculcation of proper attitudes to work hard and the will to make optimal use of the available resources for achieving higher productivity and faster rate of economic growth. At the same time, factors impeding industrial productivity will have to be resolved. We must take advantage of the favourable industrial climate. First and foremost, the idle capacity in the industry should be fully utilised. We have also to improve the quality of management in administering and decision-making. It is certainly very important that the level of management skill be bettered, and for this we must expand management training and provide better and more training facilities for educating the new generations of managers through professional and other institutions. Managers are conditioned by their social and economic environment and have to be responsive to it, and I feel that it would be worth-while bringing this factor to the knowledge of managers through their educational and training programmes.

But by far the most important problem which needs to be tackled urgently is in the field of industrial relations. The success of any industrial enterprise largely depends on good industrial relations, if it has to achieve the objectives of maximising production, ensuring fair and adequate returns to investors and meeting labour's legitimate demands. The Government has announced that it proposes to bring a comprehensive law on industrial relations envisaging the setting up of an Industrial Relations Commission, both at the Centre and in the states.

Sharing Gains of Productivity

Besides establishing fair and sound personnel policies, a satisfactory solution to the sharing of the gains of productivity may pave the way for better industrial relations. So also, examining the question of linking bonus above agreed minimum with productivity might make a positive contribution towards improved industrial relations. The NPC certainly deserves the credit for working out broad guidelines and "models" for sharing the gains of productivity. I have always been pleading for a proper linking up of wages, productivity and prices. Due to increasing cost of living, there has been a growing unrest on the part of the working class. This is but natural. At the same time, I would like to stress on my working class comrades that the primary responsibility devolves on them to see that productivity and

production are maintained at the highest possible tempo. There is no use of saying that the wages must be increased without any step in the direction of increased productivity. If the wage factor is not matched by a proportionate, or more than a proportionate, increase in productivity and production, the very system will not be able to adjust itself to the growing demands of labour. For, our past experience has shown the phenomenon of the benefits of increased wages being offset by the increase in prices. In developing countries, we find an increasing awareness on the part of labour that they should be paid what is due to them. This conflict can be resolved only if wages are linked to productivity and prices.

Challenge of Change

Rapid changes are taking place in the country's socio-economic life. We have to face the challenges of change. This new situation certainly calls for an enlightened approach. We cannot any longer function in an atmosphere of unrest and distrust. That was why, some time back, I had called for a moratorium on strikes and lockouts for three years. We should realise that industrial management is an area for co-operation, and I feel that the time has come when there should also be a healthy competition in increasing production and productivity rather than living in conflicts which would hit the labour class no less than the community as a whole. Labour must consider it its supreme duty to maintain production and productivity at a high level for they are the co-sharers and co-partners in progress. They should no longer consider themselves as mere wage-earners working for their daily bread but as citizens of a free country trying to build a new order of society where justice and equality will prevail. As far as rationalisation is concerned, Gandhiji had enunciated long time ago the three cardinal principles for effecting rationalisation :

1. Rationalisation should not create unemployment.

2. Additional work-load, if any, ought not be such as to jeopardise the worker's health.

3. The profits of rationalisation should be equitably shared by management and labour.

These principles have stood the test of time and would, if applied reasonably, safeguard the interests of the workers even today.

Important Role of Small Industries

I would like to stress the importance of the small industries sector in creating ample employment potential. The NPC and the Local Productivity Councils have a much greater role to play by way of providing training and consultancy services, enabling this sector to produce goods and services at competitive prices and of desired quality. The NPC should also gear itself to help the prospective young entrepreneurs in identifying investment opportunities for them and preparation and evaluation of the feasibility of their new industrial ventures.

I have the firm conviction that the country's progress, prosperity and ultimate strength will depend on our ability to increase national productivity and employment potential. We have celebrated the Silver Jubilee of our Independence. Let us devote the next 25 years to achieving higher productivity in all spheres of activities and employment for all. Let us remember that poverty can be abolished only through higher productivity. I am sure that the managements, labour and the NPC will join in this effort, and contribute usefully to the building of a society in which our millions can live a fuller and more abundant life. □

Increased Productivity : Key to Prosperity

Prof Siddeshwar Prasad*

The need today is for a concerted drive for productivity, covering all areas of our national endeavour. A total approach to economic development and productivity needs to be adopted by integrating planning for productivity with the National Five Year Plans. At the enterprise level, with the complex man-machine system, management has to play the role of a vitalising factor. The trade unions should support the application of such productivity techniques as would lead to improved industrial relations and higher productivity without causing any retrenchment or unemployment. Continued efforts must be made to derive the fullest advantage from technological developments and innovations taking place all over the world, taking due care of the sociological implications arising therefrom by fostering and maintaining harmonious industrial relations

WE are passing through a very critical phase in our economic development, and the position of our resources being what it is, the task of raising productivity needs to be given top priority and it needs to be integrated with our national economic plans. This is imperative because one of the paradoxes of an underdeveloped economy lies in the inability of the economic system to secure optimum utilisation of its resources. This inability has been adversely affecting the growth of our national economy. What we need today is a concerted drive for productivity covering all areas of our national endeavour.

Commendable Efforts by NPC

In fact, it was with this very objective in mind that the National Productivity Council was established in 1958 and entrusted with the task of creating in the country a widespread consciousness about the importance of productivity, helping the development of the right motivation and providing assistance in the actual application of productivity techniques. The productivity movement in this country, however, has mostly remained confined to the corporate industrial sector of the economy so far. It now needs to be taken out of the confines of industry and extended in a big way to cover such important sectors of economy as small scale industries, utility services and even to agriculture as the movement gathers momentum. It is, however, a sign of awakening among the industries about the usefulness of productivity techniques that the National Productivity Council, with the help of the Local Productivity Councils, which are its arms in the field, has conducted more than 2,750 training programmes and undertaken nearly 900 consultancy assignments for demonstrating the validity of the productivity techniques on the shopfloors, in just over 12 years of its existence. Although from the Council's point of view this is a commendable achievement, looking to

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the vast size of the country we have succeeded only in dealing with a fringe of the problem.

National Seminar on Productivity

The NPC is not, however, complacent of its achievements but is continuously exploring new avenues for the further strengthening of the Productivity Movement in the country. It was with this objective in view that a National Seminar on Productivity was organised in March 1972 which laid down a number of guidelines. As many as 300 delegates, including top leaders of industry and trade unions, economists, educationists, technologists and senior officials, both from Central and State Governments, took part in the deliberations and exchanged views on promotion and growth of productivity in the country. I also had the privilege of being associated with the two-day deliberations of the Seminar. Valuable suggestions for tackling the productivity problems emerged from the Seminar—some to be implemented by the employers, some by the workers and trade unions and some by the Government. As an organisation concerned with productivity, the NPC is doing its best to see that these suggestions are taken note of and implemented in whomsoever's sphere they lie.

Integrating Productivity Plans with National Plans

Perhaps the most important recommendation of the Seminar was that the Government should adopt a total approach to economic development and productivity, and integrate planning for productivity with the National Five-Year Plans. The National Plan for Productivity may clearly lay down the objectives, tasks and priorities so that the economy achieves a self-sustaining growth rate. It should also evolve a productivity-oriented industrial policy and prepare industry-wise plans for achieving pre-determined rates of productivity and economic growth. The enterprises should be encouraged to achieve higher productivity and higher earnings for the working-class with the applications of productivity techniques and by entering into long-term productivity agreements as well as by adopting suitable fiscal measures to reward the enterprises for achieving higher productivity.

The national plan for productivity should clearly lay down the objectives, tasks and priorities so that the economy achieves a self-sustaining growth rate.

Productivity at Micro Level

At the enterprises level, it is an important function of management to induce mental attitudes for increased industrial efficiency and productivity, as these are the most essential requirements for the survival and growth of an enterprise. In modern enterprises, with their complex man-machine system, management has to play the role of a vitalising factor by the use of modern tools of analysis and sophisticated techniques for developing manpower effectiveness and increasing their productivity and profitability. Such an approach also emphasises the integration of the employees into the organisation by creating an environment which may satisfy their need for ego reinforcement, and provide them an opportunity for self-ful-

In modern enterprises, with their complex man-machine system, management has to play the role of a vitalising factor by the use of modern tools of analysis and sophisticated techniques for developing manpower effectiveness and increasing their productivity and profitability.

filment, thus enabling them to produce abundantly and live securely. Since, in the ultimate analysis, productivity is a problem of making use of resources more rationally, effectively and efficiently to produce as much wealth as possible at the lowest possible cost, increased productivity generates a genuine surplus, which is available for distribution among the various interests involved.

Sharing Gains of Productivity

In this context, the somewhat complicated problem that comes up is that of sharing the gains of productivity. In considering measures for raising the levels of productivity this question becomes a matter of concern, particularly, to the two partners of industrial production, namely, management and labour. Whereas labour wants a major share of the gains to accrue to itself on the ground that its contribution to the increase in productivity is greater than that of management, the management contends that labour is often not the main factor in increasing productivity, and new technologies, modern machines, higher investment and improved managerial practices are important. A factor that has added another dimension to this problem is the inter-union rivalry due to which some people are vying with each other in demanding increased wages, bonus and dearness allowance without any appreciation of the fact that these should have some connection with productivity. The National Productivity Council, which is a tripartite body on which labour, employers as well as Government are represented, had been making concerted efforts to bring about a consensus on the issue of sharing the gains of productivity in the hope that this would not only lead to better industrial relations but achieve a breakthrough in economic and industrial development. Such a consensus is now nearly reached in the form of the "Guidelines" evolved by the Governing Body of the National Productivity Council and these guidelines deserve due consideration and support for their wider adoption.

In all these efforts for increasing enterprise level productivity, the Trade Unions must also lend their wholehearted cooperation by supporting techniques which lead to improved industrial relations and higher productivity without causing any retrenchment or unemployment, or intensification of labour's burden, by endeavouring to establish their own Productivity Departments with the assistance of NPC/LPCs and utilising their services in adopting a scientific approach in dealing with the various problems.

Productivity Measures for Small Industries

Notwithstanding the predominant role played by the large-scale sector in an industrial society, the small industries have an important and continuing role to play in the economies

of densely populated but industrially less-advanced countries like ours. In fact, the small industries sector has been making a very significant contribution to industrial production and employment, and thus to the development of the national economy. The estimated gross value of output in this sector, including both registered as well as unregistered units was approximately Rs 36,700 million in 1969-70. Small enterprises registered as factories accounted for 39 per cent of the total factory employment in industries under the purview of the Small Scale Industries Development Organisation. Their contribution to the exports from the country is not insignificant either.

Small industries, however, do have their problems. They could certainly make a still better contribution if they were helped in improving their methods of working, in improving the quality of their goods, in the marketing of their products, and so on. It is an encouraging sign that some of the State Governments, like Tamil Nadu, Mysore and the Punjab, realised the great potential of these industries and have given the lead in establishing special consultancy cells for them in collaboration with the National Productivity Council and the Local Productivity Councils, and are providing to them productivity services at subsidised rates. It is also heartening to note that more and more small units are coming forward to avail of these services. But a lot still remains to be done, and it is high time that the other State Governments also followed suit in establishing such consultancy cells.

The National Productivity Council is already seized of the various technological problems faced by the small units and has taken steps to diversify its activities in respect of technological services. It has already organised expertise in the field of Plant Engineering, Production Engineering, Fuel Engineering, Product Design, and so on. There is no doubt that if we have to carve a place for ourselves in the comity of industrially-advanced nations, we must continue our efforts to derive the fullest advantage from technological improvement and innovations taking place in all parts of the world, at the same time taking due care of sociological implications arising from these through development and maintenance of harmonious industrial relations.

Productivity is essentially an attitude of the mind, and this attitude must be cultivated by each and every citizen of the country, whatever his vocation.

It must be emphasised that productivity is essentially an attitude of the mind, and this attitude must be cultivated by each and every citizen of the country, whatever his vocation. In inducing such attitudes, it is no doubt important to impart knowledge of better working methods through formal training, wherever necessary, and also to see that this knowledge is really put to use. □

Based on the speech delivered on the occasion of the foundation stone laying ceremony of NPC Building in New Delhi on 11th October 1972.

New Directions and Dimensions for Productivity Movement

SM Patil*

Besides measures for productivity improvement at the unit level there is need for a systematic and continuing application of sophisticated input-output models in taking fiscal decisions and the use of risk-probability criteria at the macro level in planning infra-structure capacities. Radical changes in outlook and organisation structure are required to implement sophisticated productivity techniques. Quantitative techniques of productivity improvement would be fully effective only if people at all levels in an organisation are correctly motivated. Organisations like the NPC should evolve and field-test appropriate communication systems and also train specialists in adequate numbers to design and install specific systems at the operating unit level. Incentive payments should be linked with improvement in productivity. A productivity-based rewards scheme would contribute significantly towards national economic growth.

THE National Productivity Council deserves congratulations on its 15 years' pioneering efforts in spreading productivity consciousness throughout the country. The educational and advisory programmes launched by the NPC have proved to be relevant to the developing economy. Up to this point the major emphasis by the NPC has been on the improvement of productivity at the micro level. All the modern techniques popularised by the NPC, and all its educational and advisory programmes, highlight how the resources available at the production unit level should be utilised in order to maximise outputs. This limited objective of the NPC might have been perhaps sufficient in a developed country with free-market economy.

In a developing country such as India, in which effective economic resources are in short supply, a sense of priorities in economic development would be very essential so that the available scarce resources are best utilised. Until the basic internal resources become plentiful, economic development planning at the macro level would be essential. Naturally, this becomes the responsibility of the Government. It is inevitable that economic development in such a situation becomes mixed up with the socio-political ideologies of the Government, and results in what has been loosely called "controlled economy", in which the Government would be the major investor in development ventures, and there would be Government controls on big investments even in the private sector.

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An Enormous Task

In this plan of overall development, the co-ordination and balancing of innumerable individual ventures becomes an enormous task. In the case of ventures connected with the country's basic economic needs or with self-sufficiency objectives, the problems could more easily be identified and appropriate remedies found to solve these problems. Examples are : fertilisers, mineral oils, basic metals, etc. Even these do require coordination with transport, storage, and distribution facilities; but these problems are comparatively straightforward and relatively easy to quantify and solve. The free application of productivity techniques in these areas at the micro level is quite feasible.

At the other extremity of economic development, lie consumer goods of various need-levels which largely depend on the standard of living and the buying power of the population. Although the total demands for such consumer goods are easy to forecast, the market share of individual enterprises would be a matter of competitive excellence. In these cases also, the application of productivity techniques at the production, i.e. micro level could be relevant in the efforts to attain and maintain competitive excellence.

However, between these extremities lie : (a) Non-essential Consumer Goods, and (b) Producer Goods — consumable as well as durable.

In a controlled economy, restrictions are imposed on the employment of scarce resources for the production of non-essential consumer goods. Demand for such goods would, therefore, be in excess of supply. Competitive forces would be absent to compel producers of such goods to maintain productivity and quality excellence. Consumers would have to be content with shoddy, overpriced goods of this category. Manufacturers would not care to improve quality or to make available such goods at reasonable prices. With this attitude of the producers, the consumers suffer. The productivity movement in this area would do well to give place temporarily to "consumerism", the new wave of popular pressure sweeping in countries like USA.

Goods normally classified as non-essentials, nevertheless, are known to give the consumers who can afford them a sense of improved standard of living. Since the socio-economic objectives of the Government are also to enable more and more people to get a sense of improved standard of living, even the 'non-essential' and so-called 'luxury' goods, (terms which have only temporary significance—for in Western countries like USA and Europe, cars, refrigerators, television sets, etc., are no longer luxury goods) which give this sense of improved standard of living, must be available in the country for those who can afford them. Such goods must be of high quality and must be reasonably priced so that with improving wage levels more and more people could acquire them. But the manufacturers of such goods do not seem to cherish these noble ideals, and the consumers are helpless in the sense that they lack the strength to force manufacturers to take their moral obligations a little more seriously. It would be quite in order for the National Productivity Council to act as the catalyst in starting the "consumerism" movement in India.

Self-Reliance in Producer Goods

Producer goods fall into a special category. In a developing economy, producer goods fac-

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tories would constitute "Infra-structure Investments", which are expected to create the necessary materials and machinery based on which the whole economic edifice builds up. A greater degree of self-reliance in the production of producer goods is essential for independent economic growth.

A wide variety of assumptions are made in planning these infra-structure investments. Demands for the types and quantum of producer goods required at the various stages of economic growth are initially forecast at macro-planning levels on the basis of the most likely course the economic growth may take. However, depending on a multitude of circumstances, economic growth may deviate from this originally-intended path. Famines, wars, international political and economic developments, etc., are factors which enforce these deviations. These factors are beyond the control of economists and planners. This would create unpredictable inflationary and recessionary trends with consequent demand variations in the producer goods sector and seriously affect the operational efficiency of producer goods industries both in the public and private sectors.

The demand for durable producer goods in particular is also very sensitive to the nation's own fiscal and economic policies. Whatever affects the users of these durable producer goods would in turn affect the manufacturers of such goods. For example, increase in tax on petroleum products may affect the demand for tractors; diversion of Plan funds from the industrial sector to the agricultural sector, or for any other purpose, would seriously affect the demand for machine tools, and so on.

Productivity Planning at Macro Level

The usual productivity improvement techniques alone would thus not be meaingful in the case of producer goods and even the non-essential consumer goods if they were applied only at the factory or micro level. What is necessary, therefore, is a systematic and continuing application of the sophisticated Input-Output models in taking fiscal decisions and the use of reliable risk-probability criteria, *at the macro level* in planning infra-structure capacities. Any number of examples can be cited of over-investments in this sector, which could have been avoided if only a little more thought had been given to these aspects in the beginning.

The NPC and other organisations which possess the necessary technique-skills should help the Planning Commission in future economic planning, and forewarn the various Ministries in the Government about the macro-effects of decisions which affect the country's economy.

Performance Evaluation

In over-capacity situation, any improvement in productive efficiency would only result in increased idle time. If incentives are to be paid for these productivity improvements, it would be further waste of money. The application of profitability or return-on investment criteria to evaluate organisational efficiency in

such situations would not be meaningful. Such assessment would also be inadvisable in view of the managerial frustration, it is likely to cause. It is a paradox that such situations actually demand the best of managerial talent, but, in the end, the conventional performance reviews would unfortunately mislead one into believing that managerial performance was indeed below par. The NPC and other organisations must evolve new methods of performance evaluation to prove managerial excellence in the correct perspective.

In the case of organisations which are highly sensitive to economic fluctuations, the Government must also assume a protective role in all justifiable cases, with the clear understanding that infra-structure investments have a much larger role to play than merely generating short-term profits. Organisations in the public sector which have to compete with those in the private sector are especially vulnerable. Committed as they are to public sector ideologies, they occasionally require sympathetic financial and moral support from the Government in order to continue rendering useful service to the nation. The NPC must make efforts to find a satisfactory solution to it.

Another important aspect which must receive attention of NPC is in respect of costs and budgeting. Traditional methods of costing and budgeting in use in most organisations do not seem to serve as aids for productivity improvement. The 'Book-keeping' approach to costing must give place to Cost-Engineering; Cost Reports must be based on the concepts of management accounting; the mystery and secrecy that enshroud cost data must be removed, and staff down to front-line supervision must be fed with relevant cost data and they must be encouraged to participate in cost reduction programmes. Expenditure budgeting must yield place to performance budgeting. A combination of costs, budgets and the concepts of MBO (Management By Objectives) must be forged into an integrated management information and control system. HMT has initiated some action in this direction in one of its factories. Any useful ideas emerging from this experiment would be shared with other units of HMT.

Expenditure budgeting must yield place to performance budgeting. A combination of costs, budgets and the concepts of MBO must be forged into an integrated management information and control system.

Need for New Outlook

Radical changes in outlook and organisation structure are required to enable such ideas to take hold. People who hold positions of authority in the accounting profession need a change of heart and the willingness to interact with Engineers, particularly Industrial Engineers. On the other front, engineers must be given sufficient appreciation of costing and budgeting. A concerted effort in this direction by the National Productivity Council, the Institute of Chartered Accountants, the Institute of Cost and Works Accountants, the Indian Institutes of Management, etc. would be very appropriate at this moment. A corps of Cost Engineers must be developed and they must be placed at the right levels in the organisation

structure. Cost-norms and cost-audits must become obligatory, even as financial norms and financial audits are.

Pricing should also be subject to critical reviews. Advanced ideas such as 'product-feature-pricing' should be adopted, in place of 'Cost-Profit' concepts. Such moves would bring in enforced use of productivity improvement techniques by which the organisations, the consumers, and the country at large, would substantially benefit in the long run.

Effective Communication Systems

Quantitative techniques of productivity improvement would be fully effective only if people are correctly motivated. By Motivation does not mean just a Bonus Scheme ; it means the creation of a healthy socio-psychological environment in which everyone gives his best. One of the barriers to the attainment of this ideal environment is the woeful inadequacy of the *system of internal communications*. In most of the present-day organisations, workers and supervisors exist as entities mutually incompatible, and also incompatible with management. Whatever management does, even with the best of intentions, the two other groups react to it with suspicion and distrust. This distressing situation can be relieved only by a positively-designed and validated communication system. Design of such a system cannot be undertaken by amateurs ; incompetently designed systems do greater harm than good. There is a great scarcity in India of people who can design proper communication system. The NPC should join hands with other organisations which specialise in communication and behavioural sciences, to evolve and field-test appropriate communication systems, and also to train specialists in adquate numbers to design and install specific systems at the operating unit level.

Problem of Multiplicity of Unions

There is also the complementary need for improving communication to employees from external sources, mainly through external trade union leadership. Such communication has often been motivated by considerations other than those that are good for the organisations or for the country. In multi-union organisations, the situation frequently becomes most depressing. The Government's recent stance towards the multi-union porblem is encouraging, but the results are yet to be seen. What is even more important than not having a multiplicity of unions, is the enlightenment of Union Leadership. There ought to be a kind of national code on this. This writer would prefer union leadership to come from within the organisation itself, but there could be *external registered professional consultants to Unions* who must conform to the prescribed code of ethics. Just as in the case of legal, medical, auditing, etc. professions, the performance of a *trade union consultant* must also be liable for examination, and censure if necessary, by a professional association. The NPC would be rendering a great service to organisations and the country, if it could initiate this process in consultation with all concerned.

One of the factors that has been affecting union-management relationships in most organisations is the vexed problem of *profit sharing*. Organisations which are not making sufficient profits are under intense pressure to cut expenditure on research and development, marketing, and other essential functions without which the continued viability of the organisations would be impossible. On the other hand, organisations making good profits are also under heavy

pressure to part with more and more of such surpluses, on the only plea that extra profits were earned by the efforts of workmen. In the ultimate analysis, such pressures would retard or stall economic growth and promote inflationary trends. Re-investment of surpluses is vital for economic growth.

The cry for larger and larger compensations to industrial workers would not be in keeping with the socio-economic ideals of the Government. The number of industrial workers is a very small fraction of the country's population. At some stage, this group must start thinking of the millions of unemployed people who would continue to swell in numbers and suffer ever-increasing privations, if investible funds which would create new job opportunities are thus used up to satisfy a small minority of the population. It is not the intention to dispute the concept of extra rewards for extra results. But profits are not always directly proportional to effort or productivity. It would be preferred if extra payments were linked to improvements in productivity. A productivity-based-rewards scheme would adequately contribute towards national economic growth. The NPC and similar other organisations should take the lead in evolving such concepts which would be just and proper, not only in the short term, but in the long term as well. In this context, the following measure of productivity which could be considered is the index:

$$\frac{\text{Value Added*}}{\text{Wages}}$$

Training Industrial Workmen

The NPC and the Local productivity Councils must consider seriously the need for training industrial workmen in management techniques. *With worker's participation in management* in the air, this need has become very urgent. If workmen, not endowed with management acumen, are put on management participation programmes, one of three things may be expected to happen.

(1) Management meetings would be converted into collective bargaining and grievance-hearing occasions.

(2) Workers' representatives would be unable to contribute materially to the management of enterprises, thus cutting at the root of the concept itself.

(3) Workers' representatives would lose the confidence of their followers and be disowned by them in due course.

In the end, a magnificent concept would become an unfortunate casualty.

A disturbing feature, however, is that while thinking of giving participative rights to workmen, we are ignoring the supervisory and middle management personnel from such considerations. This lapse would be fraught with grave risks for the success of any organisation. The NPC the IIMs and other organisations competent to consider such questions should immediately apply thier minds to them and suggest the right course of action. □

Based on the Paper presented by the author at the National Seminar on Productivity, held in New Delhi in March 1972.

*Value Added=Sales--Value of purchased materials and services.

Production Engineering and Productivity

TA Sadasivan*

Production Engineering is mainly concerned with the design of the processor of a manufacturing system. Though effective operation and control of the system Input → Processor → Output can help maintain high efficiency, it cannot make up for an inefficient process. In manufacturing industries production engineering plays a vital role in achieving greater productivity. The aim of this article is to present an overview of the various principles of process engineering that affect productivity.

THE time involved in manufacturing a batch of components can be expressed as

$$T_{batch} = T_{su} + T_{st} \times N \quad \ldots (1)$$

where T_{batch} = Time for a batch

T_{su} = Set up time

T_{st} = Standard time per piece

N = Number of pieces in a batch

$$T_{st} = T_m + T_h + T_{all} \quad \ldots (2)$$

where T_m = Actual machining time

T_h = Handling time

T_{all} = Allowances

Time for producing a batch of components can be reduced by reducing T_m, T_h, or T_{su}. Most of the methods adopted to reduce T_{st} invariably increase T_{su} and tooling costs. An analysis of fixed and variable costs involved in various alternative process would indicate the range of quantity over which a particular process design would prove economical.

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Machining Time

Machining time is primarily dependent upon the area of surface to be machined, the number of cuts by which the material is removed, and the speeds and feeds used. One of the principal means of reducing machining time is the application of higher speeds and feeds and depth of cut commensurate with the workpiece accuracy and surface finish required. One must be aware of the economics of machining according to which there is an optimum speed for minimum cost or maximum production. Careful analysis of machining allowances provided in a casting or forging will reveal scope for reducing machining allowance and thus enable removal of material in minimum number of passes.

The machining time could be reduced, among others, by the following methods :

1. Reduction of tool approach

2. Machining a surface with a number of tools progressively (e.g. boring bar with two tool bits)
3. Adopting plunge machining where possible
4. Machining a number of surfaces progressively with a special combination tool (e.g. drilling and countersinking with a combined drilling and countersinking tool)
5. Machining a number of surfaces simultaneously with a number of tools (e.g. multispindle drilling)

Handling Time

The handling time forms a great proportion of the total cycle time. The benefit of faster machining made possible with superior cutting tools can be fully realised only if handling time is proportionately reduced. Productivity could be increased either by directly reducing handling time or by overlapping handling time in machining time (e.g. shuttle milling).

The handling time can be conveniently divided into that involved in workpiece setting, tool setting and machine control. Jigs and fixtures, by helping to set workpieces repeatedly at the same position with respect to machine elements, reducing handling time concerning workpiece setting and by providing cutter guiding elements or cutter setting elements reduce handling time concerning tool setting also. Preset tools and use of stops and limit switches avoid trial cuts and skill required for machining (e.g. in the case of turret lathe) and thus reduce handling time involved in tool setting. Power-assisted clamping helps reduce clamping time in standard work holding devices as well as in jigs and fixtures. Quick tool change devices reduce tool setting time.

One of the principal means of reducing machining time is the application of higher speeds and feeds and depth of cut commensurate with the workpiece accuracy and surface finish required.

The time required to handle machine tool controls can be reduced by concentrating controls in one place, and by automating them. Rapid traverse mechanisms, preselection of speeds and feeds, rapid braking are devices which reduce machine tool handling time. These are factors built into the machine tool and must be taken into account while selecting a machine tool.

Varying degrees of automation like process automation and automation of loading, unloading and guaging contribute to minimising handling time.

Machining Workpieces Simultaneously

For large quantity production, machining a number of workpieces together reduces setup time, machining time and handling time. For example, string milling, abreast milling, and combined string and abreast milling are used to increase productivity in milling process.

Simultaneous machining of number of workpieces on more than one surface can be accomplished on high production equipment like multispindle automat, multiple spindle and multiple station unit built machine tools and transfer machines.

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Automation

Full automation in machining leads to the highest level of productivity. Full automation is achieved in single spindle automats where bar feeding, clamping, speed changes and movement of slides are automated through cams. Chucking automats and tracer controlled automats are considered semi-automatic as long as no automatic loading devices are used.

Programme control contributes to automation of milling machines, turret lathes etc. and helps reduce handling time considerably but proves economic only at fairly large quantities of production.

Special-purpose machines built specifically for a component or a family of components help achieve greater productivity when very large quantity of production is involved. Automatic loading, unloading and inspection help increase productivity still further.

Transfer Machine

Special-purpose machines for single operation is the ultimate in productivity of a man-machine system. But when one looks at the total system one could see that the movement of material from station to station and the handling at each station could be further automated if a few special purpose machines are linked together by a transfer mechanism which moves component from station to station and locates it automatically. Such transfer machines prove economical for really large quantity production as obtained in automobile industries abroad.

Group Technology

Although rapid strides have been made in the past in improving productivity in large quantity production, the small-quantity production has not received as much attention. Group technology applied to machining offers great scope in this context. In small-lot production the main field to be attacked for improving productivity is the set-up time. Set-up time not only increases cost directly but also reduces the proportion of time a machine is available for actual machining. Group technology aims at grouping a family of components according to geometrical shapes, sizes and features and machining them in a definite order with a view to minimising the time required for change in set-ups. Incidentally it will cause a reduction in tooling costs. This concept may be applied to a single machine and when applied to a group of machines can lead to setting up a line for a family of components giving the benefit of line-flow. If this concept is applied at the design stage itself so that components are conceived as much similar to the family they resemble, the maximum benefit will accrue. It

must not, however, be forgotten that this implies a constraint on the design.

Numerical Control Machining

Numerical Control Machining is yet another method of machining offering great scope for improving productivity for small-lot production. In all the above cases of automation for large quantity production, the machines become less flexible as they become more and more automated. Numerical Control Machines can be fully automated but at the same time retain flexibility like any conventional machine tool; the numerical control has replaced the man operating a general-purpose machine tool and the movements of the slides, tools, tool changes, speed changes, etc. are carried out by instructions given through punched tape. The punched tapes can be used repeatedly. Although their preparation time is considerable, they do not cause any downtime of machine. Tooling required is minimum. Although developed initially for machining intricate shapes and profiles, they have now proved to be economical even for normal components. N/c machining centres which enable a number of machining processes to be performed in the same machine reduce considerably handling time, in-process inventory, and set-up time in the same manner as Transfer Machine does for large quantity production.

NPC's Role

The various means of achieving higher productivity as discussed above more than establish that the process design is to a great extent responsible for productivity in manufacturing industries. Realising this, the National Productivity Council has taken steps to strengthen its activities in the field of production engineering, As a first step, it has developed a series of six training programmes which together cover the core of Production Engineering. The first series of programmes was conducted at Bangalore towards the end of 1972.

Group technology aims at grouping a family of components according to geometrical shapes, sizes and features and machining them in a definite order with a view to minimising the time required for change in set-ups.

The NPC now offers the following advisory services in the field of production Engineering:

1. Study of bottleneck operations and suggest methods for increasing productivity
2. Reduction of tool costs
3. Establishment of time standards and effective production planning and control procedure in tool room
4. Introduction of Group Technology
5. Provide assistance in developing product, process and tooling know-how.

The future plans of the NPC in this field of activity include specialist courses, seminars, processing and tooling for large projects, publication of literature, and research work. □

Tool Life and Economics of Machining

Dr VC Venkatesh*

In this article the author discusses the importance of a tool. According to him, the criteria to be considered for selecting the tool will depend upon the prevailing cutting conditions as well as tool material and work material used, as these factors affect the type of tool wear. Tool wear is a complex phenomenon and two types of tool wear are encountered, namely : (i) abrasion or ploughing wear or mechanical wear and (ii) physico-chemical or adhesion and asperity transfer wear. The author also discusses the various criteria that are relevant to economics of machining.

THE terms tool wear and tool life are often used synonymously, though there is a distinct difference between them. Tool life is the life of a tool in minutes and this "life" is based on several wear criteria :

(a) the time taken for catastrophic failure, i.e. total failure (Taylor criterion)

(b) the time between regrinds of a tool

(c) the time taken for a specified amount (arbitrarily chosen) of wear that takes place on the tool.

The tool again is subject to friction on the rake as well as clearance face, thus producing crater and flank wear respectively. Under varying cutting conditions crater wear can predominate with very little flank wear, or *vice versa*, or both can occur simultaneously in a sufficiently measurable quantity. Hence, the need to define criterion (c) very clearly. Fig. 1 shows flank and crater wear patterns that could occur on a cutting tool. When tool life is to be measured with flank wear measurement as a criterion, the flank width VB should be measured. Various width for VB are indicated as criteria, amongst them being 0.2, 0.3, and 0.4 mm. [1,2] The crater wear criterion can be a maximum depth KT of 0.1 mm. Alternatively the crater ratio K=KT/KM = 0.2 to 0.4 could be taken as a criterion. When both flank and crater wear are present to a large extent, the radioactive method[3] or the gravimetric method using a precision balance with an accuracy of $\pm$ 0.01 mg. can be used[4]. With H.S.S. tools the crater wear is confined within the rake face but with carbide tools it tends to break into the cutting edges[2]. With ceramic tools, however, flank

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1. Venkatesh, VC, High Speed Machining of Cast Iron and Steel, Annals of the CIRP, Vol. XV 1967 (Pergamon Press, London) p. 387-391.

2. Venkatesh, VC, Radhakrishnan, V. & Chandramouli, J, Wear Propagation in Cutting Tools. Annals of the CIRP, Vol. XVII, 1969, (Pergamon Press, London) p. 317 - 323.

3. Venkatesh, VC, Doctoral Thesis, University of Paris, 1963.

4. Eugene, F, La Coupe Des Metaux. Publications Estoup, 1960.

wear is more predominant and, VB is often used as a criterion[1].

The criteria to be selected will depend on the prevailing cutting conditions as well as tool material and work material used, as these factors affect the type of wear that will be developed. Gibson[5] for instance finds the cirterion KB a more useful tool-life criterion than either VB or K. Hence, the comparison of tool-life data obtained from various sources is incorrect, unless the same tool-life criterion has been used.

Tool wear is a complex phenomenon. It has been broadly divided into two types :

1. Abrasion or ploughing wear or mechanical wear in which interlocking of surfaces at the sliding contact surfaces produces not only additional resistance to sliding but also wear of mechanical origin.
2. Physico-chemical or adhesion and asperity transfer wear in which rupture occurs in a thin layer of material adjacent to the tool chip interface as a result of weakening due to diffusion and alloy formation.

These two types of wear do not necessarily occur independently but simultaneously. Tool wear at high speeds is essentially of the adhesion and transfer type. Diffusion wear studies have been carried out largely on carbide tools [6,7] and one of the major pioneering contributions has been by Loladze.[8] Diffusion wear of H.S.S. tools has been studied by the author [3,9,10].

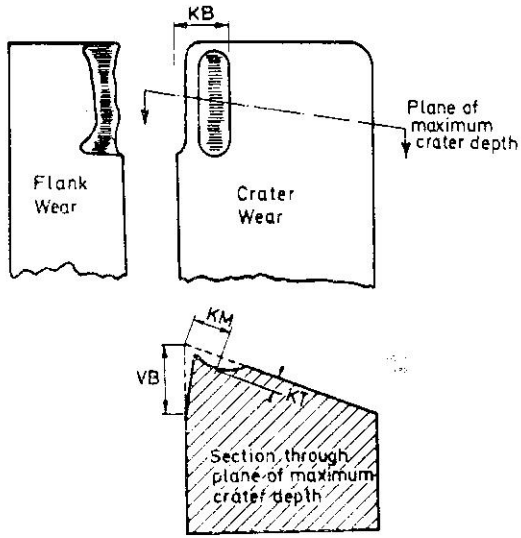

Fig. 1
Wear Pattern on a Cutting Tool

With carbide tools the interface temperature is in the neighbourhood of 900°C and could attain 1100°C at higher speeds. Loladze[8] studied diffusion wear of single carbide (WC) as well as double carbide (WC and TiC) tools up to 900 C and beyond. He found that carbon from this tool diffused rapidly into the chip and iron from the chip into the tool. Other tool alloying elements like tungsten also diffused but

5. Gibson, A, Tool Life and Cutting Forces When Machining XC 45 Steel, Int. JI. of Production Research, Vol. 9, No. 3, (1971) p. 409 - 421.

6. Trent, EM, Cutting Steel and Iron with Cemented Carbide Tools. JI. Iron and Steel Institute 201. 847 (1963), p. 847 - 855.

7. Opitz, H and Konig, W, Basic Research on the Wear of Carbide Cutting Tools, Proc. Conference on Machinability. Iron and Steel Institute, London, 1965.

8. Loladze, TN Adhesion and Diffusion Wear in Metal Cutting, JI of Institution of Engineers (India), Vol. XLIII, No 3, Nov. 1962, p. 108 - 141.

9. Venkatesh, VC Contribution to a Physical Study of the Manner of Tool Wear. CIRP Annalen, Band XI, Heft 3, 1962/63 (Springer Verlag, Berlin) p. 147-158.

10. Venkatesh, VC, Diffusion Wear of H.S.S. Tools, Proceedings 7th International M.T.D.R. Conference, Birmingham 1966, (Pergamon Press, London) p. 401 - 413.

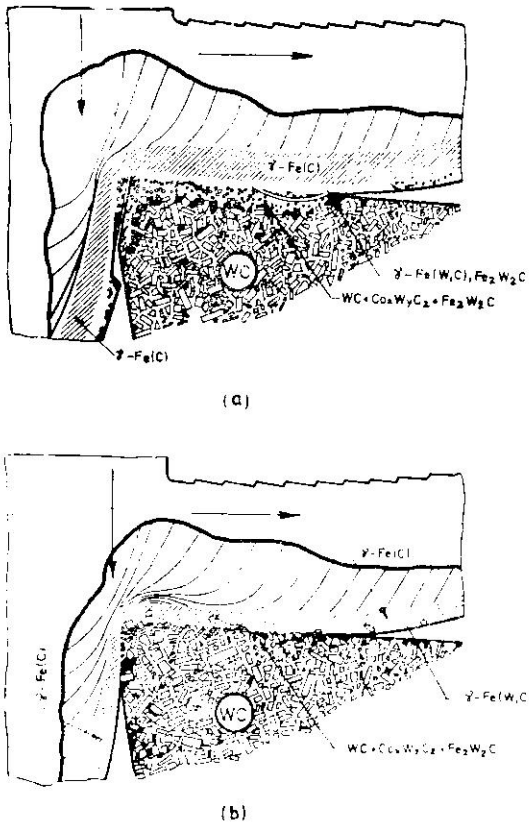

Fig. 2

LOLADZE's model of diffusion wear for a single carbide tool material (a) By fracture as a result of weakening at the surface of the tool material ; and (b) as a result of diffusion of tool material into the work material.

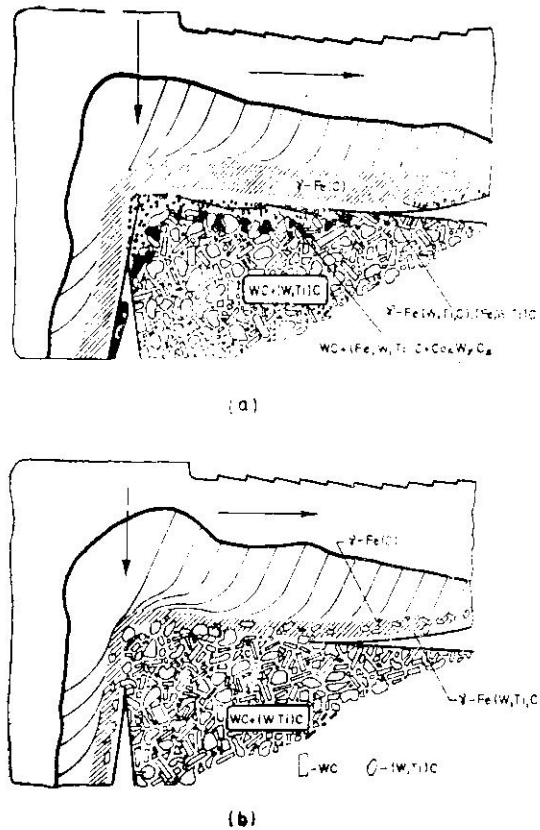

Fig. 3

LOLADZE's model of diffusion wear for a double carbide tool material. (a) fracture as a result of weakening at the surface of the tool material ; and (b) as a result of diffusion of tool material into the work material.

at a slower rate. Loladze found that three layers were formed :

(a) a carbide layer in the chip— γ Fe (C)

(b) a solid solution of C and W or of C,W and Ti in γ iron to form Fe (W,C) or Fe (W, Ti, C).

(c) an intermetallic layer of ferro-tungsten carbide $Fe_2 W_2 C$ or Fe (W,Ti) C and a more complex carbide $Co_x W_y C_z$.

For speeds where the interface temperature is less than 900°C the tool fails by weakening of the surface as a result of diffusion of elements of the tool material. At higher speeds when the temperature is more than 900°C there is not only diffusion but dissolution of the tool material in the chip.

Though diamonds are very hard, they wear out when machining steel, because they consist

only of carbon which diffuses rapidly into the chip. They, however, can be used successfully to machine non-ferrous material, when diffusion of carbon does not take place. On the other hand, ceramic tools which do not contain carbon or any other diffusing element, are not subjected to crater wear as they have no chemical affinity for steel or cast iron. Ceramics have not made much headway because of their brittleness and the need for very high speeds.

In the case of H.S.S. tools, however, the cutting temperatures are lower. They could be in the neighbourhood of 700°C though measured values would indicate 550°C or thereabout. The plastic state of the chip and high isostatic chip pressures bring about a very intimate contact between chip and tool, resulting in the formation of a "white layer" on the rake surface[9]. This layer contains diffused chromium [9,10] and carbon [11] and has zero thickness at the tool tip and gradually increases to a thickness of about 2 to 3 microns at the end of the built-up edge, as shown in Fig. 4. The white layer is a mixed carbide[12] consisting of iron and chromium. The periodical formation of this layer and its removal impoverishes the tool surface, thereby weakening it and promoting wear. The white layer, however, does not form easily on cobalt H.S.S. tools, thus showing that cobalt tends to act as a white layer inhibitor[9]. Figure 4 shows the author's model of diffusion wear of H.S.S. tools. Kikuchi and

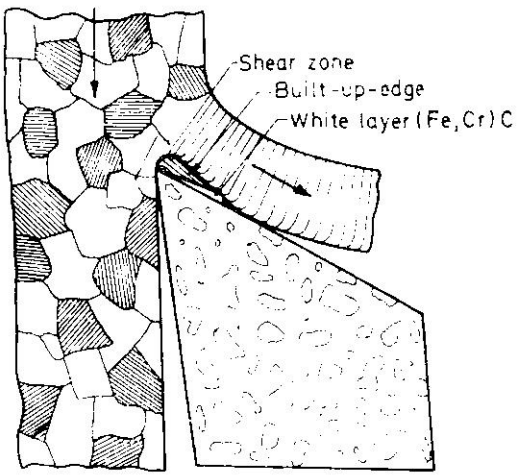

Fig. 4
Author's model of diffusion wear of H.S.S. tools. Chromium and Carbon diffuse from tool into the white layer.

Tanaka[13] have in a recent paper confirmed the author's findings.

Though diffusion wear occurs at higher speeds and the diffusion rate also increases, the surface finish obtained shows a marked improvement because of the disappearance of the built-up-edge and the emergence of the secondary shear flow zone. Higher speeds also mean higher productivity. Hence, in discussing the economics of machining one has to consider various criteria :

(i) minimum cost per part
(ii) maximum production
(iii) surface finish.

Gilbert [14] has done pioneering work in the field of economics of machining. Fig. 5

11. Venkatesh, VC, Further Contribution to a Study of the White Layer on H.S.S. Tools, Annals of the CIRP, Vol. XVI, 1968 (Pergamon Press, London). p 173 - 177.

12. Venkatesh, V.C. and Philip, P.K., Carbon Diffusion During Machning of Plain Carbon Steels with H.S.S. and Carbide Tools, December 1971, J1. of Iron and Steel Institute, London, p 981—985.

13. Kikuchi, K and Tanaka, Y, On the diffusion wear of H.S.S. tools. J1. of Japan Society of Precision Engineering, April—June, 1971, p. 44-50.

14. Gilbert, WW, "Economics of Machining". Machining—Theory and Practice, American Society of Metals, 1950.

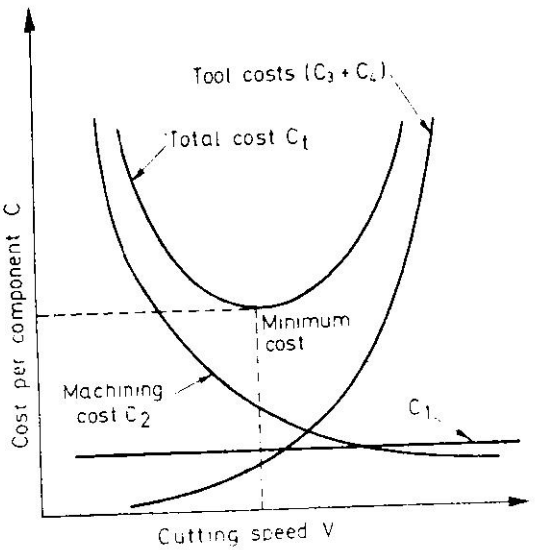

Fig. 5
Variation of Cost per Component with Cutting Speed

shows the variation of cost with cutting speed; the minimum cost is obtained from the total cost curve.

If C_1=nonproductive cost per component, i.e. cost of loading and unloading the component, the idle time costs and other noncutting time costs not included in the total cost per component.

C_2=cost of machining time per component

C_3=tool changing time cost per component

C_4=tool cost per component.

Total cost $C_t = C_1 + C_2 + C_3 + C_4$

Using the Taylor tool-life equation $VT^n = C$ and substituting for V and T in the total cost, an equation is obtained which when differentiated and equated to zero gives the minimum cutting speed for minimum cost, namely:

$$V_{min} = \frac{C}{\left(\frac{1}{n} - 1\right)^n \left(\frac{C_2 C_3 + C_4}{C_3}\right)^n}$$

Similarly the tool life for maximum production is

$$T = \left(\frac{1}{n} - 1\right) C_3$$

In either case we find that the non-productive cost C_1 is not directly involved. For minimum cost, all other costs are involved but for maximum production only the tool changing cost is a factor to be taken into account along with the exponent n. In armament industries or in prototype development, the maximum production rate criterion should be used. Further extension of this work involving the use of a computer to determine optimum feed and depth of cut have been done. Armarego and Brown[15] have extended the analysis to single-pass shaping and milling operations and have discussed double-pass and multi-tool operations which are much more complex.

An example of the use of the last criterion, namely surface finish, is in the utilisation of ceramic tools at high speeds in the range of 1000 to 1400 metres/minute, when a grinding finish is obtained in turning operations[1]. Thus, a second operation, that of grinding, can be eliminated. Very high speeds mean low machining time and a very low tool life of the order of 2 to 5 minutes[1]. Tool changing cost is negligeable as ceramic tools are available in the form of throwaway inserts. Thus, in the economics of machining, manufacturing objectives will determine the criterion to be selected.

15. Armarego, EJA and Brown, RH, The Machining of Metals, Prentice-Hall, USA, 1969.

Numerical Control

KL Bakshi*

Numerical control provides one of the major technical innovations of our age. It is a system in which direct insertion of programmed numerical values stored in some form of input medium are automatically read and decoded to cause a corresponding movement of the machine which it is controlling. Numerical control ensures manufacture of superior products more economically. It permits more control over operations and facilitates achievement of optimum conditions for maximum results.

THE advent of Numerical Control can be linked to a period as early as 1725, when knitting machines in England were controlled with punched cards. The patterns in cloth were woven according to a prepunched set of cards that directed the weaving machine. It was not until the late 1940's that research and development of Numerical Control as we know it today got under way. By 1947, the US Air Force was experiencing that the complex shapes required for modern Aircraft and Missile-manufacture were causing the various manufacturing programmes to fall behind their projected schedules. Manual and tracer-controlled machines could not keep up with the demand and at the same time accommodate the many engineering design changes needed as the Aircrafts were further refined.

In an effort to simplify, or in fact to even make possible a completely satisfactory inspection of the various configurations of the Helicopter Blade, the Parsons' Corporation developed 602A programme to produce X-Y-Z values of critical check-points on the Blade. In this effort, Mr John T Parsons, while developing the templates required for the Helicopter Blade inspection, also recognised that the same principle might well be used to drive a machine tool automatically. The Parsons' Corporation then presented to the Air Force a proposal to develop a machine that would prepare such templates. This resulted in a Development Contract between Air Force and Parsons Corporation in 1948. In 1949, Parsons was joined by Massachusetts Institute of Technology, as a major sub-contractor on the project. In 1951, MIT was awarded the prime contract which resulted in the successful demonstration in 1952 of three motion NC Milling Machine, (Cincinnati Hydro-tel) whose table, saddle and head were controlled by punched tape.

The work of MIT continued and was supplemented by numerous Machine Tool Builders and Producers on Electronic Controls and Computer Equipment. In 1955, at the National Machine Tool Builders' Show, two of these new numerically controlled machine tools were exhibited. At the next NMTB. Show in 1960, ninety-nine numerically controlled

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machine tools were exhibited. Sales doubled yearly, and the value of and necessity for NC was increasingly recognised and it was expected that by 1972 more than 80% of machine tools used in USA would be numerically-controlled.

What is Numerical Control ?

Numerical Control is defined by Electronic Industries Association as : "A system in which actions are controlled by direct insertion of numerical data. The system must interpret at least some portion of this data". As applied to machine tools, it is a method of controlling machine movements automatically with the aid of a number language. The number language enables the machine tool operator to communicate to the machine the commands "What to do", "When to do" and "Where to do".

The primary difference between a manual and an NC Machine is in the method of supplying input data and obtaining feedback signals. With Numerical Control, automatic operation is achieved by means of numerical instructions expressed in code. And these instructions or programmes are prepared in advance. Recorded on tape, these coded instructions can control the sequence of machining operations, machine positions, spindle speeds and rotational direction, distance and direction of movement of the tool or workpiece, flow of coolant, table indexing, and even the selection of the cutting tool for each operation.

The coded tapes are placed on a control unit which consists of a system of electronic interpreting devices and, when activated, the control unit guides the machine tool through the programmed operations and movements with little or no human intervention. Thus numerical control has been defined as a system in which the direct insertion of programmed numerical values stored in some form of input medium are automatically read and decoded to cause a corresponding movement of the machine which it is controlling.

Advantages of Numerical Control

Numerical Control provides one of the major technical innovations of our age. The machine can change its mode of operation with a simple change of tape and without adjustments to any cams, limit switches or other control devices. Numerical Control gives machines the ability to respond to mathematical language so that they can describe complex curves and surfaces without requiring a model or pattern.

Numerical Control has attained its popularity through its ability to manufacture superior products more economically than by alternative methods. It is a popular misconception that numerical control is chiefly applicable to large-quantity production. In fact, the opposite is the case to the extent that where either numerically-controlled or conventional machining are available for the production of parts, the break-even point is reached earlier with NC production.

Fig. 1 shows the break-even point for NC Machines compared to number of parts and selling price with reference to the conventional machine. Fig. 2 indicates the machining methods and their associated straight line curves which represent the total cost for each method, based on varying lot sizes.

As mentioned earlier, the evolution of NC machines took place primarily in the aircraft industry where the shapes of workpieces called for complex machining operations set-ups. The aircraft industry is still the major user of sophis-

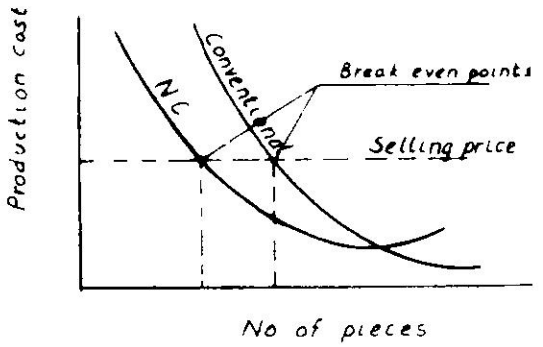


Fig. 1

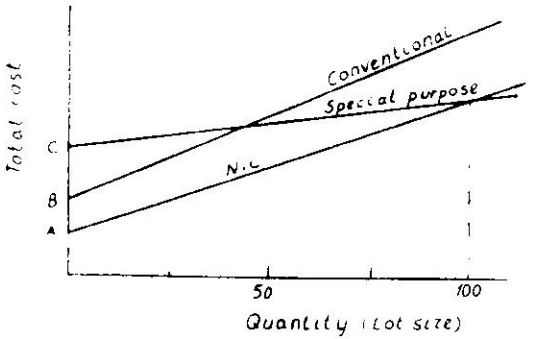


Fig. 2

ticated NC machine tools, but recently the industry in general has come to realise the advantages and potentials of such machines. The NC machines have become of late more and more acceptable to the general-purpose industry. It is even expected that this demand may surpass that of the sophisticated requirements.

Benefits accruing from Numerical Control can be clearly outlined in the following four areas: machine shop supervision, production engineering, estimating and management.[1]

Machine Shop Supervision

Numerical control leads to greater efficiency in an experienced worker even though less skill would be required for any given condition. The set-up time is enormously reduced. The greatest benefit of NC is that machine is cycled at constant, automatic rate. Tool breakages are considerably reduced and inspection is greatly simplified after the part is machined. The forte of NC is consistent repeatability.

After the tape is prepared and, if necessary, corrected, further human error is eliminated for the first and all subsequent jobs. The handling of parts is reduced and handling between machines is also reduced, since many operations can be combined at one setting. The operator can attend to more than one machine or he can do deburring, inspection and second operation. The hand layout is eliminated, thus offering greater floor area for active production. The shop personnel would need greatly reduced time to study blueprints.

Production Engineering

Since little tooling is required with NC, manufacturing, record keeping and maintenance are considerably improved. The lot sizes may be geared to requirements and there is no need to justify large preparation time or expense. The lead time is reduced and an opportunity is provided to incorporate design changes. The machine utilisation is positively increased and a higher workload can be processed in the given time. Some NC machines offer increased potentialities : more operations at one setting and fewer secondary operations. The other advantage of NC is that right and left-hand workpieces may use the same tape. The specified speeds and feeds, in many cases, will be

[1]Raymond (HD): "NC—Have You Checked These Benefits?" Metal Working Production, 107, 3; 16 Jan 1963; p. 71-72.

mostly those actually used on the shopfloor. NC reduces many machining problems in the shop.

A factor which is particularly important is that NC permits more control over operations and thus facilitates achievement of optimum conditions for maximum results. The tool life is enhanced and estimating becomes more precise with NC. Slow-down due to fatigue of the operator is eliminated and shop loading can be very accurately forecast. The psychological strain and slow-down caused by very tight tolerances are obviated by NC. The elimination of models and templates permits achievement of greater machining accuracies. NC also permits machining of complex forms and thus adds to the confidence of the production engineer to face intricate problems with equanimity.

Estimating

The noteworthy advantage of Numerical Control in estimating is that parts can be produced in any desired quantity at substantially the same relative cost. The need for planning and estimating tooling is almost eliminated. Quoting is rendered precise and cost estimating is more reliable. There is a lesser opportunity for profit shortfall due to guessing and crystal-gazing. NC makes machine loading more realistic and consistent; and bottlenecks are considerably reduced. All phases of jobs can be methodically itemized and business for one piece or special parts becomes more profitable. NC offers competitive advantage by being able to perform complex contouring which is beyond the scope of conventional machines with human operator. NC assures increased capacity without additional labour costs and thus makes the products more competitive. The prototype production is also accelerated.

Management

With Numerical Control, the cost of planning new products is reduced, and the burden is reduced due to lead time and tooling; the lot sizes become more flexible, the inventory costs are reduced, thus bringing down paper-work and economising on storage space. NC offers greater lattitude in design. The time-lag between design concept and marketable product is also curtailed. The design information can be transferred on tape between factories of the same company as well as to sub-contractors. The design changes are facilitated because the tapes are merely duplicated automatically. Expensive modifications of toolings are avoided. There are no design compromises due to limitations of conventional machine tools and/or operators. There is less time delay before all factories are in production with the revised design. Human errors are restricted to the preparation of the tape. If the tape is once corrected, random errors on repeat orders or due to change in work shift are completely eliminated. NC gives the small as well as the medium producer a form of automation comparable to the mass producer. NC considerably reduces scrap; this is particularly advantageous with tungsten, titanium and other exotic alloys which are very expensive. NC reduces cutting tool costs; feeds and speeds can be preset by the engineers for optimum efficiency. NC machines are useful as feeders in transfer lines and these machines can take care of variations in standard parts. NC assures constantly high quality, low rates for a job and faster deliveries are achieved.

Field of Application

While considering the introduction of NC machines, the overall economy must be weighted against the investment. Experience has shown

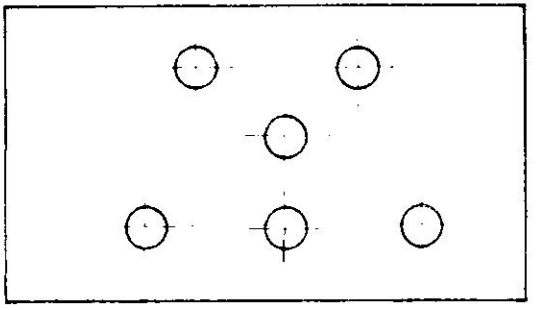
that NC is particularly well-suited to manufacturing operations when quantity of parts produced in any single set up is relatively small. This may range from 1—100 pieces. Greater productivity of NC equipment (3-5 times) when compared to conventional machines means fewer machines.

As can be seen, the economic advantages derived out of the use of NC depend on and differ from job to job and the lot size. To illustrate this point, direct savings in pre-production stage in a drilling operation, for instance, can be made only if production run is small and the cost of jigs is large, compared to the programming cost.

As illustrations, two examples are presented here, the first one a simple plate with 6 drilled holes and the second a master cam. The various costs of NC *vs* conventional machines are also listed[2].

[2]Examples of Economic use of Numerically Controlled Machine Tools. PERA Report No. 119; Section 3, p. 23 & 25.

Numerical control provides one of the major technical innovations of our age. The machine can change its mode of operation with a simple change of tape and without adjustments to any cams, limit switches or other control devices.



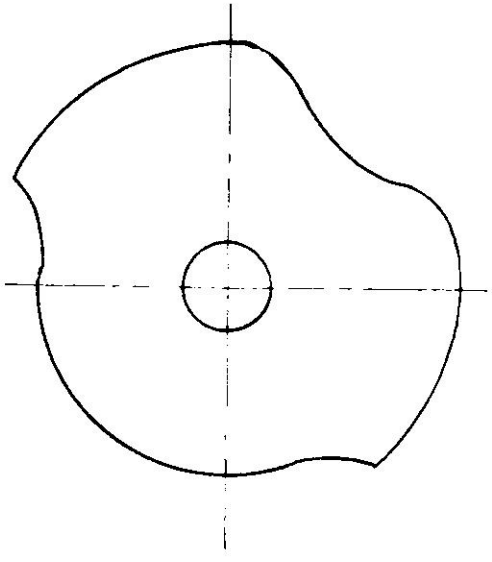
Example (1): Plate with drilled holes

Production Details	*NC*		*Convention*	
	Time Hr. Min	*Cost in Rupees*	*Time Hr. Min*	*Cost in Rupees*
Programming, Planning	1.30	22.50	1.00	15.00
Data Preparation	0.30	3.50	0.30	3.25
Jigs/tools designs & manufacture	—	—	17.00	400.00
Pre-production cost/time	2.00	26.00	18.30	418.25
Marking off and setting up	1.00	20.00	1.00	20.00
Machining and inspection	1.30	64.00	1.30	54.00
Fitting and assembly	—	—	—	—
Processing time/cost	2.30	84.00	2.30	74.00
Total for 12	32.00	1034.00	48.30	1306.25

With numerical control, cost of planning new products is reduced and the burden is reduced due to lead time and tooling; the lot sizes become more flexible, the inventory costs are reduced, thus bringing down paper work and economising on storage space.

An examination of the relative costs for pre-production and processing phases shows that a break-even point will be reached beyond which conventional machines will be cheaper. This occurs when 40 components have been made at which point total cost in each are approximately Rs. 3,380.

Though this is an oversimplified example, it shows how an NC machine could be unsuitable for this kind of work.



Example (2) : Master Cam

This cam is an ideal type of component to produce under NC since savings can be made in both the pre-production and the processing phases. Since the component is only a one-off but will subsequently be used as a template for large-scale production, the reduction in lead time is an important indirect saving. □

Production Details	*NC*		*Conventional*	
	Time Hr. Min.	*Cost in Rupees*	*Time Hr. Min.*	*Cost in Rupees*
Programming/Planning	40.00	600.00	—	—
Data Preparation	—	47.00	—	—
Jigs and tool design and manufacture	—	—	160.00	240.00
Pre-production time/cost	40.00	647.00	160.00	240.00
Marking off & setting up	—	—	—	—
Machining & Inspection	2.00	63.00	18.00	410.00
Fitting & Assembly	—	—	—	—
Processing cost	2.00	63.00	18.00	410.00
Total for 1	42.00	710.00	178.00	2810.00

Group Technology : Key to Productivity

BG Kemshetti*

Group Technology is a technique for identifying physical and technological similarities among the components of various products of a company and forming their families. These families form artificially increased economic lot of sizes and can be processed with common manufacturing facilities. Advantages accruing through the application of Group Technology include: reduction in total manufacturing time, reduction in setting time, reduced inventory, design retrieval and rationalisation, reduced production documentation, simplified rate fixing, and simplified production planning and control.

It is common experience that the most economic and productive method of manufacturing components lies in mass producing them by resorting to flow-line methods. In mass production, the manufacturing facilities are matched to the technological requirements of the workpiece so that noncutting time losses are kept to the minimum. Initial tool setting time though considerable is shared among a large number of identical components. The net result is the vastly reduced floor to floor time per piece and hence higher productivity. The precondition, however, to be fulfilled before deciding on mass producing a product is to ensure that the product has been fully rationalised and commands an established market over a considerable length of time. Then alone the heavy investment on the flow-line production facilities could be justified.

Problems of Batch Production

In actual practice, the privilege of mass production is enjoyed by a few products like automobiles only. The vast majority of products are subject to the vagaries of fluctuating demand and obsolesence and are to be necessarily manufactured under batch production conditions. One of the ills associated with batch production is the traditional process specialisation or, in other words, functional layout wherein like machines are put together—all lathes in one place, milling machine in another place, etc. Therefore, components requiring several operations have to be routed all around the factory with the associated time losses due to transportation, queing, setting, etc., resulting in large lead time and considerable amount of work-in-progress. Moreover, manufacturers in their anxiety to reduce setting time tend to process economic batch quantities. This in turn results in huge stocks of finished components awaiting orders and locking up much needed capital.

Concept of Group Technology

Group Technology (GT) is a technique which helps create flow-line production environments even in batch manufacture. The technique con-

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sists in identifying physical and technological similarities among the components of various products of a company and on demand at a particular period of time and forming their families. These families form artificially increased economic lot sizes and can be processed with common manufacturing facilities as inflow line production.

The concept of Group Technology is not entirely new. Bringing together related components by informal and intuitive methods for the purpose of manufacture was being practiced even in earlier days. There are many who maintain that this technique is nothing but simple commonsense approach and that they are already practising it without calling it by the fancy name GT. They are partly right because there is nothing original in its theory. It is this simplicity of the concept which makes it difficult to understand why the word GT is making frequent appearances in recent times in many treatises on engineering manufacture. The answer is that it is planned and formalised and thereby contributes over and above what the normal application of commonsense has been able to accomplish without it. The scientific approach to GT was initiated after Second World War in Russia. At first, it was concerned with the complete manufacture of technologically-similar components requiring a single machine tool with single set up of tooling so as to reduce set up costs for each seperate component. During the fifties this idea was extended to include the manufacture of components requiring more than one machine tool. Subsequently GT became popular in most of the East-European countries and West Germany.

Present Status

At present, in each East European country there is at least one major institute engaged in GT research. In West Germany, Aachen and other universities are doing commendable work in the field. More recently in U.K., a special Institute for study on GT has been established by the Ministry of Technology. In USSR, this technique is being applied not only in the metal-working sector but also in the wood-working sector and very recently even in footwear industry. In Japan too, the Mechanical Engineering Laboratory has initiated study on GT.

Classification and Coding System

Since the concept of GT is based on the grouping of similar components, one is naturally interested in convincing himself whether at all there exists physically and technologically similar components even in diversified products, that a company is called upon to manufacture. In this regard it will be interesting to quote a survey conducted in USSR in 6 different plants situated at far away places from each other and manufacturing diversified items like engine lathes, capstans, automatics, knee-type milling machines, radial drills and gear-cutting machines. In each plant the following structure of components was revealed.

(1) 20 to 25% parts were in bar shape
(2) 8 to 10% were of flange type
(3) 20 to 30% were of bush type
(4) 5 to 17% were gears.

This shows that it is always possible to get hold of similar components in any manufacturing organisation. The key to identify similar components and form families is to use a classification and coding system wherein the shape and manufacturing requirements of the components are described by digits. Components bearing the same classification number would then form families. There are many classification systems now available for

GT. Some are freely available in documented and published form, some made available as part of consultancy services and some developed by individual firms for their own use. Any classification system to be suitable for GT should be capable of describing the following workpiece features :

(1) Geometry of external and internal surfaces
(2) Size of the component
(3) Technological features deciding manufacturing facilities (such as holes, slots, splines, etc.)
(4) Raw material and its initial form (bar stock, forging, casting, etc.)

Supplementary information regarding accuracy, finish, weight, etc., should also be capable of being coded. It is, however, important to note that none of the classification systems available at present is ideally suited for GT.

More often, a long code would be necessary to describe precisely all the features of a component. As the number of digits in a code increases, the very process of codification becomes cumbersome and time-consuming. It is, therefore, generally preferred to make use of a simple classification system which gives the broad idea of what the component is like and then consult the actual part drawing for deciding whether the component should be included in one or the other family. The classification systems available for GT include Optiz system, Brisch system, VUOSO system and PERA system.

Application of Group Technology

Having established families of similar components the next step would be to work out a comprehensive operation schedule so as to take care of all the requirements of individual components. This operation schedule is generally worked out for a composite component which could be a real representative component or a fictitious one incorporating all the technological elements occuring in individual components. Tool layout is also planned for this composite component. Once this has been done, the machines required to complete all the operations on the family could be brought together in one place so as to form what is known as a cell. The machines in the cell are arranged so as to enable a flow line production and the components come out of the cell as finished products ready for assembly. To gain maximum benefits out of the cell system it may be preferable to localise the service and tooling facilities in the cell itself and make it self-contained. A superivisor could be made in-charge of the cell and a team of operators given to him. Each operator may have to work on more than one machine and, therefore, he gets acquainted with operations of all machines in the group—a real advantage since the flow-line could be kept running even if some operators are on leave.

Advantages of GT

(a) *Reduction in Total Manufacturing Time :* Since components enter the cell as raw materials and come out of it as finished parts without having to wait in inter-operational queue as in a functional layout, the total manufacturing time and work-in-progress is drastically reduced.

(b) *Reduction in Setting Time :* Since the machine setting is done for the composite component which represents all the components in a family, there is no individual setting with the change of workpiece except for minor adjustments. As a result, setting time for individual components is virtually eliminated.

(c) *Reduced Inventory :* In order to meet small orders and ensure customer satisfaction, a certain amount of buffer stock is generally maintained by companies having their manufacturing facilities functionally laid-out, resulting in locked up capital. Since small orders could be effectively met in a cell system of manufacturing organisation, there is no need to maintain the earlier levels of inventory.

(d) *Design Retrieval and Rationalisation :* Since GT brings with it the classification of components based on similarities, ample opportunity is provided to the designer to study each component in relation to others so as to even out the differences which may have no functional significance. This leads to variety reduction and reduced tooling costs. The existence of families also enables the designer to retrieve any information before he plans to design a new component, which may fit in one of the existing families.

(e) *Reduced Production Documentation :* In the absence of component family, each component has to be engineered individually requiring its own operation sheet, tool layout, etc. When families are formed, the necessary documents are worked out for the composite component only and as such the work of the technology department is simplified.

(f) *Simplified Rate Fixing :* Since all the components of a family are virtually hidden in the composite component, a systematic time study for this one component enables the rate-fixing engineer to interpolate time standards for individual member of the family, depending upon the relative work content in each. The usual disputes between the rate-fixing engineers and workers regarding the tightness or otherwise of time standards could be minimised, since the new time standards no more depend upon the experience and personal factors of either of them. This could help in promoting harmonious labour relations.

(g) *Simplified Production Planning and Control :* Since component families and the manufacturing facilities are matched once for all, production planning and control is simplified.

Work Done by CMTI

For the obvious advantages mentioned above, the need to go for GT in Indian industries where batch production is more prevalent than in the developed countries, requires no emphasis. Central Machine Tool Institute, Bangalore, right from the start of its activities has been trying to popularise GT in India. A specialised group consisting of trained engineers in GT has been created to offer consultancy services in this field. The results of two preliminary exercises on GT undertaken by the group may be worth mentioning.

1. *M/s Mysore Kriloskar, Harihar :* Round parts (numbering about 107) for Herbert 2D & No. 4 Capstan Lathes were manufactured as per Group Technology technique and the savings in setting time have been found to be 66 to 80% for both bar work and chuck work. It is learnt that on seeing these remarkable results an earlier decision of adding a few more (about 6 Capstan Lathes) machines for manufacturing these parts was deferred.

2. *M/s Bharat Heavy Electricals, Trichy :* Work is under way to machine 400 types of valves by family grouping techniques and it is reported that only 4 group fixtures are necessary in place of earlier 15 fixtures for machining valve bodies. Further investigations are in progress.

Some Case Studies

The Group Technology Centre, Blacknest, UK which is offering consultancy services in GT has quoted a number of case studies from British industries. Some of them are listed below:

1. Serck Audco Ltd.

Aim—To increase overall efficiency.

Manufactured Stock—Reduced by 46%= £ 855,000

Product Manufacturing Time—Reduced from 12 weeks to 5 weeks.

Value of Despatches Per Employee—Increased from £ 2,218 p.a. to £ 4,068 p.a.

Average Income Per Employee—up 63%.

2 Serck Controls—Glocon Div.

Aim—To streamline production

Stocks—Reduced by 22.5%

Number of Operations — Reduced by 50%

Machining Times — Reduced by 70%

Average Product Manufacturing Time—Reduced from 16 weeks to 2 weeks.

3. English Electric Co. Ltd.

Aim—To improve component production on individual machines.

Machine Output—Increased by 70%

Machine Setting Time—Reduced from 50% to 10%.

4. Ferranti, Edinburgh

Aim—To reduce component manufacturing time using multi-machine groups.

Component Manufacturing Time—Reduced from 26.5 days (average) to 3 days.

Machine Setting Time—Reduced by 66%.

5. Elliott Automation (Fisher Goveror Div.)

Aim—To increase productivity

Setting Time—Reduced from 4 hours to ¾ hour.

Lead Time—Reduced from 8– 9 weeks to 3 weeks.

Component Queuing Time—Reduced from 3 days to 1 day.

6. Sigmund Pulsometer Pumps, Reading

Aim—To increase productivity.

Overall Throuput Time—Reduced from 6 weeks to 1 week for a typical batch.

Production Time—Reduced by at least 20% (using throwaway tips and preset boring bars. etc.)

Conclusion :

From the pattern of applications of GT in engineering industries abroad and the encouraging reports as can be seen from case studies it can be concluded with a fair degree of certainty that GT has an assured future although it will be necessary to solve a few problems associated with it. Classification and coding systems will have to be improved so as to minimise the element of judgement on the part of the technologists while forming families. Since the introduction of GT may warrant substantial changes in company organisation, the initiative in this regard should come from top-management so as to ensure an integrated approach to the technique since only an integrated approach could bring in the full benefits of GT. The effectiveness of GT could be further enhanced in the context of numerically controlled machine tools and preset tooling which themselves are powerful tools of productivity increase. The firms engaged in engineering manufacture should take the earliest possible opportunity to give a fair trial to this tested tool of productivity increase and get themselves practically convinced. □

Low Cost Automation: A New Approach to Productivity

PR Srinivasan*

The concept of Low Cost Automation (LCA) has particular relevance to situations in developing countries like India, not so much to save on labour but to improve the quality of the product. Application of LCA techniques to manufacturing activities benefits not only the enterprise but the workers as well. It enables the workers to work more effciently and *not* harder. LCA supplements labour's efforts but does not supplant labour. It offers potential for exploitation to the benefit of both the Industry and the Labour.

Low Cost Automation (LCA) is a concept which has gained ground in developed countries over the last two decades. It is called by different names in different countries. For instance, it is referred to as spotomation in USA, Approaching Automation in Britain and Low Cost Automation in Europe. Of late, however, the name Low Cost Automation has gained universal acceptance.

Again, LCA has been defined in different ways by different authorities, as the following two definitions will show:

> "LCA is a simpler arrangement than full automation. It will bring forth, compared with the traditional systems, more improvement in cost, more saving of labour and more advancement in productivity. It is a system using standard machines of hydraulic, pneumatic or electrical sytem and applicable to standard universal machines or unit machine or equipment to realize mechanization and automatic operation to a certain degree".
>
> —*British Productivity Council.*

> "LCA is a step-by-step approach to automation through application of low cost machines or equipment to existing machines or equipment."
>
> —*UK Ministry of Technology.*

WHY LCA ?

Whatever be the definition, the ultimate aim of LCA is to improve productivity: that is, to increase the ratio of output to input by incurring a very small incremental expenditure—as its very name implies—in automating certain critical operations of a manufacturing process, the output being measured in physical terms of quantity. It is, of course, well-known that the three main factors which affect productivity are men, materials and machines or capital. It may, therefore, be argued that where labour costs are low as compared with material costs, or where the plant is large and equipment is expensive, it may not be very rewarding to automate a process mainly with a view to saving labour, particularly in a developing country

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like India. However, it should be pointed out that the concept of LCA has particular relevance even to situations in developing countries, like ours, not so much to save on labour but to improve the quality of the product. The word automation produces an unfavourable reflex action among the workers. However, it should be realised that introduction of LCA techniques will result in the following benefits:

i) Improvement in product quality
ii) Reduction of material wastage
iii) Utilisation of unskilled workers for skilled work
iv) Turnout of more accurate work with a less accurate machine
v) Reduction in idle time of equipment
vi) Reduction in fatigue of the worker
vii) More accurate control of dimensions by accurate prediction of tool life
viii) Consistently accurate performance in hazardous, arduous and monotonous jobs
ix) Overall saving in the cost of the product
x) Adherence to delivery schedules
xi) Prolongation of tool and machine life.

It will, therefore, be seen that application of LCA techniques to manufacturing activity benefits not only the company but workers as well. With the need for exporting more and more of nontraditional engineering goods to foreign countries, where quality and competitive prices are a supreme consideration, there is tremendous scope for introducing LCA into many of the manufacturing operations.

Where LCA ?

The next question that naturally arises is as to what are the areas where LCA should be introduced and, if so, what should be the priority. While it is difficult to lay down any hard and fast rule for this, the following areas in the order of priority can be considered:

i. Mechanisation of simple repeated movements like:
   a) Movements that require physical strength
   b) Movements that require precise operation
   c) Movements that require speed.
ii. Mechanisation of materials being fed to the individual machine.
iii. Mechanisation of removal and transfer of material to converyor or storage space.

To illustrate this point, let us consider a simple drilling operation for LCA.

The different steps involved in the process would be the following, in order of complexity:

i. To attach a pneumatic, hydraulic cylinder to the hand operated lever of the drilling machine to make it automatic.
ii. To make the clamping operation automatic by having a pneumatic vice instead of a hand-operated vice.
iii. To have movable type (indexing type) two or more vices, so that while the drilling job is in progress with one vice the material can be loaded and unloaded from the other vice.
iv. To make meterial-feeding automatic by having automatic index table equipped with pneumatic or hydraulic cylinders.

LCA means automating those critical areas of manufacturing activity where too much of human effort is required. It replaces strenuous manual effort by hydraulic or pneumatic power. For example, if a hand-press normally operated

by a flywheel is operated by a pneumatic or hydraulic cylinder, it would relieve the operator of a great deal of avoidable physical strain. Similarly operators of metal-turning lathes know how much effort is involved in shaping a sheet of metal around former into a desired shape. If this operation were to be replaced by a pneumatic or hydraulic cylinder, the operator would be in a position to turn out more products of better quality and finish. Similarly, pneumatic power could be usefully employed in an operation where an operator is required to handle a highly-corrosive fluid, or to work in a place where the temperature is very high.

LCA and Labour

It should, however, be remembered that in all these cases, the operator himself is not displaced, but his efforts are supplemented by pneumatic or hydraulic power. Besides, the hydraulic or pneumatic power does the work, such as feeding a tool or drill bit into the work, at a remarkably uniform rate, thereby increasing tool life and also reducing rejects. Since the rejects are reduced, an operator is able to increase his production and, therefore, his earnings, without having to put in unnecessary physical effort or having to work in dangerous atmospheres and locations. This shows that introduction of LCA on a selective basis is beneficial to the labour as a whole; in fact, it is the labour unions which should ask for the introudction of LCA in areas mutually agreed upon between them and the management.

Perhaps the most important aspect of LCA is that it enables the workers or operators to work more efficiently and *not* harder. LCA supplements labour's efforts but does not supplant labour. In our country. LCA has not yet been applied in a big way in our manufacturing industries. One reason for this may be that the necessary hardware components required for rigging up a system are not yet manufactured extensively. Even the one or two firms which are in this business possibly do not manufacture the entire range of the hardware required for the purpose. Further, our industries do not seem to be aware of the potentialities of applying LCA techniques in their manufacturing operations and some may be exercising caution so as not to raise a controversy with the labour.

In countries like Japan, UK, Germany, etc., LCA has been adopted extensively, with remarkable results. For a developing country like ours, which is struggling to have a faster industrial growth so as to catch up with the more-advanced nations, application of LCA techniques promises to bring enormous benefits. Not only will it raise the quality of our products but also reduce their manufacturing cost. In other words, it could prove to be a useful method of pushing up the productivity of an enterprise in particular and the nation at large. It would, therefore, be in the fitness of things that our labour leaders take the initiative in creating a climate in our country in which the full potentialities of LCA can be exploited for the benefit of everyone concerned.

In Japan, application of LCA techniques in small industries is extensive and one of the significant results has been a dramatic reduction in the rejects of components turned out by them. Big manufacturers who have been depending on small industries for many of their components have also benefited by this. In Japan, it is the labour which has been responsible for introducing LCA in many of the manufacturing operations. Each factory has a committee consisting of labour and management which keeps on exploring new areas for introducing LCA. It is hoped that a similar approach will soon be adopted in this country. □

Modern Developments in Welding

AD Datar*

The quest for finding solution to the problem of joining two materials has led to a number of innovations and inventions in the field of welding technology. Welding techniques have kept pace with the rapid development of technology and very significant developments have taken place in the field, particularly during the present century. In this article, the author traces out various developments that have taken place in the field of welding technology, beginning from Pressure Welding and Forging Welding to the more modern Electron Beam Welding and Laser Welding.

WELDING is a process of joining two materials. The joint is made with or without an external filler material which may be same as the parent material or an alloy of the two parent materials. The strength of the joint is due to the inter-atomic and intermolecular forces between the joining portions of the parent materials or between the parent materials and the filler material.

In welding, the atoms and molecules on the joining surfaces are brought sufficiently close to each other for the interatomic or intermolecular forces to be effective. This close contact between the joining surfaces is brought about by melting on application of heat (fusion welding), by plastic deformation at the joining surfaces on application of pressure (pressure welding) or by using both heat and pressure (forge welding). The strenth of the joint is proportional to the cross sectional area that is brought into close contact.

One of the practical difficulties in bringing about a close contact between the joining surfaces under atmospheric conditions is the inevitable presence of oxide films and impurities on these surfaces. These oxide films are generally hard, tenacious and much weaker than the parent materials. Thefore, in all welding processes steps have to be taken to remove these oxides and impurities. In fusion welding if the oxide melting temperature is lower than that of the parent material and also the oxide is lighter than the metal (as in the case of iron and low carbon steel) the molten oxide easily separates form the molten metal. If, however, the oxide melting temperature is higher than that of the parent metal (as in the case of oxides of alloying elements in cast iron and alloy steel and oxides of non-ferrous metals) fluxes are used to melt the oxides and thus enable their separation from the molten metal.

In the case of pressure welding, during the plastic deformation at the mating surfaces the oxide films crack and the parent metal extrudes through these cracks and a close contact is brought between the two pure parent materials.

Development of Welding Process

Man has felt the necessity of joining ever since he found his ideas of construction being

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restricted by available shapes of raw materials. He started with simpler techniques like tying, interlocking, etc., but found that such joints did not give properties which were identical in all respects to the parent materials. In developing newer and newer processes his aim has all along been to make an internal or homogenous joint, i.e., a joint between the atoms and molecules of the joining materials as against an external or heterogenous joint which is only a mechanical one. The welding technique more or less satisfies this requirement. It can be applied to all such materials which can be fused on application of heat (consider wood), or are ductile i.e. which yield plastically under an applied force (consider stone).

The first welding technique developed by man was probably that of pressure welding which was used for sealing edges of sheet metal boxes and for joining a foil of one metal (gold) over a base metal. This was done by manually hammering (giving concentrated force and thus stressing the material locally beyond yield point) on the work and naturally the use of this technique was restricted by the thickness of work material. For bigger work pieces the forge welding technique was developed, where the joining portions were heated and hammered together in their plastic state. The strength of material being reduced at higher temperature relatively larger thicknesses could be joined with the same force. The oxides also were either squeezed out in their moltenstate or got gradually diffused around the welded zone in forge-welding. The use of heat for welding must also have led to the fusion-welding process, but compared to the previous two techniques this process could develop fully only later on because of the necessity of close control over the temperature and the mass of molten metal during welding. The development of the fusion-welding process, however, was an important step becauseof the complete elimination of the use of force and corresponding ease and convenience in the welding operation.

Based on these three basic techniques a number of welding processes have been developed till now. The tables on the next page give the different processes and also how they have developed on a time scale.

It is quite natural that in keeping pace with rapid development of technology in the twentieth century, especially during the later part, the welding technique also has developed very fast during this period. Though the basic welding techniques were known for a long time the development and modification of these techniques to suit a particular requirement or application could take place only when such a need arose. These needs or root causes of inventions of the various welding processes can briefly be listed as follows :

1. To provide an effective shield or protection for the joining portion to prevent oxidation of the material.
2. To increase the welding speed.
3. To improve the weld joint quality and cost.
4. To weld very small or very large workpieces.
5. To weld materials which are difficult to weld.
6. To find out additional sources of energy for welding.

More Recent Developments

The nature of some of the modern welding processes as well as the reason for their development will be clear if we trace the progress of welding technology from about 1930 onwards. For a long time gas welding and elec-

Pressure Welding	*Forge Welding*	*Fusion Welding*
(1) Spot welding	(1) Resistance welding: Spot, seam, projection & butt welding	(1) Gas welding
(2) Seam welding	(2) Percussion welding	(2) Thermit welding
	(3) Gas pressure welding	(3) Manual arc welding
	(4) Friction welding	(4) Submerged arc welding
	(5) Diffusion welding.	(5) Inert gas arc welding
	(6) Ultrasonic welding	(6) CO_2 gas arc welding
	(7) Explosive welding.	(7) Plasma arc welding
		(8) Induction welding
		(9) Electric slag welding.
		(10) Electron beam welding
		(11) Laser welding.

Invention Calender of Welding Processes

	Invented during	*Invented in.*
Pressure welding	1400 to 1000 B.C.	—
Forge welding	1200-800 B.C.	—
Electric Manual arc welding (fusion)	1874	—
Electric Resistance (forge) welding	1886	U.S.A.
Gas (fusion) welding	1901	FRANCE
Submerged arc (fusion) welding	1930	U.S.A., U.S.S.R.
Inert gas (fusion) welding	1945	U.S.A.
Plasma arc (fusion) welding	1909-1956	U.S.A.
Ultrasonic (forge) welding	1943-1950	—
Explosive (forge) welding	1944	
Electric slag (fusion) welding	1955	U.S.S.R.
Friction (forge) welding	1957	U.S.S.R.
Electron beam (fusion) welding	1907-1957	France.
Laser (fusion) welding	1958-1960	U.S.A.

Note: The two figures in the above table indicate the date of invention of a particular principle and the date of its application for welding.

tric arc welding processes were in common use as joining processes. Gas welding could not be used on production scale because of its relatively low temperature (3400° C) and large spread of heat source (the gas flame). This made welding of thicker sections of high mp materials like steel a slow process. It also resulted in large heat affected portion on both sides of the joint which in turn produced distortion in the workpiece.

The electric arc, on the other hand, has much higher temperatures (5000-10000° C) and is a much more concentrated heat source. The electrode can be a consumable one, serving also as filler material. The arc welding process, therefore, had these factors in its favour. There was however a limitation to the amount of heat generated in the arc and in turn to the metal deposition rate as current density could not be exceeded beyond say about 10 A/mm^2. Higher

current densities gave a wild unstable arc and filler metal loss due to splattering increase. An idea to strike the high current arc under an envelope of granular flux fed through a hopper would control the arc, prevent splattering and also give high heat efficiency because of prevention of heat loss by radiation. This granular flux as well as the molten flux below it would protect the molten metal from atmospheric conditions to a better extent and also act as a blanket giving a slow cooling rate for molten metal, thus preventing a quenching and corresponding hardening or cracking tendency. Current densities upto 400 A/mm^2 are used in this *submerged arc welding processs*. The large mass of molten metal resulting from use of high currents upto 4000 amperes would have trickled or drained out but is held in place by the heap of granular flux. The process is made semi-automatic or automatic by feeding a continuous wire electrode by rollers, the current being fed to the wire through a sleeve near the tip of the electrode and mounting the welding head on a trolley. All these factors make this process suitable for welding plates up to 50 mm thick. Welds requiring a number of passes in manual arc welding using stick electrodes could be done in one or two passes in submerged arc welding. The weld profile also is clean and smooth.

With the development of aircraft industry a need was felt for high quality welds in aluminium and magnesium alloys. The oxides of these materials are tenacious and highly refractory. Fluxes used to melt these oxides are generally corrosives in nature and if the joints are not thoroughly cleaned, they are harmful to the work-piece in the long run. An idea to provide a shield of inert gases like helium or argon for the molten metal resulted in the *inert gas arc welding process*. An inherent surface cleaning property of D.C. reverse polarity arc was also discovered. When the work-piece is negative the electrons emitting from it crack and disperse the tough oxide film from parent materials (just as large waves in an ice-covered lake would break the ice layer). Any further oxidation is prevented by the shield of inert gas. The inert gas welding process uses either a non-consumable tungsten electrode (TIG, Tungsten Inert Gas process) or a consumable electrode (MIG — Metal Inert Gas process). The TIG process uses low current values and is mainly suited for thinner materials. The MIG process can, however, operate at higher currents, since there is no overheating of the electrode as in the case of TIG. The high currents give a characteristic spray transfer of filler material, giving deep penetration and also enable welding in vertical and overhead positions.

The high cost of shielding gases like argon, though justified in certain applications will not prove competitive with other processes in general-purpose welding of ferrous materials. But the advantages of a gaseous shield over a solid flux shield are obvious. There is a complete absence of fluxes and slag, generally abrasive in nature, of cleaning operations after welding and chances of slag inclusions in the weld. The joint visibility and correct manoeuvring of electrode are also possible. A cheaper shielding gas viz., CO_2, therefore, was tried and the *CO_2 welding process* was developed. The CO_2 gas, however, is not inert in nature. Therefore, the consumable electorde wire is double or triple deoxidised and contains deoxidising elements like Si and Mn—which reduce the iron oxide formed during welding. The spray metal transfer possible in Aluminium-Argon combinatton is not observed in steel-CO_2 combination because of the sluggish behaviour of molten metal in CO_2 arc. The process

is, therefore, designed for dip transfer of metal where the molten tip of the electrode frequently dips or short-circuits the pool of molten metal and metal transfer takes place by surface tension. A restriking of the arc follows the transfer of molten metal from the tip to the molten metal pool.

An electric arc between a rod electrode and a flat work material is bell-shaped, the arc spreading out near the work material. This gives out a spread-out heat source and accompanying lesser heat intensity. If the arc column consisting of heated ions is made to pass through a narrow or constricted passage, the heat is concentrated and much higher temperatures upto 20000° C are reached. This is the principle of *plasma arc welding process*. The arc is struck between a non-consumable electrode in a nozzle and the nozzle itself in an inert gas atmosphere like agron that is fed through the nozzle. The hot ionized gas or plasma is made to come out through a narrow opening in the nozzle and we get a narrow high-temperature high velocity plasma jet which is used for welding. Once the arc is struck and the atomosphere is ionized, the arc can be transferred and directly struck between electrode and work-piece, the arc being constricted by the narrow passage of the nozzle. This process is suitable for welding high temperature melting alloys of smaller thicknesses (upto about 6 mm). A characteristic feature of this process is the key hole action whereby the plasma jet completely passes through the metal thickness, producing a hole. As the plasma jet travels ahead, the key hole also travels with it, its previous positions being filled by the metal that is melted by the jet. This is similar to a string or wire passing through an ice block, with the block remaining solid and uncut. The key hole action ensures complete penetration of the weld joint, i.e. joining the parent materials through its full thickness.

In keeping pace with rapid development of technology in the twentieth century, especially during the later part, the welding technique has also developed very fast.

The Ultrasonic Welding Process utilises high-frequency (10^5 cps) vibrations obtained in a magnetostrictive crystal to produce a reciprocating or sliding action between the joining surfaces. The vibrating crystal has an extension (sonotrode) which holds the two work-pieces under pressure in a lap joint over a support or anvil. The high frequency vibrating sonotrode moves the work-piece on its side (holding it by friction force) over the other work-piece (held stationary on anvil by friction force). This sliding action scrapes out the oxides and impurities on joining surfaces and, under the pressure exerted by the sonotrode as well as frictional heat developed, the two pure metal joining faces are brought in intimate contact. Once the oxides are removed the pressure on the sonotrode is gradually released so that vibrations and corresponding sliding action is not transmitted to the work-piece and a firm joint is established. The process is applicable for joining foils or a foil on a thicker material.

Large sheets or plates can be lap-welded over their entire surface areas by utilising the energy in an explosion. In this process of

explosion welding, one of the work-pieces (usually the thicker one) is rested on an anvil and the other work-piece, arranged at slight inclination with it, is made to have an impact on the fixed work-piece with a high velocity produced by detonation of an exclosive charge. The inclination ensures that the impact gradually proceeds from one end to the other and that no air is entrapped. The process is well suited for cladding operations.

All these processes discussed till now are mainly suitable for welding small and medium sized materials. Attempts were, however, under way for developing a process that could join a large thickness in one pass. This would tremendously simplify the construction of heavy machines by making possible use of simple castings or forgings. The outcome was the *electric slag welding process*. In this process the consumable electrodes in wire or plate form are dipped into a molten slag pool which floats over the pool of deposited molten metal forming the weld joint. To enable the steady holding of such a large mass of molten metal, a mould is formed between the two joining faces of parent materials (held about 25-30 mm apart) and two water-cooled copper shoes which travel vertically along the joint as the deposited metal gradually solidifies. The consumable electrodes melt and are continuously fed into the molten slag pool heated because of its resistance to passage of electric current. The molten slag also provides protection to molten metal from atmospheric gases.

A journal-bearing operating without lubrication gets hot or seized. This common observation led to utilisation of frictional heat for forge welding of butt joints. The heat is developed by keeping one work-piece stationary and revolving the other or alternatively revolving both in opposite directions. The two work-pieces are held pressed towards each other giving rise to the frictional force. The frictional heat thus developed heats the joining faces even to their melting temperature. The molten metal and oxides are squeezed out because of the axial thrust and as the joining surfaces attain a sufficiently high uniform temperature throughout the cross-section and are converted into their plastic state, the rotation is suddenly stopped and the axial thrust maintained or even increased to improve the contact area between the two materials.

The process is primarily suited for round bars and pipes. Any other shape would cyclically expose part of the heated surfaces to atmospheric conditions leading to oxides in the joint and weaker strength. The process at its present state of development can join sections up to 100 mm diameter and, considering equipment cost, is cheaper than the electric flash or upset butt welding process.

Weldability or the ease with which a material can be welded is determined by various factors. In fusion and forge-welding the factors that influence weldability are hardenability (which itself is a function of chemical composition, solidification characteristics and quenching rate determined by the section size), melting temperature (higher the temperature lesser the weldability) and reactivity of the materials i.e. its affinity towards other materials especially atmospheric oxygen and also its tendency to dissolve gases at higher temperatures. One of the criteria for measuring the weldability can be the quality of the weld joint and since the quality required will depend upon the end use of the joint, the weldability has also to be seen in the light of the end use of the weld joint.

Welding of Nuclear Material

In nuclear engineering, highly-reactive materials like titanium, tantalum, niobium, zirconium, etc., are used. With the development of nuclear technology, the fabrication technology of these materials had also to be developed. The weld quality requirements in this field are also highly demanding. The difficulties in welding these materials are their high melting temperatures (3000-4000°C) and their high affinity for oxygen even at about 300° C. With a view to giving a more efficient protection in such cases for the molten metal inert gas arc welding in evacuated chambers was tried. At about the same time, the higher heating capacity of electrons bombarding a cathode at high voltages as in case of X-rays was utilised for welding and the *electron beam fusion welding process* was invented.

At voltages ranging from 15 to 150 KV, the electrons emitting from its cathode are having a high velocity up to 10 meters per second. On striking the work-piece, this kinetic energy of the electrons is converted to heat and temperatures even enough to vapourise the material are reached. The electrons, however, are extremely light particles and are easily diverted by atmospheric gases. The apparatus, therefore, is operated under vaccum. In order to increase the heat intensity, the electron beam is focussed by means of magnetic coils and beam spots 1 to 3 mm diameter are obtained. In vacuum the beam can be focussed to a length of about 75 centimeters and hence welding is possible in difficult or inaccessible positions. A non-vacuum *EBW process* has also been developed which can weld at a length of about 25-50 mm. Another advantage of EBW process is the relatively deep penetration obtained in the joint. The highest depth to width ratio of the weld bead in EBW is about 25:1 as against 2:1 normally obtained in other welding processes. Because of these advantages EBW is adopted even for general-purpose welding.

LASER (Light Amplification by Stimulated Emission of Radiation) is a device which when irradiated by light from an intense source is capable of amplifying radiation in certain wavebands and emitting this as a coherent parrallel beam in which all waves are in phase. The high-heat intensity (comparable to that obtained in electron beam welding) in a laser beam was immediately utilised for welding after its invention. The ability of the laser beam to travel in a straight line and its high-heat concentration (0.1 mm dia. beam spot) make the process suitable for making small or microwelds in heat-sensitive materials or even ceramics. Welds in foils or fine wires required in electronic equipment is also a typical field of application. The process is at present not suitable for welding large thicknesses as the sustained heat capacity of laser equipment is limited.

Potential for Exploiting Solar Energy

The various sources of energy that have been tapped till now for welding, especially for producing heat are :

(1) chemical reaction : combustion or exothermic reactions,
(2) electrical energy,
(3) mechanical energy.

One more source with abundant supply of heat is the solar energy. This energy has already been utilised for various other applications. The problems in its application for welding are mainly (i) suitable equipment to concentrate the heat in sufficient quantity at required spot and (ii) the variable and undependable nature of solar heat at different places in the world. In our country, however, this energy is available for a relatively long part of the year and there is scope for utilising this free and ample supply of energy for welding. ❑

Relating Individual Development and Organisation Development

John F Connors*

Organisation development (OD), according to one definition, is the use of group dynamics and related psychology techniques to assist an organisation in examining its technical systems and social relationship problems so as to develop better solutions. An OD specialist is one who assists management through improving 2-way problem solving communication, uncovering inter-personal blocks to organisational effectiveness, and guiding, supporting and encouraging organisation members as they work through the process. The author firmly believes that manager development and organisation development are indeed compatible techniques. While Manager Development programmes are oriented to developing managers, Organisation Development is a continuous process of developing social conditions, so that the managers can make greater contribution. OD is individual development, but it clearly relates that development to the organisation of which the individual is a part.

It is not difficult to believe that we all understand what is meant by individual development. Whether we all agree on where responsibility and accountability lie for this kind of development may be a moot question. But let us now tackle a definition of organisation development. According to Robert Pearse of Boston University's College of Business Administration — "Organisation development is the use of group dynamics and related social psychology techniques to assist an organisation in examining its technical systems and social relationships problems so as to develop better solutions. In business organisations the goals of planned change and OD are to assist in profit and performance improvement leading to planned growth." Unless you should be confused by some definite relationships between the newer concepts of organisation development and the World War II derivative, operations research (OR), Prof Pearse helps to obviate confusion by stating that: "Whereas OR is performed by a team of specialists using mathematical techniques to arrive at 'optimal' solutions, OD (on the other hand) is a facilitating technique. It's designed to assist members of the organisation in diagnosing their own problems and developing their own solutions."

The only fault one may find with Prof Pearse's excellent definition of OD may be simply that after a first reading many people are inclined to ask themselves: "What did he say?" The definition applied to OD by William J Crockett, a vice president of SAGA Administrative Corporation in Menlo Park, California, may be better understood. In a talk he gave in 1970 before the Sequoia Chapter of the Administrative Management Association, Mr Crockett said, essentially, that OD is the act of mature people learning all over

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again how to act as human beings. Inherent in his definition, he says, is the concept that these mature people, *must be willing to learn*. Crockett says that OD starts people saying "I'm a human being. I have feelings. I have ideas. I have a right to express my ideas and my feelings." In the OD climate, people will and do express their feelings. To continue with Crockett's approach : "If you make the proper climate for your children, your spouse, your subordinates, you will get their ideas, their disagreement, their feedback. That is OD."

Few of us within the organisational structure fail in our roles for want of adequate technical, managerial or other types of skill. Most of us have skill to burn. Where we can and often do fail is in the area of role-playing. We do not seem to realise that we consciously or subconsciously play many roles in our lives. (Didn't Shakespeare tell us that when he decscribed the world as a stage and demonstrated the many roles a man must play?) Our failure stems from the fact that we do not really play our roles well. We have difficulty getting along with people—our interpersonal relations are not good. Why? Well, the failure is probably within us — it is with our feelings—our feelings about ourselves as well as others. As Mr Crockett said in his talk in California: "We don't know each other. We don't know ourselves."

A Change Agent

The very early practitioner of OD generally referred to himself as a change agent. A certain mystique, which this early practitioner probably made no effort to dispel, developed around his use of intergroup/interpersonal dynamics skills. He might have remained to this time the Merlin of industry and business had it not been for the fact that line and staff managers began to find available to them mystique-dispelling courses in group dynamics, planned change, OD, conflict resolution, etc. from professional societies, management associations, graduate schools of business and management consultants. Prof Pearse properly describes today's OD specialist as someone who "assists management through improving two-way, problem-solving communication; uncovering interpersonal blocks to organisational effectiveness; and guiding, supporting, and encouraging organisation members as they work through the process." We can all surely recognise that this type of assistance is, in essence and reality, directed toward the growth and development of the *people* who comprise the organisation. Unnecessary though it may be, it would not be right to go past this point without calling attention to the fact that the organisation is *people*, not just some graphic model of names and titles enclosed in rectangular framework!

Let us go back to the "change agent" concept. It's not difficult to understand why the early OD practitioner attached this descriptive title to himself. The need for his expertise stemmed (in the United States) from the trauma that developed in business and industry as the nation moved rapidly between two major wars from a rural agricultural economy into a complex urban technology whose organisations reflect tremendous diversity and complexity as well as almost monstrous size. And this change which we have seen in the United States most certainly has counterpart situations in every country in the world.

What are some of the major environmental changes in which modern organisations must operate? Try these —

(1) *Human rights:* As we moved from an economy of scarcity—almost privation —to one of vast abundance, there emer-

ged vast changes in social values, political values, beliefs and expectations regarding the human conditions. In the United States the impact of human rights consciousness has produced a tremendous environmental change within organisations.

(2) *Science and technology:* A machine technology of astounding proportions has evolved from the recent two-decades breakthrough in the fundamental knowledge of man.

(3) *Cybernation:* Pearse calls our attention to the joining of cybernetic feedback systems — certainly including computers—with automation which together have produced highly-automated manufacturing and distribution systems.

Influence of Environmental Changes

Now let us add to these external environmental changes what we have seen happening in business organisations. The last thirty years of the nineteenth century and the first thirty years of this century produced the evolution of large organisations in the basic industries: steel, automobiles, petroleum, mining. Great corporations developed from small manufacturing, processing or selling companies—and these giant vertically integrated organisations are completely equipped with raw materials, manufacturing and selling capabilities.

In America, we are familiar with the story of Henry Ford's introduction of the assembly-line technique and Alfred Sloan's refinements of the administrative, organisation and control systems of industry. We recall the depression years and their introduction in the United States of economic controls imposed by the Federal Government. We saw the labour union movement grow. We saw then big union and big government start unilaterally to challenge the power of big business to install changes of any significance.

America and other Western Powers moved directly from the deflation climate of the Depression Era into the inflationary climate of World War II and all-out production. The task of winning the war necessitated major changes in business operating techniques. The War years demanded and produced the rapid acceleration of scientific discovery and technological invention. And the most recent major change in the business organisation has been the growth of the conglomerate organisation structure in business, with diversified products and services operated under one corporate head.

These environmental and business organisation changes occurring as they did over a period of generally growing awareness on the part of all peoples everywhere—although it is difficult to identify whether the changes or the growing awareness of people is the egg in the chicken/egg cycle—identified clearly the need for organisational change. As business and industry grew larger, and especially as they grew more complex, changes in their social systems (such as relationships, rewards, status, etc.) had to be most carefully planned and coordinated. Prior to World War II, technical and social systems changes were invariably accomplished by technical and engineering specialists who resorted to Taylor's scientific management concepts or, perhaps, to the managerial efficiency concepts of the Gilbreths.

The slowly-paced introduction of change that characterised the period before World War II did not seem to threaten too much the job security or work habits of employees and if

the impact of the change was ameliorated by pay increases, employees tended to see them as helpful. But, the Great Depression in America accompanied by unprecedented control powers of the Federal Government and of large labour unions had the effect of limiting the right of business management to introduce unilateral change. Then, too, management from lower levels right up to the middle levels as well as hourly paid employees began to resist some changes. And this resistance usually took the form of minimal cooperation and commitment to make the new systems or methods work profitably.

Contribution of Behavioural Scientists

The need brought about by the changes in external environment and in business organisations brought out significant contribution from among specific behavioral scientists in the areas of organisational behaviour and management theory. A number of studies have been made over the past ten or fifteen years on the effectiveness of the various planned change and OD techniques of behavioural scientists. The consensus of these studies seems to be that consultive and participative management techniques (both used in OD) do produce better employee understanding and a more profitable company operation after change has been installed.

Most of the managers, in the course of involvement in OD, do come face to face with the problem of trying to establish a relationship between the development of individuals and the concept of OD. This writer was intrigued some time ago by an article that appeared in a 1971 issue of the Journal of Applied Behavioral Science, entitled "A Comparison of Management Development and Organization Development." Written by Warner Burke, Co-Director of the Center for Professional Development, NTL Institute for Applied Behavioral Science, the article attempted to establish that there are differences between MD and OD; that OD hasn't and probably won't obviate the concept of MD; and that if one is to bring about ultimate development of people in today's business world it's important that the differences between MD and OD be recognised as well as their similarities.

Burke points out that the growth of organisation development has fostered considerable confusion, predictably so, about its conceptualisation and practice. He further indicates something that we have all most likely felt at one time or another—that we have been involved in bits and pieces of OD for some time. Burke says that many people who claim to have been "conducting OD" have, in fact, simply been conducting laboratory training for members of their organisation. Others of us will attest, after hearing some explanation of OD, that we have heard nothing new—that such events are everyday occurrences in our organisations.

According to Burke, OD does consist of a large variety of activities including laboratory training. Anyone who examines in some detail the way he conducts his everyday operation, especially in the area of human relations, may be behaving in line with some practices and some principles of OD. Burke's position is that OD is *more* than the conduct of training laboratories, however. "(OD) can be defined as a *planned process* of cultural change. This process consists of two phases: (a) diagnosis and (b) intervention. OD begins with a diagnosis of the current organisational culture, i.e., an identification of norms, procedures, and general climate of the organisation. This identification process becomes more diagnostic as a distinction is then made between those standards of behaviour, procedures, and so on which seem

The need brought about by the changes in external environment and in business organisation has led to significant contribution from among specific behavioural scientists in the areas of organisational behaviour and management theory.

to *facilitate* the organisation's reaching its objectives (while meeting the needs of its members) from those which *do not facilitate* attainment of its goals." Burke goes on to say that "following the diagnostic phase, interventions are planned to change those norms which are seen as barriers to effective individual and organisational functioning." So we can see then that his premise is that although persons may be involved in events that are properly labelled as OD Technology, such activities *are not considered* organisational development if they are not part of a planned effort at changing the culture of the organisation.

OD and MD

Let us try a comparison of management development and organisation development with Burke. We all recognise management development as a technique having direct application to individual development. A better name for the technique is *manager* development—the manager is the individual at whom development is aimed. How have we practiced this manager development over the years? We have tried job rotation; we have deluged the manager with tests and post-test counseling; we have brought psychologists into our organisations as consultants (confessors?) to our managers; and, we have provided education in-house and on the outside. All good—but too often, beyond the organisation periphery.

This writer agrees with Burke as we proceed to the dimensions of comparison between OD and MD—primarily because Burke emphasises a premise in which this writer firmly believes—i.e. manager development (with the focus on the individual) and organisation development (with the focus on the organisation made up of individuals) *are*, indeed, compatible techniques. Burke points out that there are six dimensions that are critical to both of the developmental strategies for change in organisations, OD and MD. They are :

1. Reasons for use
2. Typical goals
3. Intervention for producing change
4. Time frame
5. Staff requirements
6. Values.

Bearing in mind that management (or manager) development is to be considered one of several intervention techniques available to the OD effort, let us take a quick look at the six critical dimensions mentioned here and see what can be said of them as they relate both to OD and MD.

1. *Reasons for Use :*

Generally, leaders in organisation will turn to OD (presuming here that they do know about it !) when they have difficult problems to face—when they are hurting, when they feel there is a need to make some changes in organisation in

areas such as: organisational structure and individual roles; methods of solving problem; intergroup conflict; intergroup collaboration; or the handling of mergers. These are just sample areas that may need attention.

On the other hand, a manager development programme may be established, as Burke indicates, with the tackling of these same needs as its objective—but the orientation typically focuses on individual employees rather than on the organisation. The needs have been diagnosed as managerial skill void—something so broad as: "Our people need to be updated on the latest techniques and ideas."

OD is used "to improve some or all of the *systems* that constitute the total organisation." MD is used to improve some voids in the *skills* of the manager.

2. *Typical Goals*:

It is in consideration of the goals of OD programmes and those of MD programmes that we do note some striking contrasts rather than comparisons. A typical list, as delineated by Warner Burke in his comparison table, lists the following goals of an OD programme:

a. To increase the effectiveness of the organisation by:
   Creating a sense of "ownership" of organisation objectives throughout the workforce.
   Planning and implementing changes more systematically.
   Facilitating more systematic problem-solving on the job.

b. To reduce wasted energy and effort by creating conditions where conflict among people is managed openly rather than handled indirectly or unilaterally.

OD is used to improve some or all of the systems that constitute the total organisatian. MD is used to improve some voids in the skills of the manager.

c. To improve decision-making by establishing conditions where decisions are made on the basis of competence rather than organisational status or role.

d. To integrate the organisation's objectives with the individual's goals by developing a reward system which supports achievement of the organisation's mission as well as individual efforts toward personal development and achievement.

In comparison the goals of a management devlopment programme are:

a. To teach company values and philosophy.

b. To provide practice in management skills which lead to improved organisational effectiveness.

c. To increase ability to plan, coordinate, measure and control efforts of company units.

d. To gain a better understanding of how the company functions to accomplish the goals.

From this comparison of goals of OD and MD it can be seen that manager development programmes are oriented to developing managers

who will be able to make a greater contribution to their organisations; whereas OD is a continuing process of developing social conditions so that the manager can make these greater contributions. Therefore, while there are some striking contrasts between the goals of OD and those of MD, essentially the contrasts are in the *strategies* of the two programmes. In fact OD and MD insofar as *goals* are concerned, are complementary rather than incompatible.

3. *Interventions for Producing Change*:

Of the various categories of intervention used in OD — such techniques as intergroup problem-solving, data feedback, technostructure, training, and team building—the last named, team building, is really the crux of OD. It's probably the most used form of intervention in OD practice.

Training is the major intervention technique of a manager development programme. The emphasis is on educating the manger, although, of course, other interventions such as job rotation, counseling, crew development, reading programmes, specialised training packages, etc. are regularly used.

It may be noted that where interventions are concerned, OD sets out to change the organisation's *culture* from doing things the old way to taking full advantage of available human resources and allowing for the development of a process that will provide planning expertise to the organisation and will implement needed change at all levels rather than having to adjust to changes already in progress.

4. *Time Frames*:

Management or manager development is truly a programme that has a definite beginning and end as it is applied to an individual. OD, on the other hand, is more a *process* than a programme—a continuing or timeless process. The process is constantly examining how the organisational systems are functioning and looking for ways to improve the systems.

5. *Staff Requirements*:

The manager development specialist is essentially a teacher-trainer. He is a programme manager—a designer of training programmes. If he is to be effective, he must have a knowledge of the basic processes at work as humans learn. His expertise, in short, is oriented to the development of the individual manager.

The OD practitioner is a diagnostician. He's a consultant/helper, a catalyst/facilitator. He has both knowledge and skill in the dynamics of planned change and experience in the laboratory method of learning.

6. *Values*:

In his chart of comparisons between OD and MD, Burke lists quite a few values that are inherent in both types of programmes. Suffice to say that "the major general value that OD represents is the humane and non-exploitive treatment of people in organisations. All other values of OD seem to relate, in one way or another, to this primary value of human dignity." Manager development programmes all seem to have a value premium on competition. The *collaboration* noted in OD is scarcely discernible in MD.

In summary, Burke has this to say about OD (the process oriented to improvement of overall organisational effectiveness) and MD (the programme oriented to improvement of the overall effectiveness of the individual manager)—"While there are some value conflicts between OD and management development, or at least in the way

management development is practiced in certain organisations, there is also overlap and compatibility (e.g., the right of a person—and an organisation—to seek full realisation of his or its potential)."

"In an effort to clarify the nature of OD," Burke continues, "a method of comparing it with a more common change strategy, management development, has been chosen. While this comparison technique may be useful for clarification, it should not dictate the message. The two strategies for change are not incompatible. On the contrary, management development and OD are quite complementary. Management development should be one of the several intervention techniques available to the OD effort."

"Management development programmes should *respond* to diagnosed needs in the organisation. This is not to say that other OD interventions cannot be developed as a result of some management development programme. Either strategy can develop from the other. The point is that an appropriate OD intervention, whether it be a management development programme or a change in the organisational structure, is one which originates from study and diagnosis of current, relevant data."

Relating Individual Development with OD

Up to this time, this writer has followed rather closely the thinking of Warner Burke because he believes that as a behavioral scientist he creates a most acceptable premise for the existence of a relationship between individual development and organisational development. He does it by showing a level of compatibility between manager development, the trainer's programme, and OD, the behavioral scientist's process.

The OD practitioner is a diagnostician. He is a consultant/helper, a catalyst/facilitator. He has both knowledge and skill in the dynamics of planned change and experience in the laboratory method of learning.

An attempt is now being made to move toward a conclusion by a further, but slightly different, effort at relating the development of an individual to the OD process.

In a speech made before the Administrative Management Society in California in 1970, William J Crockett, tried to relate himself to the organisation. He was a bewildered manager —and does this sound familiar at all?—who hadn't been trained; couldn't imagine what, he himself, was actually like, was loaded with concerns; worried about his self image, felt that he was out of focus with others; made a lot of unfounded assumptions about people and their intentions; attributed motives to behaviour he didn't understand; didn't know how to ask for help; was unable to recognise the impact of differences; and constantly felt a need to defend himself. This writer likes to pose this question to the managers: is that a bewildered manager: Further, "Is it you?"

Advantages of OD

Maybe these ten fears are not characterised, in every manager. There is no doubt, however,

OD can help people to build bridges across their feelings. OD can provide the climate that precludes the need for making assumptions, and enable an individual to ask freely and expect to get answers.

that we all have some of them as we pursue our jobs. As a matter of fact, as we face the various exposure of a business career it is conceivable that at one time or another each of us has to live with several or all of these fears. Fortunately we are not *usually* burdened with all of them at the same time. But, beset by these fears characteristic of the individual what can OD do for us? If we are not trained sufficiently for the role that we must play as a member of the organisation—if we don't understand what are the basic, fundameantal rules of human behaviour and human feelings—if we need additional understanding, we can get it by participation in the OD process. And if an individual cannot see himself, others can. Therefore, they privide him with the feedback he needs about how he is doing in his personal relationships as he tackles his job. He wants to improve in his role as a manager, but how can he, unless others *tell* him how he is doing. OD provides a feedback system.

The fear that is a real hang-up for an individual is that he may not be doing a good job, that others may not think he is doing a good job—fear that they are not being truthful when they tell him that he is performing well—fear that the other person, his boss, will be angry with him if he disagrees with him or tell him what he thinks Fear can destroy his self-respect—that it will eventually drain him of humanness. OD can put him in the sort of working climate that might banish fear and provide trust.

An individual may have a poor concept of himself. He knows that a bad self-image, that is the product of unfortunate hang-ups, can destroy him. He knows that motivation comes from within and that if he can get release from these hang-ups, he can do almost anything. OD can provide him with the climate that will enable him to gain the insight he requires.

An individual may be out of focus with the people around him. He does not understand much of what's going on around him or what people are really trying to say to him. He cannot release his feelings at all when he is dealing other people. OD can help people to build bridges across their feelings. OD can provide the climate that precludes the need for making assumptions, and enable an individual to ask freely and expect to get answers.

When an individual does not understand something he is prone to attribute motives. And, of course, these motives are always against him. OD can create a climate in which he can discuss things freely with anyone—discuss the things, the actions, the words that he does not understand. He may feel uncomfortable asking for help. If he is the boss how can he ask his subordinates for help? That's a sign of weakness — a sign that he has lost control ! OD can show him how he has really lost control by failing to be a human being. His subordinates, his peers, his superiors are all ready to help if he just asks for it.

He has difficulty recognising and understanding all of the differences that surround him

—the differences in values, in people, in standards—differences that stem from different age levels, from different backgrounds and education. He has to learn to understand these differences and to deal effectively with them. OD can help him. And why must he always be defending himself ? If he continues to do so how can he ever grow or learn ? If he does not listen how can he get the feedback he needs to effect the change in him that is necessary ? OD provides the climate that convinces him that listening is important—it's a continuing learning climate.

We can see that OD can make a contribution to the growth and development of the individual. OD *is* individual development but it clearly relates that development to the organisation of which the individual is a part. "The Organisational Development, Concept," Crockett says, "is really about the *quality* of life—*ours*".

Conclusion

The acceptance of the OD concept in business and industry *does not* obviate the older, perhaps better-understood, concept of manager development. MD, the programme oriented to the development of the individual, has, gained stature recently as a concept by virtue of its being recognised as one of the interventions available in the OD process. Manager development programmes will continue, as specific assists in the development of the individual. But manager development programmes that exist and operate outside of the total organisation climate are outmoded—and probably represent a great deal of wheel spinning. If the organisation isn't ready to accept this "developed" individual, what has his development accomplished for him ?

In this day of environmental complexity in business and industry it is doubtful whether we can afford just to develop the individual. Firms today are concerned not only with their present operating profit but also with their future health. They have a long planning horizon. A manager development programme alone with its short-term goals of individual development simply cannot contribute sufficiently to a continuing profit posture. Therefore, rather than being the means to an end, MD must be a component or intervention of OD, the long-term process oriented to increasing the overall effectiveness of the organisation in which the individual is a significant factor. □

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Organisational Development : Key to Greater Effectiveness

RC Jain*

Organisation Development (OD) is an effort, which is planned organisation-wide and managed from the top to increase organisational health and effectiveness through systematic interventions in the organisation's processes, using behavioural sciences knowledge. OD strategy depends upon a number of factors such as organisational health, existing management system, the type of internal and external pressures, the nature of industry and top management support. OD effort has to be tailor-made for each organisation. Experiences in the implementation of OD programmes suggest that OD effort succeeds best when the organisation is under considerable external and internal pressures for improvement. The six phases involved in any OD effort are (i) Appointment of a change agent, (ii) Legitimising role of change agent, (iii) Organisational diagnosis, (iv) Invention and commitment (5) Implementation and (6) Feedback and redesign.

DURING the last few years, many topics incorporating behavioural sciences approach have been increasingly attracting the attention of business executives. Be it organisation development, management of change, conflict resolution or sensitivity training, the central theme of all such topics focuses attention on development of human resources. As a consequence we are witnessing a new term "Organisation Development (OD)" finding its way into the organisation charts of Indian companies. OD concepts are spreading fast and as a result it is difficult for many to ascertain either its importance or probable impact. It is argued by some that most of the activities carried out under the garb of OD are essentially old activities carried out under a new name, while proponents of OD claim that activities under OD aim at an old but increasingly urgent problem.

The main challenge facing today's organisation, whether it is a manufacturing enterprise or a service industry, is that of responding to changing environment and adapting to both internal and external pressures. An organisation must constantly look into its objectives and policies, systems and procedures, short-term and long-term plans and above all its human resources development. The target of organisational change should shift from small work group or a single department to the organisation as a whole, including the top management. OD is primarily concerned with the process of organisational change stressing equal emphasis on *what* needs to be changed and the change can be introduced.

OD Definition

OD is a comparatively new concept in India.

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Unfortunately there is no universally accepted definition of OD. Beckhard[1] has, however, provided a terse, yet adequate, description of OD, which with slight modification reads as follows :

"Organisation Development is an effort which is planned organisation-wide and managed from the top to increase organisational *health* and *effectiveness* through systematic *interventions* in the organisation's processes using behavioural sciences knowledge."

Note the key words, "Effectiveness", "Health" and "Interventions". To elaborate these : By *health* of an organisation we mean the extent of competence and mastery of problem-solving skill an organisation possesses. In terms of Warren Bennis[2], an organisation is healthy if it actively masters its environment (adaptability), has certain unit of personality (the problem of identity) and is able to perceive environment and itself correctly (reality-testing).

By *effectiveness* we imply the ability of an organisation to fulfil a set of multiple objectives set forth, which may be of different kinds—qualitative and quantitative, economic and social, short and long-term, etc. It is important to distinguish effectiveness from efficiency. Efficiency is a measure of input-output ratio. It is possible to pursue the wrong objectives more efficiently. Efficiency, therefore, is a necessary but not a sufficient condition.

By *interventions* we mean any inputs to the organisation system, designed to bring about the desired change. The word 'intervention' in its simplest form means any set of managerial actions, steps or activities initiated to achieve certain results. To illustrate, the following activities could be termed as interventions :

(a) T-group for management.
(b) New organisation structure.
(c) Introduction of Management by Objective.
(d) Joint Management-Union Forum.
(e) Adoption of a new manufacturing process.
(f) Marketing a new product.

Interventions are also behaviours that come between ongoing social system. Thus, the term used here is much more comprehensive than what one normally implies.

Broadly speaking interventions are made in two areas : (1) Human-resources development and (2) Technical development. Technical development is achieved through areas of marketing, finance, engineering and manufacturing. Human-resource development concerns people, inter-personal relationships, small groups, intergroups, and organisational norms and values. The technical resources are inter-related with the human resources. Thus, an executive with high self-acceptance and who is a member of an effective management group may tend to create and use financial controls in a more constructive manner than an executive with low self-acceptance who is a member of an ineffective management group.[3]

Yet, it is on the human resources and their development that the primary focus lies. The underlying assumption is that an organisation's level of adaptation cannot be improved unless many of its employees, right from the top, exhibit desired behaviour in relationship to each other and to their jobs. All the activities of an

1. Beckhard, R, "Organisation Development". Reading Addison Weslay (1969).

2. Bennis, WG, "Changing Organisations", McGraw-Hill (1966).

3. Agryris C, "Management and Organisational Development". McGraw-Hill (1971).

organisation are initiated and managed through the competence, motivation and general effectiveness of its human resources. Of all the tasks of management, development of human resources is the most important task, because all else depends upon how well it is done.[4]

OD and Effectiveness

We are coming to recognise with increasing acceptance that the capacity of an organisation to function well depends upon the quality of its decision-making process and upon the adequacy and accuracy of the information used. Further, effectiveness of a decision rests on the quality of the decision and its subsequent acceptance; the relationship can be described in the following way :

Effectiveness (E) = Quality (Q) × Acceptance (A)

In other words, a decision should not only be of high order but should also find high acceptance, if it were to be an effective one. Accurate information about relevant factors and their correct interpretation are absolutely necessary to arrive at sound decisions. The need and importance of obtaining measurements to guide decisions was stressed by A Sloan in twenties and reported in his 'My Years with General Motors'. He writes, "An essential aspect of our management philosophy is the factual approach to business judgment".

In the above context, OD is then concerned with the creation and maintenance of an organisational climate wherein participants can—

—produce valid and useful information especially about more important problems.

—make effective decisions.

—generate a high degree of human energy and commitment to their decisions in order to diligently monitor and effectively implement them.

The probability of generating valid information increases when

—values and attitudes of individuals are favourable.

—state of human collaboration is high.

—control and leadership process used produces high motivation.

—communication between hierarchical ranks is based on openness, trust and concern.

Causal, Intervening and End-Result Variables

The foregoing discussion highlights the importance of human processes in an organisation. Rensis Likert has identified three broad variables—causal, intervening and end-result—which are useful in understanding the human and organisational processes and effectiveness[4].

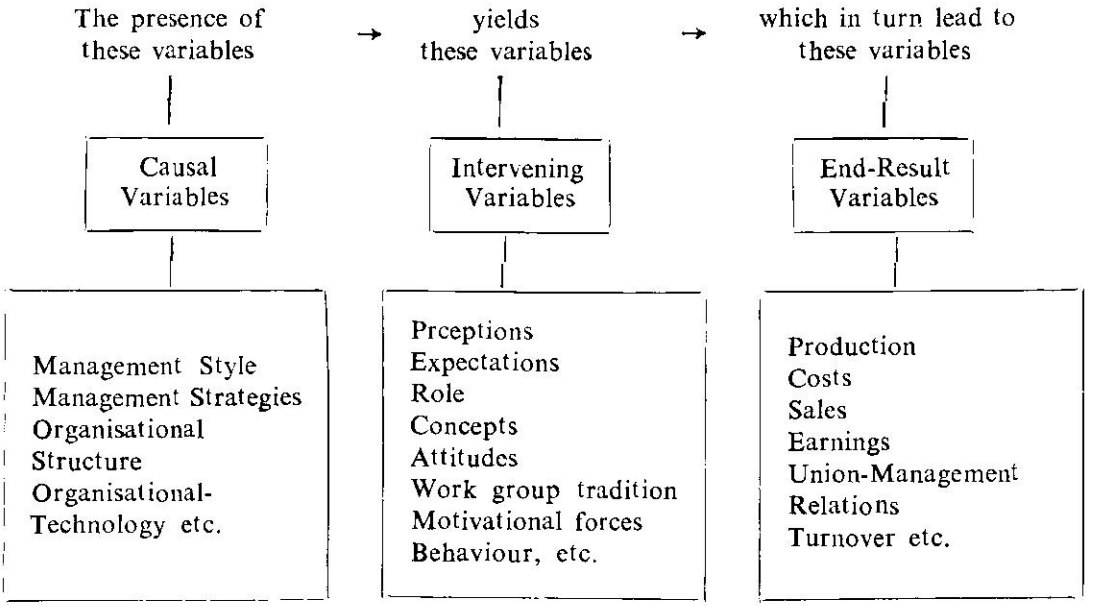
Causal Variables are those independent factors that influence the course of developments within an organisation and its accomplishments. These causal variables include only those independent variables which can be altered or changed by the organisation and its management. They include structure of the organisation, management styles, technology, management's policies, decisions, etc.

Intervening Variables reflect the internal state and current condition of the organisation, e.g., the loylties, attitudes, motivation, performance, goals, collaboration and capacity for effective decision-making, etc.

End-Result Variables are the dependent variables that reflect the achievement of the organisation such as its productivity, costs, earnings, etc.

4. Likert R, "The Human Organisation", McGraw-Hill (1969).

The inter-relationship among the above three variables is shown schematically below :



The level of the intervening variables are produced largely by the casual variables and in turn have influence upon the end-result variables. In any change process the management is essentially concerned with the output or end-result variables. Any attempt to improve the intervening variables by endeavouring to alter these variables directly will be much less successful usually than efforts directed towards modifying them through altering the causal variables. Similarly, changing the causal variables without considering their impact on the intervening variables is unlikely to produce the desired end-result. Every organisation can produce many such examples where change in causal variables failed to generate the desired output simply because either change in causal variables did not result in favourable intervening variables or the state of intervening variables ex isting at the time of change was not conducive for the change to take place. In other words, intervening variables are concerned with building and developing the organisation and OD, efforts aim at creating favourable intervening variables by making suitable intervention (causal variables), the final objective being to accomplish the desired end-result.

OD is Not Sensitivity Training

OD is often incorrectly equated with sensitivity or T-group training. Sensitivity training is basically an unstructured group experience which provides opportunity for the participants to expose their behaviour; give and receive feedback, experiment with new behaviour, and develop awareness and acceptance of self and others. T-group, when effective, provides individuals with the opportunity to learn the nature of effective group functioning.

By encouraging self-introspection and confrontation of behaviour problems surrounding tasks and relationships, OD can get people highly-motivated to change.

Sensitivity training is essentially a tool or intervention that is often employed towards directing organisational development. It has helped many executives and organisations. But it is not a panacea, nor is it a process that can help every organisation.

Equating sensitivity training with OD is like equating time study with industrial engineering or linear programming with operations research. As we all know, time study or linear programming are simply tools in industrial engineering or operations research, respectively; they, in no way, cover the entire range of activities covered by IE or OR.

OD Strategy

An important, yet difficult, question commonly raised by members of an organisation pertains to OD strategy. After being exposed to OD concepts, responsible managers are asking:

—How do we start OD in our Corporation?
—Is there any general plan of action for OD?
—Is OD really going to help us? and where shall we begin OD ?

It is not easy to tackle questions, such as these, especially when there still are not many studies of organisation development available to us. There is no ready prescription available as such which can be used to help an organisation. OD strategy depends upon a number of factors, such as, organisational health, existing management system, the type of internal and external pressures, the nature of industry, top management support and a host of others. In short, OD effort has to be tailor-made for each organisation. What is more important at this stage is to understand clearly the process of organisational change, especially in terms of approaches which lead to successful changes.

From the reported success of OD programmes, both within India and abroad, one factor which is emerging clearly is that OD effort succeeds best when the organisation, especially the top management, is under considerable external and internal pressures for improvement. Performance and morale are low, and top management seems to be groping for a solution to its problems. Larry Greiner[5] of Harvard Business School conducted a survey of 18 studies of organisational changes and identified several major patterns in studies reporting successful change. These patterns provide a good visibility for designing OD strategy.

Six Phases of OD Effort

Basically there are six phases involved in any OD effort. These are as follows :

(1) *Appointment of a Change Agent:*

First, there is a need to interact with a person, who is known for his ability to introduce changes. Such a person commonly referred to as 'change agent', enters the organisation either

5. Greiner L, "Patterns of Organisaton Change" in Organisation Change and Development, Delton Lawence and Greiner, Richard Irwin & Dersey (1970).

on a full-time or part-time basis, and deals directly with the head of the organisation.

(2) *Legitimising Role of Change Agent :*

Soon after the change agent has been appointed and he has interacted with the top management, role of the change agent, is clarified to all members of the organisation. Being a newcomer probably, allows him to make a relatively objective appraisal of the organisation; entering at the top gives him ready access to those people who make decisions affecting the entire organisation; and his being respected is likely to give added weight to his initial comments about the organisation.

(3) *Organisational Diagnosis :*

An initial act of the change agent is to encourage the re-examination of past practices and current problems within the organisation. At this stage, head of the organisation, departmental heads and other senior managers provide a supportive role and involvement in identification and diagnosis of current organisational problems. This process begins at the top, then moves gradually down through the organisational hierarchy.

(4) *Invention and Commitment :*

The change agent provides others with new ideas and methods for developing solution to problems at different levels of the organisation. Traditional practices and solutions within an organisation often maintain a hold that is difficult to shed. Thus the invention of new and unique solutions which have commitment seems necessary. Here, the emphasis is placed on the use of collaboration and participation in developing group solutions to the problems identified earlier.

(5) *Implementation :*

After the solutions have been developed, it is advisable to test their applicability on a small scale, wherever possible, before an attempt is made to widen the scope of change to larger problems and the entire organisation.

(6) *Feedback and Redesign :*

The change effort spreads with each success experience. A proper feed-back system is necessary to monitor or subsequently alter the earlier interventions. Positive results have a strong reinforcing effect.

Looking Ahead

OD is a comparatively new concept in India. Systematic OD effort has begun only since 1968. Some of the corporations where major OD work has been done are Kamani group of Industries, Hindustan Machine Tools, State Bank of India, TELCO, Indian Airlines and Hindustan Steel. The results, though encouraging, are still confined to a few cases. There is, however, a wide gap between present achievement and potential significance. OD can have a tremendous impact on the organisation system. By encouraging self-introspection and confrontation of behaviour problems surrounding tasks and relationships, OD can get people highly motivated to change.

We are living in an environment which is changing very fast. Organisations are no exception. Our managers must approach the problems of change from many different angles focussing on the cause and consequences of change in organisation's behaviour. Knowledge of behavioural sciences can be of great help in directing the rate, shape, and consequences of change. □

Environment and 'Optimal' Design of Organisations

Dr Pradip N Khandwalla*

Mr McGee, the TIMS president recently made the point that the idea of applying the management and the behavioral sciences to highly-complex phenomena is to find better solutions, not optimal solutions, for optimal solutions are either not feasible or they are not recognisable. It is much easier to design a better organisation than to design the best possible organisation. As Herb Simon once put it, the difference is one of finding a needle in a haystack versus finding the sharpest needle in a haystack. So, although the author is talking about "optimally" designed organisations, he is really talking about more effective organisations. By an effective organization, he means an organisation that achieves its primary objective to a highly-satisfactory degree, such as General Motors or Mrs Gandhi's Congress Party in India, or Harvard University.

FOR a long time, the area of organisational design was an area of aphorisms and good intentions. Systematic work began, when Weber[1] presented his ideal type of an organisation, namely the bureaucracy. After that, development was rapid. Sociologists discovered all kinds of dysfunctions of the bureaucratic model, and the human relations people pointed out what they called the informal organisation. People like Woodward[2] suggested that the technology used by the organisation powerfully affected its design, and people like Chandler,[3] Burns and Stalker,[4] and Lawrence and Lorsch[5] pointed to properties of the external environment—particularly the contingencies faced by the organisation—as another powerful influence on organisational design. Since technology as well as the external environment differ from organisation to organisation, it is widely accepted today except perhaps among hard core human relations people and principles of management people—that there is no single optimal design, that really there are a number of designs, each one effective in dealing with a particular set of techno-economic and socio-economic conditions.

Let me briefly outline the bill of fare. First, I should like to present a model of effective organisational design in the face of uncertainty, and spell out the testable predictions from this model. Next, I should like to present some data relevant to the predictions from the model in respect of two groups of firms, well-matched

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1. Weber, Max. The Theory of Social and Economic Organization. Henderson and Parsons (trans.) and T Parsons (ed.), New York : Glencoe, 1947.
2. Woodward, Joan. Management and Technology. London : Her Majesty's Stationery Office, 1958.
3. Chandler, Alfred. Strategy and Structure. Cambridge, Mass. : The M.I.T. Press, 1962.
4. Burns, T and Stalker, G.M. The Management of Innovation. London : Tavistock, 1961.
5. Lawrence, Paul and Lorsch, Jay. Organization and Its Environment. Boston : Harvard University Press, 1967.

except for a striking difference in profitability; and then conclude with some tantalising implications of the model and the data.

The Model

Several writers, such as Thompson[6] and Galbraith,[7] have remarked that uncertainty is the primary exigency modern organisations face. Earlier writers like Weber[8] totally ignored the question of uncertainty. But in this century social change has accelerated and so has technological change, and these two, along with competition for scarce material, labour, managerial and financial resources, has confronted organisations, particularly firms, with the difficulty of planning a course in a turbulent and complex social sea. After all, if your environment is turbulent, complex, and unpredictable, any kind of planning must take into account so many contingencies that planning becomes virtually impossible. We know only too well at McGill how difficult it is to plan ahead given the uncertainty of what our provincial grant will be even one year from now. So, the first order of business for an organisation is to reduce uncertainty somehow.

There are many ways of reducing uncertainty, so that decision-making can become rationalistic or even optimal in the light of the organisation's goals and constraints. For convenience, I have trichotomised them into "people" oriented devices, structural devices, and technocratic devices.

Under "people" oriented devices are included participative, consultative management. Here, decision makers consult with each other and share information with each other, to reduce uncertainty. Under structural devices are included such devices as backward and forward integration to achieve greater control over prices and supplies of factors of production and the offtake of the organisation's products and services. If we set up an organisation to place our graduates, then that would be an example of forward integration. If we pre-train our students in certain basic skills, such as in mathematics and statistics, as we do in MBA Programme, then that would be an example of backward integration. Under technocratic devices are included activities such as forecasting, research and development, market research, etc., that need fairly sophisticated staff to process and summarise the information coming in from the buzzing out there.

Let us summarize our arguments so far. Uncertainty makes organisational planning difficult, and so the organisation attempts to reduce uncertainty by such devices as consultative management, vertical integration, and staff activities like forecasting, research and development, and search for profitable opportunities.

What is the result of these activities and devices? There is certainly some reduction in uncertainty because more information is available about the environment or because its impact is slightly blunted through vertical integration. What happens in the main though is a reorganisation of perception on the part of the organisation. Instead of a great big blooming confusion, the decision-makers can now point out uncertainty about prices, or markets, or product obsolescence, or technical processes, or government policy, or the economy, etc. Uncertainty begins to get segmented for more local, more particular disposition. There is a

6. Thompson, JD. Organization in Action. New York: McGraw-Hill, 1967.
7. Galbraith, JK. The New Industrial State (2nd edition revised) Boston: Haughton Mifflin, 1971.
8. Weber, ibid.

sort of crystalisation of uncertainty into more negotiable, more manipulable blocks. No longer everything out there appears totally random, and therefore, unpredictable, or totally interrelated, and therefore unpredictable.

As Lawrence and Lorsch[9] have shown, a more differentiated perception of the environment leads to a more differentiated organisation. Every organisation of any size is differentiated to some extent through division of labour and specialisation. But uncertainty superimposes a more complex form of differentiation on this simple basic differentiation. Again for convenience, let us trichotomise this differentiation into "people" differentiation, structural differentiation, and technocratic differentiation.

Structurally, differentiated uncertainty is likely to lead to a certain amount of decentralisation in decision-making. As Thompson[10] has argued, when the task environment is highly variable or unpredictable, an organisation needs to adapt by monitoring the environment and planning appropriate responses, and this calls for localised units. So localisation or decentralisation of decision-making is one response. Another is likely to be departmentalisation. If substantial economies reside in specialisation by function, then the organisation will tend to get functionally departmentalised, so that each department, whether it be marketing, or finance, or manufacturing, adapts to its particular environment most efficaciously. On the other hand, specialisation by product line, or territory, or type of customer serviced may offer large economies, in which case, divisionalisation may be the appropriate form of departmentalisation. In other words, departmentalisation will be a response to the differentiated nature of the environment. Whether it will be functional or divisional will depend on where the economies of specialisation reside.

Structural differentiation will tend to reinforce differentiation in norms and values and interpersonal orientations that comes about through interacting with only a segment of the task envonment. For example, very different norms will tend to prevail in the marketing group as compared to the production group. The marketing group will tend to accentuate service and customer satisfaction, and may exhibit lot of informality, while the production group may be more concerned about quality, efficiency, rationalisation, and formal and structured relationships.

In terms of tools and technology, there is likely to be a proliferation of, and sometimes duplication of, staff information seeking and processing units. Every department is likely to vie with the other in building a staff empire.

To the extent that organisational units are interdependent, this organisational differentiation, involving differentiation in norms and values, decentralisation, departmentalisation, and the proliferation of technocratic units, is likely to create serious coordination problems, not to mention waste and duplication. Organisational sub-cultures develop that have difficulty in communicating with each other, or even sharing a common superordinate goal. We know only too well how difficult it sometimes is to communicate with our colleagues in operations research or finance or economics. Powerful conflicts are likely to develop. Decision-makers are, therefore, likely to feel a strong need to achieve greater coordination or integration.

Ordinary mechanisms of integration are hierarchy and standard operating procedures,

9. Lawrence and Lorsch, ibid.
10. Thompson, ibid.

used by practically every organisation. But complex differentiation will need to be offset by complex forms of integration. Attempts at complex integration can take many forms. "People" attempts include participative management, executive training and development, managerial grid type programmes, and deliberate attempts at creating a climate of mutual trust and collaboration.

Structural attempts may include the creation of crossfunctional linking pins or committees, *ad hoc* coordination groups, matrix organisation, etc.

Technocratic attempts may include the development of a sophisticated system of controls such as budgeting, inventory control, production scheduling, use of explicit financial criteria in evaluating capital budgeting projects, etc.

The model is outlined in Fig. 1. Uncertainty makes planning difficult. Therefore, the greater the perceived uncertainty, the greater the attempts at reducing it by devices such as consultative decision-making, vertical integration, and staff information seeking and processing services. Some reduction of uncertainty and its segmentation tends to differentiate the organisation in a complex way, leading to such phenomena as the development of organisational subcultures, decentralisation, departmentalisation, proliferation of staff services, etc. Organisational differentiation creates complex coordination and duplication problems. The organisation seeks to integrate its activities by such devices as participative decision-making, management development, grid type programmes designed to open up communications, committees, *ad hoc* groups and a matrix structure to improve coordination, and technocratic controls to integrate operations and improve efficiency.

The foregoing, is a model of the organisational evolution of effectively-managed organisations. For effectively-managed organisations, the model predicts the following hypothesis :

The greater the uncertainty and turbulance in the environment of an organisation, the greater will its attempts be to reduce this uncertainty, and the more differentiated as well as integrated it will get. As a corollary, it predicts that for effectively-managed organisations, the use of uncertainty reduction devices, differentiation, and integration will all be positively interrelated. In other words, organisations low in any of these three will also tend to be low in the other two, and those high in any one will also tend to be high in the other two.

What about non-effective organisations ? No specific prediction can be made, for there are infinite ways to botch up performance—ask any undergraduate! All we can say is that the relationships postulated for the set of effective organisations will (a) either not hold in part or in entirety ; or (b) if they do hold, they will be substantially weaker. What this means is that the non-effective organisation will either not adapt to its environment as the effective one does, or adapt only partially, or not show the relationships between its parts, that the effective organisation does.

Data

This writer would like now to present data which he got from about 80 American manufacturing firms[11]. The data was procured from the presidents of these firms by means of a questionnaire. The sample was selected in

11. The data collection was funded by the Graduate School of Industrial Administration, Carnegie-Mellon University.

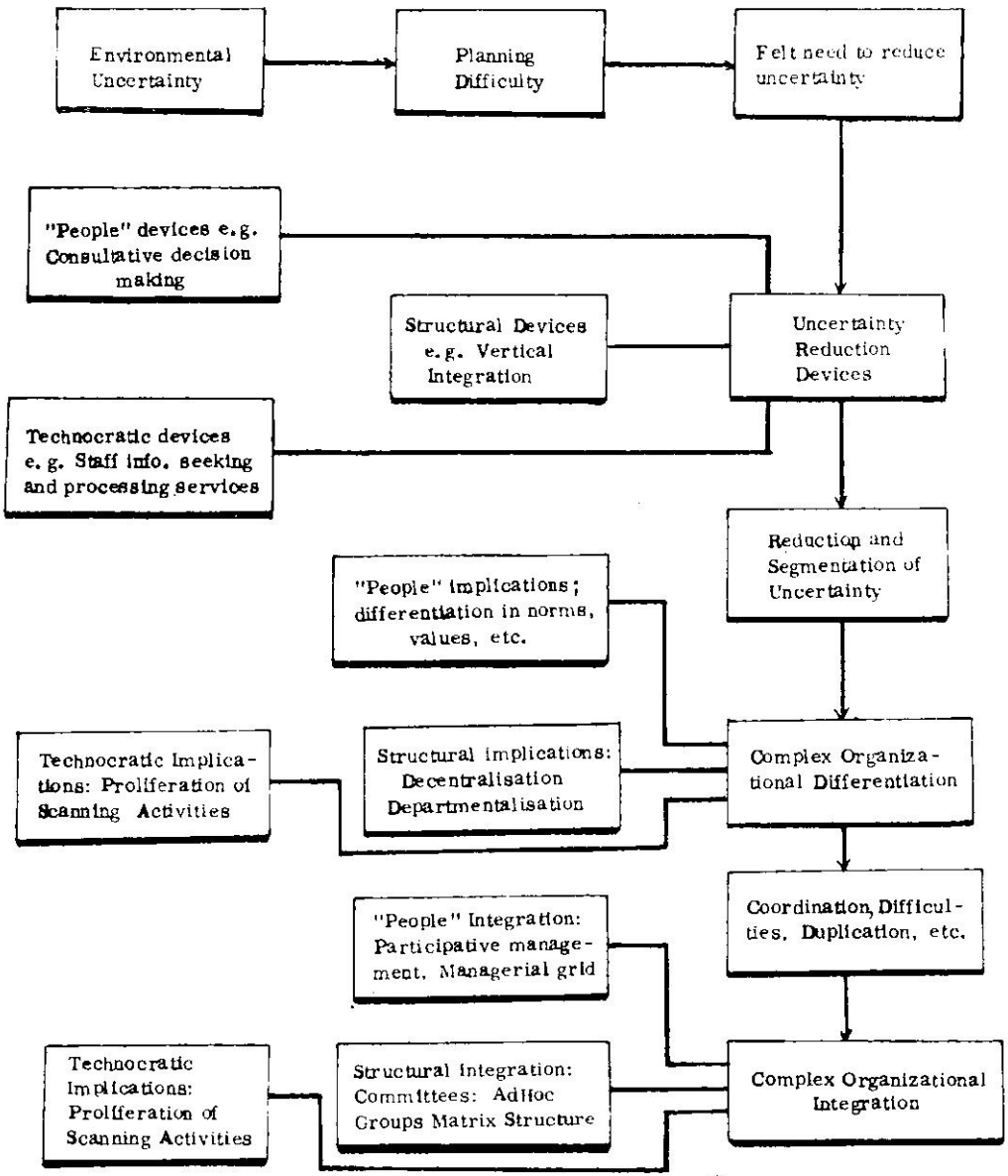

Fig. 1 : Model of Organisational Evolution of Effectively Managed Organisation

such a way as to reflect a wide variation in environmental conditions. First, pairs of industries were picked that were similar on a number of dimensions but differed significantly in one dimension like growth rate or labour productivity or R & D activity, etc. Then firms were randomly selected from each selected industry. About half the firms were manufacturers of consumer goods and half manufactured producer and capital goods.

The relational data is presented here on 10 variables, 2 environmental and 8 organisational. The two environmental uncertainty variables are competition in pricing, distribution, and product faced by the firm, and technological change resulting in new processes and products. With competition, the firm seldom knows what is coming next—whether it is a price cut, or a new promotion campaign, or the improvement of the current product, by its rivals. There is a similar uncertainty—and anxiety—about the new process that might make the present plant obsolete or the new product that might sound the death-knell of the present products, that is associated with technological change. These two are, therefore, obviously excellent aspects of uncertainty and environmental complexity faced by the manufacturing firms. The eight organisational variables include its profitability and the extent of participative management in top-level decision-making, vertical integration, staff services such as EDP, forecasting and research and development, delegation of authority by chief executive, divisionalisation, functional departmentalisation, and the usage of sophisticated controls.

The variables were operationalised as shown in Fig. 2. It also shows the results of the efforts at validating the variables.

Since the data base rested on the perceptions of a single-albeit focal-individual, it made sense to secure the perceptions of other specialist executives in the firm as a check on the validity of the president's perceptions. So, after the presidents returned their questionnaires, short questionnaires were sent to a marketing executive, a production executive, and the controller, of each participating firm. The three questionnaires contained questions called from the president's questionnaire but each questionnaire contained only those questions that seemed most appropriate to the particular executive's area of expertise. When the scores of the president and marketing executive for the two environmental variables were correlated the two correlations were found positive and significant at the 1% level for competition and less than 5% level for technological change. The ratings of the production executive for delegation of authority, participative management, staff services, and vertical integration were secured. The correlations for delegation of authority, staff services, and vertical integration were positive and significant at less than the 1% level, while the correlation for participative management was significant at the 7% level.

Finally, this writer got the controller to rate the extent to which the firm used several sophisticated management controls. There, the agreement was better than at the .1% level. All in all, the validation results were reasonably good, except for participative management, considering the exploratory and pioneering nature of the study. Six of the seven variables for which this kind of validation was attempted showed agreement at the 1% level or better. The validation effort was based on a response rate of between 35% and 40% of those firms for which the president had furnished information.

FIG. 2

Operationalisation of Variables and Their Validation

Variable	*Operationalisation*	*Source of Validation*	*Correlation Significant Level*
Uncertainty Variables			
Competition	President's rating of intensity times rating of importance to firm for each of price, distributive, and product competition aggregated.	Marketing executive	.01
Technological change	President's rating of rapidity of change times rating of importance for each of process and product technological change aggregated.	Marketing executive	.005
Uncertainty Reduction Variables			
Participative decision making	Average of president's ratings of extent of consultation by the responsible executive in each of several decision areas.	Production executive	.07
Vertical integration	President's ratings of extent to which firm was integrated forward and backward aggregatted and averaged.	Production executive	.005
Technocratic staff services	Average of president's ratings of the resources devoted to each of several staff services like R & D, EDP etc.	Production executive	.01
Delegation of authority by chief executive	Average of president's ratings of extent of delegation for each of several decision areas.	Production executive	.005
Divisionalization	President's rating of extent of divisionalization	Not done	
Functional departmentalisation	President's rating of extent of this.	Information about functions performed by senior executives in Dun and Bradstreet Directory	.005
Integration Variables			
Participative management	See above		
Sophisticated controls	Average of president's ratings of use of each of several controls.	Controller	Less than .001
Criterion Variable			
Profitability	Average of lowest and highest before tax rate of return on net worth during past five years reported by president.	Controller—the average of after tax returns on net worth for two recent years	Less than .001

FIG. 3

MEANS OF VARIABLES

Organisational Variables[1]	*Profitable firms* $n=38$	*Marginal firms* $n=41$
Delegation of authority by chief executive	3.1	3.3
Staff services	3.0	3.2
Use of sophisticated controls	3.8	4.0
Participative management at top	4.2	4.4
Extent of divisionalisation	2.3	2.3
Extent of functional departmentalisation	5.5	5.7
Extent of vertical integration	2.7	2.5
Firm size (based on a 7 point scale)	4.2	4.0
Profitability	28.9%	6.0%

[1]All of the above scores excepting for profitability and firm size are based on president's ratings on 7 point scales with 1 as minimum and 7 as maximum. For none of the pairs are the means significantly different except for profitability.

Environmental Variables[2]	*Profitable firms* $n=38$	*Marginal firms* $n=41$
Competition faced by firm	71.3	76.1
Price competition	28.0	29.7
Marketing competition	22.7	24.3
Product competition (based on president's ratings)	20.6	22.1
Technological change faced by firm	40.1	37.1
Process change	18.4	19.0
Product change (based on president's ratings)	21.7	18.0
Market concentration in firm's industry (based on a 7 point scale)	4.1	3.9
Growth rate of firm's industry (based on a 7-point scale)	4.9	4.3
Labor productivity in firm's industry (based on published data)	$7.9	$7.3

[2]For none of the above pairs do the means differ significantly.

Since this writer was interested in optimal design issues, he divided the sample into 2 parts. One consisted of 38 firms with profitability in excess of 12% on net worth, before taxes, and the other consisted of 41 firms with profitability less than or equal to 12%. The above 12% group turned out to have an average profitability of about 30% while the other group averaged about 6%. There is a considerable difference between the two groups in their profitability. Surprisingly, barring this striking difference in profitability, the two samples are quite similar. For example, about half the firms in each sample are consumer goods firms and half are producer and capital goods firms. What is more, about 90% of the firms in each sample are accounted for by the same industries. These common industries are canned foods industry, bread and related products industry, confectionery products industry, canned and bottled drinks industry, paints and varnishes, machinery, wool, sawmills, furniture, steel fabrications, and silica-based products industry. Also, as Fig. 3 shows, the means for all the variables except profitability are virtually identical. At least none of the means except for profitability are statistically significantly different. So, one gets the general impression of reasonably well matched groups of firms that differ principally in their profitability.

This impression is, however, grossly misleading. If one looks at the correlations between the environmental variables and the organisational variables, and at the correlations among the organisational variables, one is struck by the tremendous differences. The correlations for the profitable group generally support the model outlined earlier; those for the marginal group do not. Let us take a closer look at these differences.

Take a look at Fig. 4. It shows the correlations of competition and technological change with organizational variables. For each row, the upper figure is the correlation for the group of 38 firms whose profitability exceeded 12%, and the lower figure is for the 41 marginal firms.

Let us first review the results for competition. Figure 4 reveals sharp differences in the correlations for the two groups of firms. For the profitable group, the correlations of competition with the uncertainty reduction, differentiation, as well as integration variables are not only all positive as we would expect but for the most part sizeable. Looking at the pattern of correlations, one would speculate that an effective organisational strategy to cope with the uncertainty created by competition is to try and reduce it by participative management and vertical integration, differentiate the organisation by decentralizing authority along functional lines, and integrate the onganisation primarily through participative management. The relatively lower correlations of competition with technocratic devices like staff services and sophisticated internal controls suggests that a technocratic approach to uncertainty reduction, differentiation, and integration may not be as effective as a people-oriented and structural approach in coping with the shifting, short-term but intense disruptions that competition wreaks. The emphasis in such an environment is likely to be on the short run and on great flexibility. In such an environment long-term staff forecasting and other services may have marginal use, and a sophisticated control system may make the organisation more rigid than it should be.

FIG. 4

CORRELATIONS OF UNCERTAINTY VARIABLES WITH ORGANISATIONAL VARIABLES

	Competition	*Technological Change*
Uncertainty reduction variables		
Participative management	.39**	.10
	—.15	.15
Vertical integration	.33*	.06
	.16	.21
Staff services	.20	.39**
	—.14	—.04
Differentiation variables		
Decentralisation	.37**	.28*
	.06	.01
Divisionalisation	.22	.38**
	.03	.15
Functional Departmentalisation	.27*	—.08
	—.08	—.22
Integration variables		
Participative management	.39**	.01
	—.15	.15
Use of sophisticated controls	.24	.35*
	.36**	.43**

Note : For each row, the upper figures represent the correlations for the profitable group and the lower figures the correlations for the marginal group.

* Significant at the 5% level (one tail)

** Significant at the 1% level (one tail)

Correlation of Technical Change

Let us now review the correlations of technological change with the three sets of organisa-

tional variables. Technological change is another major source of uncertainty for manufacturing firms. The pattern of correlations is somewhat different from that for competition, although, like competition, cost correlations for the profitable group are positive. If we look at the correlations of technological change with uncertainty reduction, differentiation, and integration variables, the following organisation strategy seems to characterise the profitable firms' response to technological change: reduce uncertainty by staff services like forecasting and research and development; differentiate the organization by decentralisation and divisionalisation; and integrate it by means of a sophisticated control system. The strategy makes sense. You have got to have sophisticated staff services to monitor a technologically-dynamic and complex environment. Since the information from the technological environment is highly complex and technical, it is best processed by expert subordinates of the chief executive and by divisional units that can dig deeper in each unfolding area. With decentralisation and with each division dealing with its own territory, a sophisticated control system avoids waste and imposes a financial discipline on the divisions. With technological change, vertical integration does not make sense because it cannot ward off technological change. With skill obsolescence accompanying technological change, functional departmentalisation does not make much sense either. So structural responses to technological change tend to be inadequate, except for some form of decentralisation. But why not consultative management ? It seems to me that when decision-making is based primarily on technical expertise, one would tend to have a very mixed pattern. The expert may consult others when he feels that in a particular situation his expertise is limited, but will not consult others, when his expertise is preceived to be adequate. Also, situations of interdependency are rare because technological change, unlike competition, is not a matter of daily crisis. This may account for the sharp difference between the two in relation to participative management.

Although there are some notable differences between the correlations of the two uncertainty variables with the organisational variables, it is fair to say that on the whole the correlations are consistent with the assertion that the greater the environmental uncertainty the more the effective organisation strives to use uncertainty reduction, differentiation, and integration mechanisms — to a noticeably greater degree than the marginal organisation.

If you hark back to the model developed earlier, it implies that uncertainty reduction variables, differentiation variables, and integration variables all move in tandem for effectively-managed organisations, so that we should expect them to be positively intercorrelated. Fig. 5 shows that this is very much so, particularly for the profitable group of firms. It will be found that of the 24 significant relationships among organisational variables, 10 are unique to the profitable group as against only 2 to the marginal group. Both groups share 6 relationships. A high degree of positive intercorrelation among organisation variables suggests that depending upon the demands of the environment, a highly-centralised outfit may be as effectively designed as a decentralised outfit provided that the former does not invest very much in controls, staff services, and vertical integration, as the decentralised unit does. Apparently, it is the way the variables hang together—and isn't this the essence of design ?—that really matters, not decentralisation or participative management or a sophisticated control and information system by itself. In the lan-

FIG. 5

Intercorrelations of Organizational Variables

Uncertainty reduction variables	2	3	4	5	6	7
1. Top level participative management	.38**	.43**	.54**	.51**	.18	.55**
	.00	.00	.05	.18	—.24	—.16
2. Vertical integration		.43**	.55**	.28*	.36*	.22
		.20	.31*	—.01	—.09	.33*
3. Staff services			.56**	.57**	.07	.34*
			.51**	.32*	—.07	.30*
Differentiation variables						
4. Delegation of authority by chief executive				.41**	.27*	.57**
				.27*	—.12	.39**
5. Divisionalisation					—.22	.43**
					—.81**	.20
6. Functional departmentalisation						.16
						—.07
Integration Variables						
7. Use of sophisticated controls						
8. Top level participative management						

Note : For each row, the upper figures are the correlations for the profitable group, the lower for the marginal group of firms. For the profitable group 16 out of the total of 21 correlations are statistically significant; for the marginal group, 8.

* Significant at the .05 level (one tail)

** Significant at the .01 level (one tail)

guage of economics, these variables are not primarily substitute factors but complementary factors of production.

If positive intercorrelation is a necessary condition for optimality in design, then the variance of the firm's scores on these variables should have a negative correlation with profitability. In other words, a high intercorrelation for a group of firms translates into low variance for each member of the group. This turns out to be true. For the whole sample of 79 firms, the correlation of variance of the firm's scores on these variables and profitability is—.30, significant at the .005 level.

Summing Up

Let me sum up by tentatively answering a few questions in organisational design. Is there a single best design or are there many? If there are many optimal designs, which pattern is optimal in what circumstances? How important is organisational design any way? It should be clear what my beliefs are with

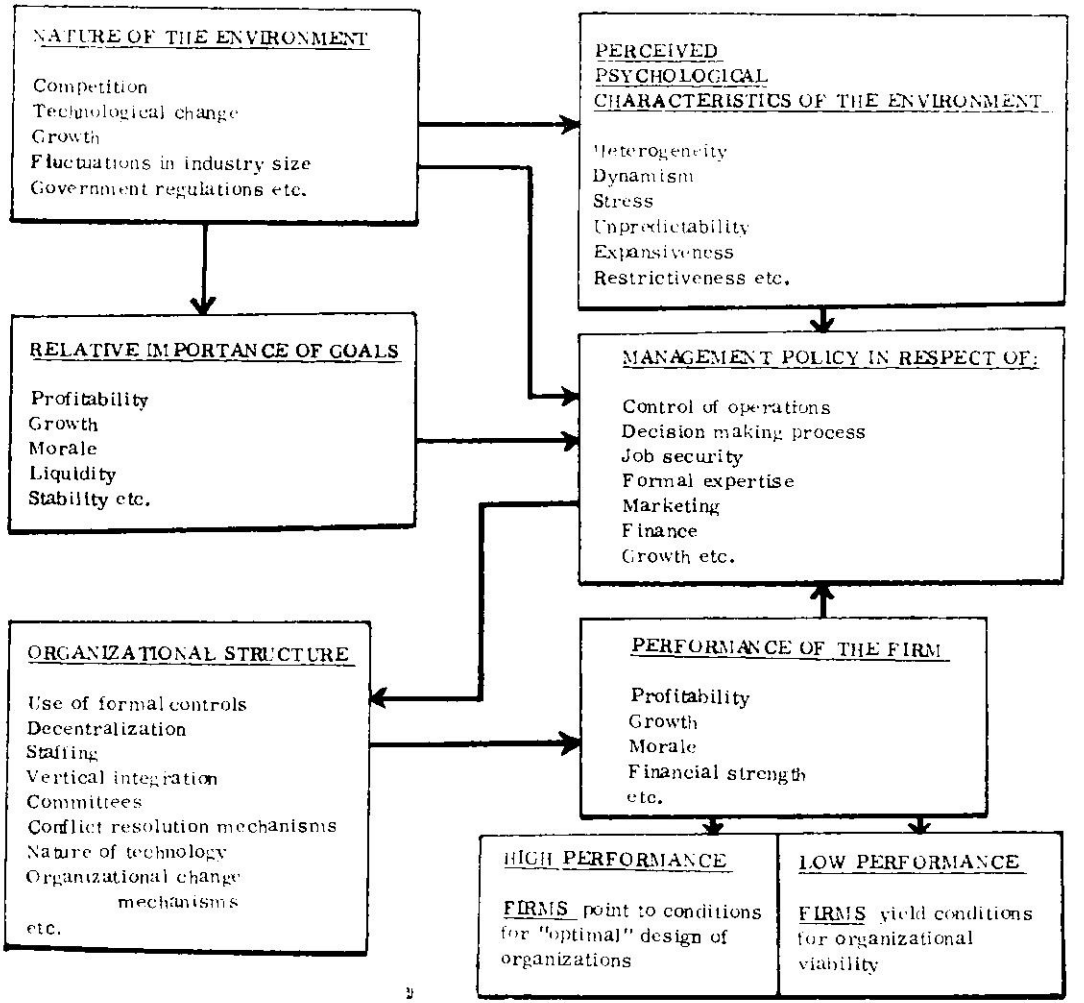

Fig. 6 : Conceptual Framework to Guide the Empirical Work

regard to the first question. My work as well as the work of Lawrence and Lorsch[12] and Morse[13] suggests that there are likely to be many good designs. Which pattern is optimal in what circumstances? My work suggests that that is determined by the extent of uncertainty an organisation faces—generally speaking, the greater the uncertainty it faces, the more uncertainty reduction, differentiation, and integration devices it uses. The form of uncertainty may crucially determine the type of device used, however. How important is designing the organization? My data suggest that it is im-

12. Lawrence and Lorsch, ibid.
13. Morse, John. "Organizational Characteristics and Individual Motivation" in Lorsch and Lawrence, Studies in Organization Design. Homewood. Ill. : Irwin-Dorsey, 1970.

portant, probably more so than the use in isolation of any one of the popular management tools like decentralisation, participative management, or a sophisticated control and information system. Indeed, there is a discernible synergistic effect when these tools are put together in gestalts that make sense given the firm's task environment.

I should like to conclude by outlinig briefly my current research efforts in this area. I am gathering interview and survey data on a large sample of Canadian firms. The sample consists of manufacturing as well as non-manufacturing firms. I am trying to explore relationships between several dimensions of the firm's environment and its goals and its corporate philosophy in different functional areas like marketing, finance, personnel, administration, operations, capital budgeting, etc. In addition, I am trying to seek relationships between goals, environment, corporate philosophy or policies on the one hand, and the firm's organisational structure, its operations, and its performance on various goals. Fig. 6 indicates the scope of this effort. I expect some very intriguing findings to emerge, of interest to the theoretician as well as the practitioner. Hopefully, these findings will be relevant not only to the field of organisational behaviour but to the field of policy as well. Slowly the architecture of complexity—of the organisation as of the atom, the cell, society, and the universe itself—is becoming clearer. It is exciting to be making a humble contribution to the unveiling of so basic an element of our life. □

STRUCTURAL CHANGES FORECAST

Management expert Peter Drucker feels that management is undergoing a major structural change, but he insists the company hierarchy will never be entirely replaced by unfettered corporate democracy. The hierarchical system will survive because "the subordinate needs it," Drucker asserted on a recent tour of the U.K. "The main purpose of the hierarchy is to protect the subordinate. He knows where he stands, where he belongs and what his job is."

Subordinates, adds Drucker, "need a little clarity, a little certainty, a little predictability. Totally free democratic forms are totally uncertain, unpredictable and they create horrible anxieties."

Druckes contends that there will be the need for an ultimate authority to give the final say in an organization. However, he believes comapnies will increasingly adopt more flexible variations of the rigid pyramid type structure which predominates today.

"The idea that there is only one form of organization will disappear," says Drucker. "We wil have pluralist organizations. We are already acquiring great freedom in using different, allied principles together."

—*Management News*, **July 1972**

Common Pitfalls in Project Management

K Chandramouli*

Project, according to the author, means an industrial project started with the main objective of setting up an industry. The thought process, planning, execution and coordination of activities involved prior to the starting of production all come under the project stage, while meeting the production targets, cost targets, and achieving other objectives of a running organisation come under the operations stage. This distinction between the two stages is very essential because of the outward differences in the management of affairs in the two stages.

AN ideal Project Management should build up the basic infrastructure with which the production can be started, stepped up and diversified in stages; the management policies and philosophies can be injected, inculcated and spread out amongst the employees so that they can get the feeling of identity with the organisation; the industrial community can be developed in such a way as to accelerate the advancement of the community around. Overemphasis on the first aspect of setting up a production unit often overshadows the other equally important aspects, thereby building a poor infrastructure which will have to be corrected at a later stage at huge extra costs and lot of unnecessary botheration. Also some of the problems created initially might remain as pinpricks for the management for ever. Thus building up of a proper infrastructure for economic and social growth should be the prime concern of any ideal Project Management.

Construction projects in India, especially under the public sector have a tendency to drag on endlessly with the estimated investment soaring up with every delay and set-back in the execution of the project. The techniques and the outlook adopted by the project management have a great bearing on the start-up schedule and efficient set-up of the operating organisation. These techniques have to be modern and, if necessary, sophisticated not only to see that the project construction is completed within the stipulated time and budget but also to see that the solutions offered to the problems encountered are considered from the long-term point of view. More often the immediate solutions to problems faced by Project Management have the narrow view of tiding over the immediate problem and such solutions lead to long-term repercussions on the running plant long after the construction is completed and the plant is commissioned. There are many problems which are common to most of the projects and even the solutions to these problems have identical mistakes repeated time and again. A survey of the common problems and solutions reveals that these usual pitfalls could be normally avoided with a good amount of fore-

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thought. These problems which Project Management generally faces can be classified under three categories—

(a) Problems needing immediate attention, so that the work of the project is not hampered or delayed. For such problems the usual pitfall solution is in patching up the situation, which will later on lead to more serious problems.

(b) Problems that are neglected as they do not affect the immediate construction work on hand.

(c) Problems which force the Project Management to take wrong decisions knowingly because of the prevailing circumstances.

These types of probiems are briefly discussed here in an attempt to bring to light the usual pitfalls in the Project Management.

Site Selection

The problem of site selection has been made very much complicated with the addition of a number of intangible political factors to the list of tangible economic and scientific factors that are considered in any analysis for site selection. Factors such as political motives, regional development, development of backward areas, balanced growth, etc. have more often counterbalanced the other sanguine factors like proximity to ore, raw materials and other facilities, proximity to the market, etc. However some of the usually forgotten factors are : necessity of good transport and communication system, proximity to city with amenities like banks, schools, hospitals and recreation centres, and also a nearby source for the disposal of waste and effluents.

Land Acquisition and Rehabilitation

Land acquisition is, perhaps, one of the most irksome of the hurdles to the initial enthusiasm of the jubiliant entrepreneurs. It can continue to be as irksome and troublesome for a long time to come for the organisation if proper care is not taken in the beginning to acquire the necessary land and also to rehabilitate the people who are thus displaced from their land. The trouble starts with the thinking of many modern managements that all their responsibilities are over with the transfer of land in their favour in exchange of money. Though legally this might be correct, the moral responsibility begins only at this stage. The poor uneducated farmer is coerced or tempted into parting with his piece of land and in the present Indian context this itself is a great blow to the farmer. The money paid in return for the land gets exhausted even before the uneducated farmer can judicially think of any fruitful investment. Also, Indian farmer without basic education or any special skill in other fields, does not like to take up other alternative employment for his living. Therefore, the most common results of large scale land acquisitions by big corporate bodies are: (i) big areas of cultivable land will not be available for farm produce and (ii) the displaced farmers and dependents increase the number of unproductive mouths to be fed by the country on the whole. It is imperative that the corporate bodies together with the Government concerned should consider it as their moral obligation to suitably compensate the farmers, not with hard ready cash, but with alternative land for cultivation. Some of the important points to be borne in mind by Project Management during the land acquisitions are :

(i) Maintain close liaison and full co-operation with the State Government.

(ii) As far as possible avoid sites with large areas of agricultural land.

(iii) Adopt a suitable rehabilitation policy for the farmers selling land to the corporate body. Give them alternative land and cash instead of cash only.

(iv) Never give false promise of employment in the organisation unless sure of the category of people available to suit your requirements.

(v) While acquiring land take into consideration the future expansions and other needs.

Network Techniques and Resources Allocation

Network techniques like PERT (PROGRAMME EVALUATION & REVIEW TECHNIQUE) and CPM (CRITICAL PATH METHOD) have become quite common and useful tools for project planning, scheduling and resource allocation. It is a pity that when the developed countries use these techniques from house building to satellite launching, India should lag behind so much as to be mostly ignorant of these techniques. Among the many advantages claimed by these techniques, the following few are important in the Indian context :

(i) The techniques highlight the most important of the wide range of the activities of the Project. The project completion as per the estimated time schedule can be achieved by exercising control over these few important or critical activities.

(ii) Resources—men, material and money—can be allocated in a way that the excesses and shortfalls in the various activities are smoothened out and the overall budget estimates are adhered to as far as possible. These two maladies—overshooting of time and budget being the major ones in the projects of our country, every effort should be made to apply and make use of the above techniques to the best possible extent.

Network techniques like PERT and CPM are now accepted as very useful tools for project planning, scheduling and resource allocation.

Materials Management

Materials Management is as important an aspect as the management of men, machines and money. The main objective of Materials Management is to bring the overall material costs under control by improving the methods of acquisition, movement, inventorying and handling of materials. To achieve this, Materials Management combines all the functions connected with materials and develops a close relationship with the activities of purchasing, handling and inventorying of the materials. However, Indian entrepreneurs have not yet fully recognised the importance of this new concept and have mostly accepted the conventional type of organisations with separate responsible units for the various activities.

Materials Management has a major role to play from the project construction stage itself. Among the many advantages claimed, it can

Materials Management has a major role to play from the project construction stage itself; it can help organise various activities systematically and reduce large-scale inventories.

help organise these activities systematically and reduce large scale inventories in three stages:

(i) MM working in close liaison with Designs can help in standardisation of the equipment selected. It can be of specific advantage in deciding the plant layout, handling methods and equipment. The type, make, specifications, etc., can well be scrutinised from an overall approach and necessary adjustments can be made to avoid a number of varieties which later on call for more spares inventory and other maintenance problems. Standardisation of motors, couplings, reduction units, V belts, pumps, compressor units, handling equipment, etc. are some of the items wherein easy standardisation is possible.

(ii) Project ordering for equipment usually covers 10% of the equipment value for the spares of the equipment also. This initial 10% value of spares generally result in a huge blockage of unwanted inventory. MM working in close liaison with Project ordering section can help in selective purchase of spares so that unwanted and high value security or insurance spares do not block the capital.

(iii) Long-range planning and procurement policies for raw materials and other supplies initiated at the project construction stage can help in keeping down the inventory value to a minimum.

Manpower Planning

A number of examples are often quoted about faulty manpower planning in Indian Industries, particularly in the Public Sector. Every example adds to the general belief that the public sector is only an agency to provide mass employment at the cost of efficiency, productivity and profitability. Outstanding examples of excess manpower in industries draw comparison not only from industries in other advanced countries but also from industries within the country in private sector. For example, the employee strength in Bhilai Steel Plant is reported to be thrice the estimated strength; Durgapur Steel Plant is reported to be employing 22,000 against an assessment of 10,000 only. In general, a one million tonne capacity steel plant in India employs about 31000 employees against the desired level of 7000-10000 employees. LIC is reported to be overstaffed by as much as 30%. One can cite other examples of overemployment and faulty manpower planning in the industries. But very few seem to realise the ill effects of these on the manpower productivity of the industry. Far less is the realisation that every unproductive employee—either unemployed or employed unnecessarily (disguised unemployment)—has to be fed from the public money to which his own contribution is nil. The arguments for employing more men to covercome the problem of unemployment and curbing all attempts at modernisation and automation are misplaced and shortsighted. The problem should be viewed from the long-range point and the rate of

modernisation should be adjusted to match with the process of industrialisation in order to avoid such conflicts which are common in developing countries.

Indian engineers and management experts can fall back on the experience of quite a few projects in the past 20 years and should try to rectify the mistakes by careful manpower planning and successful implementation of the planned projects from very beginning. Manpower could be planned from past experience, survey and study of similar industries. It should be clear that manpower requirement during project will be fluctuating and will be usually more than that required for operating the plant. Failure to recognise this fact has often led to excess manpower which can neither be disposed off nor justified in terms of productivity. Hence, recruitment at the project stage should be done with a thorough background knowledge of the manpower planning and the organisation chart of the running plant and a majority of the people recruited should be on time-bound contracts.

Recruitment, Training and Placement

The hue and cry of "Jobs for the Sons of the Soil" and similar other slogans are the direct outcome of the irresponsible recruitment policies followed in many of the projects. It has been widely known that in many projects the local people were entirely neglected and undue preference was given to people from particular outside states, creating a large scale ill-feeling among the local people. It is only natural that the people of the State also wish to get employment in the projects started in their own State irrespective of whether the project is a Central or a State Government one. If even employment is not assured, what then is the material benefit to the people of the region if mostly outsiders are employed, bulk of the revenue goes to the Centre, job contracts and project contracts are politically motivated, and ancilliary and small scale industries of the region are not benefited in any way ? In order to obviate such problems it should be made obligatory for every new industry to lay down a policy for recruitment in line with the Government policy and duly approved by the State Government. The publication of such an approved recruitment policy clears the misunderstandings of the general public, forces the new industries to follow a fair and uniform policy in encouraging the local people, and offers a control or check point for the Labour Department on the actions of defaulty industries.

Recruitment at the project stage should be done with a thorough background knowledge of the manpower planning and the organisation chart of the running plant.

Every project should have a good training scheme before placing the employee in the cadre to which he suits. The following are some of the important points to be remembered while framing the recuruitment policy:

(i) Manpower planning should be started well in advance of the project construction, at least 2 years in advance.

(ii) Recruitment policy should be laid down clearly and in all possible details at least a year in advance.

Manpower planning should be started well in advance of the project construction and every project should have a good training scheme before placing the employee to the cadre most suited to him.

(iii) Interviews, selection and recruitment should be started at least 6 months in advance for staff and at least 2 months in advance for the workers.

(iv) Certificates of date of birth and qualification should be checked thoroughly and all the persons should be checked medically in detail before employment. It has been found that many of the personnel problems later on crop up because of the incorrect information or person being found medically unfit.

(v) All the skilled, semi-skilled workers and junior supervisory staff should be theoretically trained for 3-6 months depending on their previous experience. They could also get on-the-job experience by working with the construction gangs of the contractor for a short period.

(vi) Training for lower and middle management should necessarily include company information, information about the industry, management aspects, management-labour relations, safety aspects, etc.

Construction Stage

A number of problems come up when the planning has to be executed during the construction phase of the project due to the gaps between theory and practice, between visualisation and implementation and between the estimates and actuals. Some of these problems if not tackled properly in time by the Project Management, will result in long time repercussions. It is neither possible to consider all such problems nor to delve into details of such problems. Hence, only a few of the important points which should be taken care of, are briefly dealt here.

(i) A senior person or a batch of persons who will be responsible for running the plant should be involved in Project Management right from the design stage.

(ii) Experience shows that most of the projects overshoot time and cost estimates. One of the main reasons for exceeding cost estimates is the lack of importance paid to Financial Management of the project. It is necessary to have a strong team of financial controllers headed by the Chief of Project Finance who is given a good status and authority in the project.

(iii) There should be enough leeway for minor site changes in the design or drawings so that the work is not hampered unnecessarily. Also, a separate gang should take care of the modifications and changes to the equipment or constructional details after the plant goes into operation.

(iv) Temporary new constructions for permanent facilities like temporary stores, canteen, office buildings, etc. should be avoided as far as possible. Such temporary constructions increase the cost

of the Project and leave a cluster of poorly-planned construction sheds in the final stage.

(v) All contracts for construction should include a separate penalty and bonus clause for the delay or early completion.

(vi) As far as possible the procurement of labour through contractors should be avoided. Labour through the contractor costs more and quality is not assured and further complications are likely to arise.

Policies and Practices

The policies and practices initiated by Project Management have a great impact on the running organisation. Also, since the policies and practices should not be changed too frequently it is desirable that the Project Management sets up its policies and practices with the long range views in mind. All loose practices should be avoided and clear standard practices should be set up for administrative purposes at the beginning of the Project construction. A capable administrator who is sure of the Company's objectives, philosophy and principles could help in setting up uniform and realistic policies to be followed.

Public Relations and Social Activities

Proper image building of the Company and its activities is as important as the efficient working of the Company. In this regard it is essential to develop good public relations and to enter into certain social activities which would enhance the prestige of the Company and its usefulness to the community, Perhaps the first important step in this direction would be to keep the State Government and other information bureaus fully informed of the various matters of general interest. Taking active part in community and social life and in case of projects built around small villages, involving the ladies in community and welfare services, are some of the other steps in this direction. However, every care is to be taken to avoid getting into local politics that would finally involve the Company in partisan attitudes. Adopting a village and giving all facilities for the allround development of the village is a novel but an extremely interesting idea which the Companies should be encouraged to follow. If the community around has a tradition of its own, it would be worthwhile encouraging the spread of the tradition in a healthy way.

The above points deal very briefly with a few of the common faults which have been repeated in many of the construction projects in India. It is sincerely believed that these common pitfalls could be avoided by taking necessary precautions at the starting of the project work. However, it should be noted that the above points are neither exhaustive nor complete in all respects. The present effort aims at listing out the significant points to be taken care of by a good Project Management. □

Walls are dangerous companions. They may occasionally protect from outside evil and keep out an unwelcome intruder. But they also make you a prisoner and a slave, and you purchase your socalled purity and immunity at the cost of freedom. And the most terrible of walls are the walls that grow up in the mind which prevent you from discarding an evil tradition simply because it is old, and from accepting a new thought because it is novel.

—JAWAHARLAL NEHRU

Differential Equation Approach to Sales in Response to Advertising Behaviour in Different Market Conditions

Kanti Swarup*

The paper deals with the effect of advertisement behaviour on sales in different market conditions. Differential equation approach has been used to study the relation among rate of sales, advertising, independent variable time, marketing levels and other parameters. Several basic types of market are analysed to measure their effect on sales. A comparative study is given for simple cases.

IN their paper [1, 5] Vidale and Wolfe presented the results of studies for major industrial concerns on the sales response to advertising. A simple mathematical model of the interaction of advertising and sales consistent with the outcomes of controlled experiments performed on a large number of products and several media, was formulated. This model served the useful purpose of evaluating the effectiveness of an advertising campaign and it also provided the relationship among the parameters, viz., (i) Sales Decay Constant (ii) Saturation Level (iii) Response Constant, the Independent Variable Time, Advertising and Rate of Sales. A mathematical model of sales response to advertising based on these parameters was considered as :

$$\frac{ds}{dt}=\gamma A(t)\frac{M(t)-S}{M(t)}-\lambda S \qquad (1)$$

where

S(t)=the rate of sales at time t

γ=the response per advertising dollar when sales are zero.

A (t)=rate of advertising

γ=the sales decay constant, which is defined as the rate at which sales of the product decrease in the absence of advertising.

M(t)=the saturation level of sales for the product which is defined as the partial limit of sales that can be captured by that product.

Solution of equation (1) for the constant rate $A=A_0$ of advertising expenditure maintained for time T and for fixed saturation level $M=M_0$ is as :

$$S(t)=\frac{M_0}{1+\frac{\lambda}{\gamma}\frac{M_0}{A_0}}\left[1-e^{-\left(\frac{\gamma A_0}{M_0}+\lambda\right)t}\right]+S_0e^{-\left(\frac{\gamma A_0}{M_0}+\lambda\right)t}-(t<T) \qquad (2)$$

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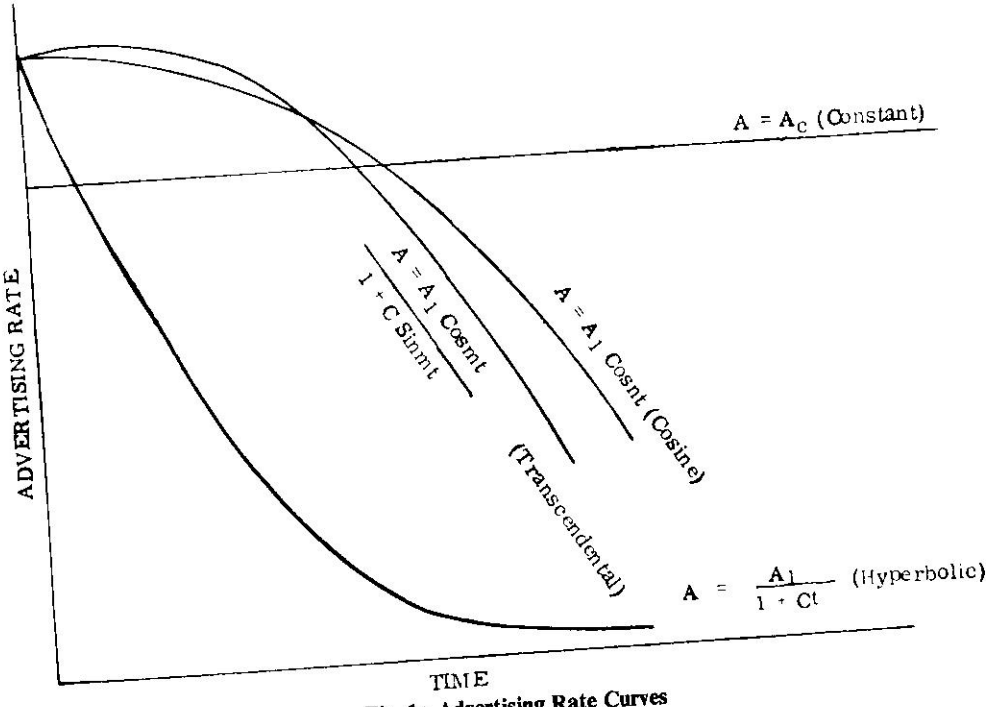

Fig. 1: Advertising Rate Curves

After advertising has stopped $(t>T)$

$$S(t)=S(T)e^{-\lambda(t-T)} \qquad (t>T) \quad (3)$$

where S_0=sales at $t=0$.

Many advertising campaigns are short and very intense. From (2) an expression for a single-pulse campaign of negligible duration is derived as

$$S(t)=M_0e^{-\lambda t}-(M_0-S_0)e^{-\left(\frac{\gamma a}{M_0}+\lambda t\right)} \quad (4)$$

where a=total expenditure spent for time T. The total additional sales generated by this campaign

$$\int_0^\infty [S(0)-S_0]e^{-\lambda t}dt=\frac{M_0-S_0}{\lambda}\left(1-e^{\frac{-\gamma a}{M_0}}\right)$$

$$=\frac{M_0-S_0}{\lambda}\cdot\frac{\gamma a}{M_0} \quad (5)$$

for sales well below saturation.

Gupta[2] explored the differential equation approach to study the relation between sales and other marketing variables such as price, advertising and distribution. Mathematical model representing relation between sales and advertising is as :

$$\frac{ds}{dA}=\varphi(M_0-S) \qquad (6)$$

where $\varphi(M_0-S)$ is some function of the untapped market potential (M_0-S).

Advertising and Market Behaviour

It is observed that advertising behaviour is governed by market conditions, by competing advertising and other external factors. Therefore, it is desirable to represent advertising as function of time. For advertising rate fo

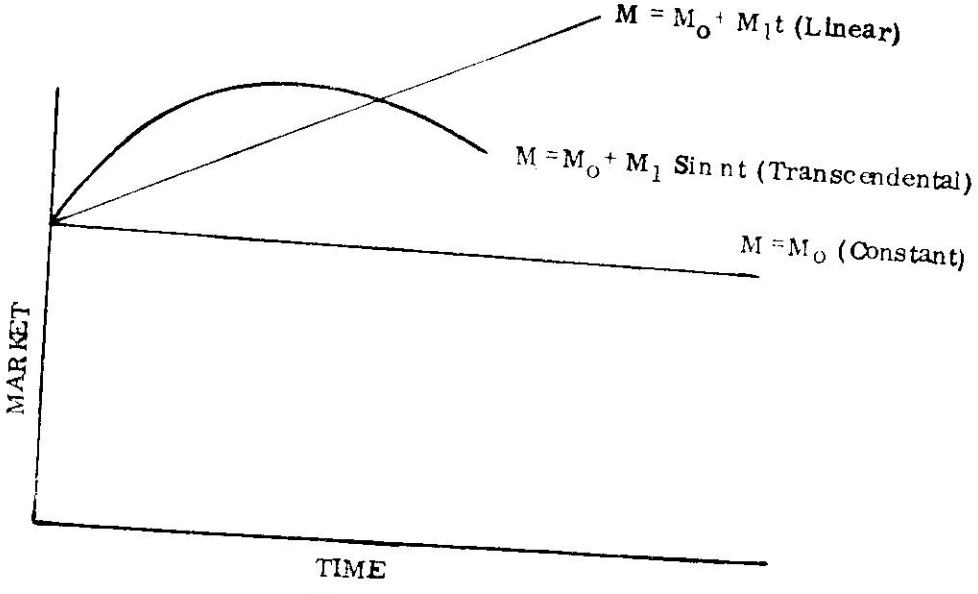

Fig. 2: Market Growth Curves

types of functions have been taken, keeping in ew the results derived from (1).

(a) $A = A_0$ (constant)

(b) $A = \frac{A_1}{1 + ct}$ (Hyperbolic)

(c) $A = \frac{A_1 \cos mt}{1 + c \sin mt}$ (transcendental) $\left((mt \leq \frac{\pi}{2})\right)$

(d) $A = A_1 \cos nt$ (cosine) $(nt \leq \frac{\pi}{2})$

Table 1 (parameter characteristics)

Market	Advertising rate	Other constant parameters
Constant	Constant	Sales decay
Linear	Hyperbolic	Response
Transcendental	Transcendental	—
—	Cosine	—

Experiments had also shown that M is altered by changes in market conditions by competing advertising and by the introduction of new products. The market characteristics have an important bearing on the outcome of any market penetration process. Thus it is necessary to predict the market as a function of time. There are many forms of market growth curves depending on the product, economic, political and social environment. Three types of market growth curves are of much interest[4] (i) constant (ii) linear, and (iii) transcendental.

These growth curves can be given as :

(a) $M=M_0$ (constant)

(b) $M=M_0+M_1t$ (Linear)

(c) $M=M_0+M_1\text{Sin } nt$ (Transcendental).

The complete problem is discussed in three sections. The first section presents the effect of advertising behaviour on sales rate, having fixed saturation level. In second section we derive sales rate in relation to changing advertising campaign and market levels. Third section is concerned with general marketing growth curve, suitable advertising behaviour and comparison of sales response in simple cases.

SECTION I

Case 1

$A(t)=\frac{A_1}{1+ct}$, $M=M_0$ (A_1, C are two constants)

Now A_1=maximum rate of advertising.

$\frac{A_1}{1+cT}$=maximum rate of advertising.

Differential equation (1) for this case is given as :

$$\frac{ds}{dt}+\left[\frac{\gamma A_1}{M_0(1+Ct)}+\lambda\right]S=\frac{\gamma A_1}{1+Ct} \qquad (7)$$

The solution of (7) is

$$(1+Ct)\frac{\gamma A_1}{M_0C}.e^{\gamma t}\,S(t)=\int\gamma A_1(1+Ct)\frac{\gamma A_1}{M_0C}-1.\ e^{\lambda t}dt+\alpha_1 \qquad (8)$$

Consider (i) $\frac{\gamma A_1}{M_0C}=1$

then $S(t)=\frac{\gamma A_1}{\lambda(1+Ct)}+\frac{\alpha_1 e^{-\lambda t}}{(1+Ct)}$

or $=\frac{\gamma A_1}{\lambda(1+Ct)}+\left(S_0-\frac{\gamma A_1}{\lambda}\right)\frac{e^{-\lambda t}}{1+Ct}$ (9)

S_0=Sales at $t=0$

Equation (9) shows that the rate of sales is most rapid at $t=0$, as saturation M_0 is approached, this rate is reduced.

(ii) $\frac{\gamma A_1}{M_0C}=\rho\ (>1)$. p is an integer.

$$S(t)\frac{\gamma A_1 f(t)}{(1+Ct)p}+\frac{S_0-\gamma A_1 f(0)}{(1+Ct)p}e^{-\lambda t} \qquad (10)$$

Where $f(t)=e^{-\lambda t}\int(1+Ct)^{p-1}e^{\lambda t}dt.$

is a polynomial of the degree less than p.

Advertising pulse (Single-pulse campaign of small duration).

Let $\int_0^T\frac{A_1}{1+Ct}dt=a \qquad 0<t<T$ (11)

$=0 \qquad t>T$

thus $A_1=\frac{aC}{\log(1+CT)} \qquad (t<T)$ (12)

using (12) in (9), we have

$$S(T)=\frac{\gamma aC}{\lambda(1+CT)\log(1+CT)}[1-e^{-\lambda T}]+\frac{S_0}{1+CT}e^{-\lambda T},\ \left(\frac{\gamma A_1}{M_0C}=1\right)$$

$$\therefore\ \underset{T\to 0}{lt}\,S(T)=S(0)=S_0+\gamma a \qquad (13)$$

(13) expresses the new level of sales rate to which sales jump instantaneously due to single pulse injection of advertising at $t=0$. From this point on, this new level decays exponentially. Therefore sales rate at any time

$$S(t)=(S_0+\gamma a)\,e^{-\lambda t}$$

Thus total *additional* sales generated by single pulse advertising is given by

$$\int_0^\infty[S(0)-S_0]e^{-\lambda t}dt=\int_0^\infty\gamma ae^{-\lambda t}dt=\frac{\gamma a}{\lambda} \qquad (14)$$

For $\frac{\gamma A_1}{M_0C}=p$

$$S(T)=\frac{S_0e^{-\lambda T}}{(1+CT)p}+\gamma ac\frac{[f(T)-e^{-\lambda T}f(0)]}{(1+CT)p\log(1+CT)}$$

$$\underset{T\to 0}{lt}\,S(T)=S(0)=S_0+\gamma a[f'(0)+\lambda f(0)].$$

$$f'(0)=\left[\frac{df(t)}{dt}\right]t=0$$

S(t), sales at any time t in short intense compaign is :

$$S(t)=S_0e^{-\lambda t}+\gamma a[f'(0)+\lambda f(0)]e^{-\lambda t} \quad (15)$$

and total additional sales generated is

$$\int_0^\infty [S(0)-S_0]e^{-\lambda t}dt=\frac{\gamma a}{\lambda}[f'(0)+\lambda f(0)]. \quad (16)$$

Case 2

$$A(t)=\frac{A_1\text{Cos } mt}{1+C\text{ Sin } mt}.\ M=M_0$$

The differential equation (1) is :

$$\frac{ds}{dt}+\left[\frac{\gamma A_1\text{Cos } mt}{M_0(1+C\text{ Sin } mt}+\lambda\right]S = \frac{\gamma A_1\text{ Cos } mt}{1+C\text{ Sin } mt} \quad (17)$$

Solution of (17) is

$$(1+C\text{ Sin } mt)^{\frac{\gamma A_1}{mM_0C}}e^{\lambda t}\,S=\int\gamma A_1\text{ Cos } mt\ (1+C\text{ Sin } mt)^{\frac{\gamma A_1}{mM_0C}-1}e^{\lambda t}\,dt+\alpha_2$$

for (i) $\frac{\gamma A_1}{mM_0C}=1$

$$S(t)=\frac{\gamma A_1}{\sqrt{\lambda^2+m^2}}\cdot\frac{\text{Cos }(mt-\tan^{-1}\frac{M}{\lambda}}{1+C\text{ Sin } mt}+\left(S_0-\frac{\lambda A_1\gamma}{\lambda^2+m^2}\right)\frac{e^{-\lambda t}}{1+C\text{ Sin } mt} \quad (18)$$

(ii) $\frac{\gamma A_1}{mM_0C}=\bar{p}(>1)$, an integer

then

$$S(t)=\frac{\gamma A_1\,\psi(t)}{(1+C\text{ Sin } mt)\bar{p}}+\frac{S_0-\gamma A_1\psi(0)e^{-\lambda t}}{(1+C\text{ Sin } mt)p} \quad (19)$$

where

$$\psi(t)=e^{-\lambda t}\int\text{Cos } mt(1+C\text{ Sin } mt)^{\bar{p}-1}e^{\lambda t}\,dt$$

Advertising pulse

$$\text{Let}\int_0^T\frac{A_1\text{Cos } mt}{1+C\text{ Sin } mt}dt=a \quad (0<t<T)$$

$$=0 \quad (t>T) \quad (20)$$

or $A_1\log(1+C\text{ Sin } mt)=maC\ (0<t<T)$ (21)

for $\frac{\gamma A_1}{mM_0C}=1$, using (21) in (18), we get

$$S(T)=\frac{S_0e^{-\lambda t}}{1+C\text{ Sin } MT}+\frac{\gamma maC}{\sqrt{\lambda^2+m^2}}\text{Cos}\left(mT-\tan^{-1}\frac{m}{\lambda}\right)\frac{\lambda e^{-\lambda T}}{\sqrt{\lambda^2+m^2}}$$

$$(1+C\text{ Sin } mT)\log(1+C\text{ Sin } mT)$$

$\therefore$ *It* $S(T)=S(0)=S_0+\gamma a$

$T\to 0$

then $S(t)=(S_0+\gamma a)e^{-\lambda t}$ (22)

and total sales generated is

$$\int_0\gamma ae^{-\lambda t}dt=\frac{\gamma a}{\lambda} \quad (23)$$

for $\frac{\gamma A_1}{mM_0C}=\bar{p}(>1)$

$$S(T)=\frac{S_0e^{-\lambda T}}{(1+C\text{ Sin } mT)\bar{p}}+\frac{\gamma maC\,[\psi(T)-\psi(0)e^{-\lambda T}]}{(1+C\text{ Sin } mT)p\log(1+C\text{ Sin } mT)}$$

$\therefore$ $S(0)=\text{lt}\,S(T)=S_0+\gamma a\,[\bar{\psi}(0)+\lambda\bar{\psi}'(0)]$ (24)

where $\bar{\psi}'(0)=\left[\frac{d}{dt}[\psi(1)]\right]t=0,$

$S(t)=S_0e^{-\lambda t}+\gamma a[\bar{\psi}'(0)+\lambda\bar{\psi}(0)]e^{-\lambda t}$

and total sales generated

$$=\frac{\gamma a}{\lambda}[\bar{\psi}'(0)+\lambda\bar{\psi}(0)] \quad (25)$$

Section II

Case 1

$$A=A_0.\ M=M_0+M_1t$$

Differential equation (1) is :

$$\frac{ds}{dt}+\left(\lambda+\frac{\gamma A_0}{M_0M_1t}\right)S=\gamma A_0$$

Solution is

$$(M_0+M_1t)^{\frac{\gamma A_0}{M_1}}e^{\lambda t}S$$

$$=\int\gamma A_0(M_0+M_1t)^{\frac{\gamma A_0}{M_1}}e^{\lambda t}+B_1 \qquad (26)$$

Consider

(i) $\frac{\gamma A_0}{M_1}=1$

$$S(t)=\frac{\gamma A_0}{\lambda}-\frac{M_1\gamma A_0}{\lambda^2(M_0+M_1t)}+$$

$$M_0\left(S_0-\frac{\gamma A_0}{\lambda}+\frac{M_1\gamma A_0}{M_0\lambda^2}\right)\frac{e^{\lambda t}}{M_0+M_1t} \qquad (27)$$

(ii) $\frac{\gamma A_0}{M_1}=q(>1)$ an integer

$$S(t)=\frac{\gamma A_0g(t)}{(M_0+M_1t)^q}+\frac{[M_0qS_0-\gamma A_0g(0)]}{(M_0+M_1t)^q}e^{\lambda t} \qquad (28)$$

where $g(t)=\int(M_0+M_1t)^qe^{\lambda t}dt$, where degree of g(t) is less than q.

Advertising pulse

Let $\int_0^T A_0dt=a \qquad (0<t<T)$

$=0 \qquad (t>T)$

ie $A_0=\frac{a}{T} \qquad (t<T) \qquad (29)$

for $\frac{\gamma A_0}{M_1}=1$, we have $M_1T=\lambda a \qquad (30)$

Using (29) and (30) in (27), we have

$$S(T)=\frac{M_0S_0}{M_0+\gamma a}e^{-\lambda T}+\frac{\gamma a}{\lambda(M_0+\gamma a)}$$

$$\left[T\left\{\left(M_0+\gamma a\right)-M_0e^{-\lambda T}\right\}-\frac{\gamma a}{\lambda}\left(1-e^{-\lambda T}\right)\right]$$

$$\therefore \text{let} S(T)=S(0)=\frac{M_0S_0}{M_0+\gamma a}+\frac{\gamma a}{2(M_0+\gamma a)}[2M_0+\gamma a]$$

$T\to 0$

$$S(t)=\frac{1}{M_0+\gamma a}\left[M_0S_0+\frac{\gamma a}{2}(2M_0+\gamma)a\right]e^{-\lambda t} \qquad (31)$$

Now total additional Sales generated is :

$$\int_0^\infty[S(0)-S_0]e^{-\lambda t}dt=\frac{\gamma a}{\lambda(M_0+\gamma a)}\left[M_0-S_0+\frac{\gamma a}{2}\right]$$

$$=\frac{\gamma a}{\lambda}\left[1-\frac{S_0}{M_0+\gamma a}-\frac{\gamma a}{2(M_0+\gamma a)}\right] \qquad (32)$$

$$\to\frac{\gamma a}{\lambda}\left[1-\frac{S_0}{M_0}-\frac{\gamma a}{2M_0}\right] \qquad (33)$$

for Sales well below Saturation.

Case 2.

$A=A_1\ \text{Cos}\ nt, \qquad M=M_0+M_1\ \text{Sin}\ nt$

Differential equation (1) is

$$\frac{ds}{dt}+\left[\lambda+\frac{\lambda A_1\ \text{Cos}\ nt}{M_0+M_1\ \text{Sin}\ nt}\right]S=\gamma A\ \text{Cos}\ nt \qquad (34)$$

solution of (34) is :

$$S.e^{\lambda t}[M_0M_1\ \text{Sin}\ nt]^{\frac{\gamma A_1}{nM_1}}=\int\gamma A_1\ \text{Cos}\ nt$$

$$(M_0+M_1\ \text{Sin}\ nt)^{\frac{\gamma A_1}{nM_1}}e^{\lambda t}dt+\beta_2$$

Let $\frac{\gamma A_1}{nM_1}=\bar{q}(\geqslant 1)$ an integer.

$$S(t)=\frac{\gamma A_1h(t)}{(M_0+M_1\ \text{Sin}\ nt)^q}+\frac{[M_0\bar{\xi}S_0-\gamma A_1h(0)]}{[M_0+M_1\ \text{Sin}\ nt]^q}e^{-\lambda t} \qquad (35)$$

where

$$h(t)=e^{-\lambda t}\int\text{Cos}\ nt\,(M_0+M_1\ \text{Sin}\ nt)^{\bar{q}}e^{\lambda t}dt$$

for $\bar{q}=1$

$$h(t)=\frac{M_0}{\sqrt{\lambda^2+n^2}}\text{Cos}\left(nt-\tan^{-1}\frac{n}{\lambda}\right)+\frac{M_1\ \text{Sin}}{2\sqrt{4n^2+\lambda^2}}\left[2nt-\tan^{-1}\frac{2n}{\lambda}\right]$$

Advertising Rate	Sales Rate	Total additional Sales generated by advertising pulse
$A = A_0$	$S(t) = \frac{M_0}{1 + \frac{\lambda}{\gamma}\frac{M_0}{A_0}}\left[1-e^{-(\frac{\gamma A_0}{M_0}+\lambda)t}\right] + S_0 e^{-(\frac{\gamma A_0}{M_0}+\lambda)t}$	$\frac{M_0-S_0}{\lambda}\left(1-e^{-\frac{\gamma a}{M_0}}\right)$
$A = \frac{A_1}{1+ct}$	$S(t) = \frac{\gamma A_1}{\lambda(1+ct)} + (S_0 - \frac{\gamma A_1}{\lambda})\frac{e^{-\lambda t}}{1+ct}\cdot(\frac{\gamma A_1}{M_0 c}=1)$ $S(t) = \frac{\gamma A_1 f(t)}{(1+ct)\,p} + \frac{S_0-\gamma A_1 f(0)}{1+ct}e^{-\lambda t}\cdot(\frac{\gamma A_1}{M_0 c}=p)$	$\frac{\gamma a}{\lambda}$ $\frac{\gamma a}{\lambda}[f'(0)+f(0)]$
$A = \frac{A_1 \cos mt}{1+c\sin mt}$	$S(t) = \frac{\gamma A_1}{\sqrt{(\lambda^2+m^2)}}\frac{\cos(mt-\tan^{-1}\frac{m}{\lambda})}{1+C\sin mt} + \left(S_0 - \frac{\lambda\gamma A_1}{\lambda^2+m^2}\right)\frac{e^{-\lambda t}}{1+C\sin mt}\cdot(\frac{\gamma A_1}{mM_0 C}=1)$ $S(t) = \frac{\gamma A_1 \bar{\psi}(t)}{(1+C\sin mt)\,\bar{p}} + \frac{S_0-\gamma A_1\bar{\psi}(0)\,e^{-\lambda t}}{(1+C\sin mt)\,\bar{p}}\cdot(\frac{\gamma A_1}{mM_0 C}=\bar{p}>1)$	$\frac{\gamma a}{\lambda}$ $\frac{\gamma a}{\lambda}[\bar{\psi}(0)+\lambda\bar{\psi}(0)]$

Table 2 : Summary of Results ($M=M_0$)

Advertising pulse

Let $\int_0^T A_1 \cos nt\,dt = a \qquad (0<t<T)$

$= 0 \qquad (t>T)$

i.e. $A_1 \sin nt = an$

for $\bar{q}=1=\frac{\gamma A_1}{nM_1}$, $M_1=\frac{\gamma a}{\sin nT}$ (36)

Using (36) and value of M_1 in (35), we have

$$S(T)=\frac{M_0 S_0 e^{-\lambda T}}{M_0+\gamma a} + \frac{\gamma a n}{(\sin nT)(M_0+\gamma a)}[h(T)-h(0)\,e^{-\lambda T}] \qquad (37)$$

Let $S(T)=S(0)=\frac{M_0 S_0}{M_0+\gamma a}+\frac{\gamma a}{M_0+\gamma a}\left[M_0+\frac{\gamma a}{2}\right]$

$$S(t)=\frac{1}{M_0+\gamma a}\left[S_0+\gamma a\left(M_0+\frac{\gamma a}{2}\right)\right]e^{-\lambda t} \qquad (38)$$

and total additional Sales generated is

$$=\frac{\gamma a}{\lambda(M_0+\gamma a)}\left[M_0-S_0+\frac{\gamma a}{2}\right]$$

$$\to\frac{\gamma a}{\lambda}\left[1-\frac{S_0}{M_0}-\frac{\gamma a}{2M_0}\right]$$

for Sales well below Saturation. (39)

SECTION III

$$A(t)=A_1\psi'(t), M(t)=M_0+M_1\psi'(t)\psi'(t)=\frac{d\psi}{dt}$$

Market	Advertising rate	Sales rate	Total additional sales generated by Advt. impulse
$M = M_0 + M_1 t$	$A = A_0$	$S(t) = \frac{\gamma A_0}{\lambda} - \frac{M_1 \gamma A_0}{\lambda^2 (M_0 + M_1 t)} + M_0 \left(S_0 - \frac{\gamma A_0}{\lambda} + \frac{M_1 \gamma A_0}{M_0 \lambda^2}\right) \frac{e^{-\lambda t}}{M_0 + M_1 t} \cdot \left(\frac{\gamma A_0}{M_1} = 1\right)$	$\frac{\gamma a}{\lambda} - \frac{M_0 - S_0 + \frac{\gamma a}{2}}{M_0 + \gamma a}$
		$S(t) = \frac{\gamma A_0 g(t)}{(M_0 + M_1 t)^q} + \frac{M_0^2 S_0 - \gamma A_0 g(0)}{(M_0 + M_1 t)^q} e^{-\lambda t} \cdot \frac{\gamma A_0}{M_1} = q (\geq 1)$	----
$M = M_0 + M_1 \sin nt$	$A = A_1 \cos nt$	$S(t) = \frac{\gamma A_1 h(t)}{(M_0 + M_1 \sin nt)^q} + \frac{M_0^q S_0 - \gamma A_1 h(0)}{(M_0 + M_1 \sin nt)^q} e^{-\lambda t}$	$\frac{\gamma a}{\lambda (M_0 + \gamma a)} \left[M_0 - S_0 + \frac{\gamma a}{2}\right]$
		$\frac{\gamma A_1}{M_1} = q (\geq 1)$	for $q = 1$
$M = M_0 + M_1 \psi(t)$	$A = A_1 \psi'(t)$	$S(t) = \frac{\gamma A_1 F(t)}{[M_0 + M_1 \psi(t)]^w} + \frac{M_0^w S_0 - \gamma A_1 F(0)}{[M_0 + M_1 \psi(t)]^w} e^{-\lambda t}$	-----
		$\frac{\gamma A_1}{M_1} = w (\geq 1)$	

Table 3 : Summary of the Results (Variable Market)

differential equation (1) is :

$$\frac{ds}{dt} + \left[\lambda + \frac{\gamma A_1 \psi'(t)}{M_0 + M_1 \psi(t)}\right] S = \gamma A_1 \psi'(t)$$

its solution is

$$S(t)\, e^{\lambda t} [M_0 + M_1 \psi(t)]^{\frac{\lambda A_1}{M_1}} = \int \gamma A_1 \psi(t) [M_0 + M_1 \psi(t)]^{\frac{\gamma A_1}{M_1}} e^{\lambda t} dt + K$$

If $\frac{\gamma A_1}{M_1} = W (\geqslant 1)$ an integer

then $$S(t) = \frac{\gamma A_1 F(t)}{[M_0 + M_1 \psi(t)]^w} + \frac{(M_0^w S_0 - \gamma A_1 F(0))}{[M_0 + M_1 \psi(t)]^w} e^{-\lambda t}$$

where

$$F(t) = e^{-\lambda t} \int \psi'(t) [M_0 + M_1 \psi(t)]^w e^{\lambda t} dt \qquad (40)$$

F(t) can be obtained if $\psi(t)$ is an exponential function, i.e. exponential market and exponential behaviour of advertising can also be considered for obtaining Sales rate.

COMPARISON (for Simple Cases)

I. (a) $A = A_0$, $M = M_0$ & $A_0 T = a$

From (2)

$$\bar{S}(t) = \gamma A_0 t - \frac{\gamma A_0}{M_0} (\gamma A_0 + \lambda M_0) \frac{t^2}{2} + S_0 \left[1 - \left(\frac{\gamma A_0}{M_0} + \lambda\right) t + \left(\frac{\gamma A_0}{M_0} + \lambda\right)^2 \frac{t^2}{2}\right] + 0(t^3)$$

(b) $A = A_0$, $M = M_0 + M_1 t$ & $\gamma A_0 = M_1$

$A_0 T = a$

From (27)

$$\bar{S}_M(t) = \gamma A_0 t - \tfrac{1}{2} t^2 \left(\frac{\gamma^2 A^2_0}{M_0} + \gamma A_0 \lambda\right) + S_0 \left[1 - \left(\frac{\gamma A_0}{M_0} + \lambda\right) t + \left(\frac{\gamma A_0}{M_0} + \lambda\right)^2 \frac{t^2}{2} + \frac{\gamma^2 A^2_0}{M^2_0} \cdot \frac{t^2}{2} + 0(t^3)\right]$$

Now

$$\bar{S}_M(t) - \bar{S}(t) = \frac{S_0 \gamma^2 A_0^2}{2 M_0^2} t^2 + 0(t^3)$$

or $$\int_0^T [\bar{S}_M(t) - \bar{S}(t)] dt = \frac{S_0 \gamma^2 A^2_0}{6 M_0^2} T^3 + 0(T^4) \qquad (41)$$

(c) $A = \frac{A_1}{1 + ct}$, $M = M_0$ & $\frac{\gamma A_1}{M_0} = c$,

$A_1 \log (1 + cT) = ac$

From (9)

$$\bar{S}_A(t)=\gamma A_1 t-\gamma A_1\left(\frac{\gamma A_1}{M_0}+\frac{\lambda}{2}\right)t^2+S_0\left[1-\left(\frac{\gamma A_1}{M_0}+\lambda\right)t+t^2\left(\frac{\lambda^2}{2}+\frac{\lambda\gamma A_1}{M_0}+\frac{\gamma^2 A^2{}_1}{M^2{}_0}\right)\right]+0(t^3)$$

Now

$$\bar{S}_A(t)-\bar{S}(t)=\frac{\gamma t(A_1-A_0)(M_0-S_0)}{M_0}+\frac{\gamma\lambda}{2}t^2(A_1-A_0)\left(\frac{2S_0}{M_0}-1\right)-\frac{\gamma^2 t^2}{M_0}\left(A^2{}_1-\frac{A^2{}_0}{2}\right)\left(1-\frac{S_0}{M_0}\right)+0(t^3)$$

$$\int_0^T[\bar{S}_A(t)-\bar{S}(t)]dt\to\frac{\gamma T^2}{2}\frac{(A_1-A_0)(M_0-S_0)}{M_0}+\frac{\gamma\lambda T^3}{6M_0}(A_1-A_0)(2S_0-M_0)+0(T^4)$$

(for small γ and large M_0) (42)

It is obvious that $A_1>A_0$

Also

$$\int_0^T\left[\bar{S}_A(t)-\bar{S}_M(t)\right]dt=\frac{\gamma T^2}{2}(A_1-A_0)\left(1-\frac{S_0}{M_0}\right)+0(T^3) \quad (43)$$

Conclusion

(i) In stable market, the rise of rate of sales is more rapid for hyperbolic advertising policy than for constant advertising.

(ii) Penetration of market is more rapid in a linear market trend than in a stable market.

(iii) The effect of hyperboiic advertising compaign in fixed market is more sound than constant rate of advertising.

(iv) For equal amount of advertising expenditure, during same period T, the effect of hyperbolic advertising campaign in fixed market is better than that of constant advertising campaign in a linear market for some length of time.

(v) The rate of sales is strongly influenced by the market and advertising behaviour.

(vi) For large value of M_0, total sales generated for a single pulse campaign are independent of advertising and market behaviour and equal to $\frac{\gamma a}{\lambda}$

(vii) In case of advertising pulse for a given amount of expenditure, penetration of market is more deep in linear market and transcendental market with transcendental advertising behaviour than in a stable market with constant rate of advertising.

(viii) Penetration of market in linear market behaviour is the same as in transcendental market with transcendental behaviour.

(ix) Results obtained will prove useful only in those situations which lead to present mathematical model.

(x) Some of the above-mentioned effects continued to exist for a longer time if $\frac{\gamma a}{M_0}$ is small. □

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Coverage Analysis Approach for Materials Management : Concepts and A Case Study

Prem Vrat* & Mam Chand*

This paper outlines the basic concepts of the coverage analysis approach for materials management. This approach does not require cost informations like carrying cost, replenishing and shortage costs which are very difficult to determine realistically. It eliminates the need of ABC analysis. The approach has been applied in an Industrial situation and optimal stock ordering policy has been suggested for the work-order processing. Significant savings in the capital invested are reported as a result of the application of coverage analysis approach.

OPERATIONS Research has been directed more towards inventory systems than towards any other problem area in business and industry. For this reason, there is an abundance of mathematical models for inventory systems. It is difficult to even review all these Models in a single paper. Fabrycky and Banks[1] and Naddor[2] have given a very systematic presentation of various types of inventory problems.

Most OR models in inventory systems require pertinent cost information like cost of carrying inventory, cost of replenishing inventory and cost of shortage. Unfortunately, more often it is difficult to estimate these cost parameters even approximately. For example, the estimation of the cost of shortage is an extremely difficult task because a large number of intangible factors involved which are difficult to quantify. In such a situation even if we use a very sophisticated mathematical model it is futile to expect good results because of unrealistic cost estimates. In fact, sometimes the results might be misleading and even with serious implications.

To circumvent these difficulties a relatively recent approach has been reported by Ramachandran.[3] This approach has been called the "Coverage Analysis Approach". The only cost data required in this approach are the unit costs of the items which can be estimated quite easily. It does not require cost data like cost of shortage, cost of carrying inventories, etc. This paper describes a case study where this approach has been actually applied to an industrial problem.

Basic Concepts of Coverage Analysis Approach

The Coverage Analysis approach, while overcoming the usual problems associated with the Economic Order Quantity (EOQ) approach, optimises the ordering policy for stock by minimising the total inventory capital over the range of items keeping the total number of orders same as at present. This method is applicable

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to inventory problems where a large number of items are involved and the demand for the items is fairly stable. The approach automatically takes into consideration the annual usage value of the items and this eliminates the need of a selective inventory control using ABC analysis.

The coverage of an item is the ratio of the average stock carried to the annual usage of the item. Thus,

$$\text{Coverage (C)} = \frac{\text{Average Stock}}{\text{Annual usage}} = \frac{\bar{S}}{Y}$$

Where $\bar{S}$ = Av. Stock $= \frac{\bar{Q}}{2} + K\sqrt{T+L}\,\sigma R$

Where $\frac{Q}{2}$ = Economic Order quantity (E.O.Q.)

L = Replenishment time.

σ_R = Standard deviation of consumption per unit time.

K = Constant dependent on the acceptable level of shortage (K = 2.33 for one in 100 chances of shortage)

T = Time interval between two orders or the scheduling period.

Y = Annual usage of the item

If X is the number of orders placed per year, then

$$X = \frac{Y}{Q}$$

Substituting, we get the expression for coverage as,

$$C = \frac{1}{2X} + \frac{K\sqrt{T+L}}{Y}\,\sigma_R$$

Thus the coverage factor of an item consists of two terms ;

viz., $\frac{1}{2X}$ and $\frac{K.\sqrt{T+L}}{Y}\,\sigma_R$ the latter being a constant and independent of the number of orders placed in a year. Thus the actual coverage will be always more than $\frac{1}{2X}$ and the gap will indicate the buffer stock in relation to the stock rotation. It can be very easily observed that the larger the value of X the lessor is the live stock carried out by the firm.

The coverage analysis approach is based on the assumption that the no. of orders placed per year are directly proportional to the square root of the annual usage and the unit cost of the item.

Thus, $X \propto \sqrt{Y.P}$.

If P is the unit cost of an item.

This principle in fact is based on E.O.Q. formula and can be verified as follows :

$$Q = \sqrt{\frac{2C_s \cdot Y}{PI}}$$

Where Cs—cost of replenishment, I = fraction of inventory carrying cost per unit.

From this $X = Y/Q = \sqrt{PIY/2C_s}$

For a given situation I and C_s are constant hence

$X \propto \sqrt{Y.P}$. as stated earlier.

In the actual problem, the items are picked up at random and are classified into various class intervals depending upon their annual usage value. Generally 14-16 class intervals are sufficient. Then coverage factors are computed for each item. From the proposed and present coverage the proposed and present capital invested are computed. The difference will give the reduction in inventory capital. The detailed steps in the approach will be illustrated with the help of the problem actually studied. The sections that follow give the case study where coverage analysis has resulted in a significant amount of savings.

The Case Study

The study reported in this paper was conducted in a large public transport organisation. The workshop was more like a job-shop catering to a large number of items ranging in thousands. This workshop was receiving work orders from a number of consumption zones. The objective of the study was to determine optimal ordering policies for processing the work orders. The existing system for ordering policy was based on intution only and there was not much of a scientific basis. This was resulting in a very poor stock control situation and often it was realised that the present inventory policy was neither reducing the inventory costs nor the shortage costs because there were frequent shortages for items which were often in demand and overstocking of items where not much demand was experienced. Thus it became necessary to investigate the inventory policies to eliminate the confusion resulting from the set of ad-hoc rules followed earlier.

Existing Inventory Policies

The existing policy was not based on any economic analysis. The entire basis was that whenever the stock falls below five months' consumption, then an order was placed equal to three month's consumptions. The average consumption was found out by averaging the last 8 months' demand. Thus the reordering rules were :

(i) Place an order if quantity on hand + quantity under order+reorder point= 5 months' av. consumption.

(ii) Reorder quantity=8 months' av. consumption—(quantity at hand+quantity under order—reorder point)

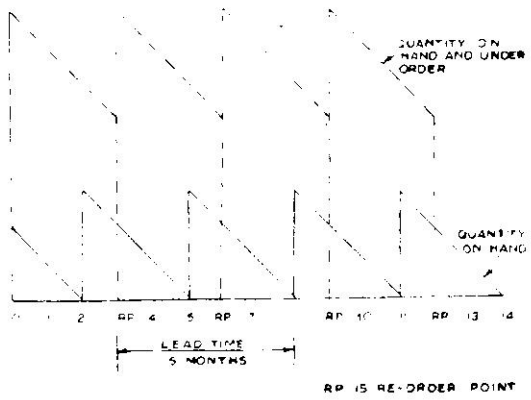

Fig. 1

Fig. 1. shows the existing policy for placing orders.

The drawbacks of this system were that too much of computational work and bookkeeping was required, in addition to lack of any economic basis. The workshop situation was such that a realistic estimate of set-up cost was difficult because sometimes a batch used to be split in smaller batches, sometimes not. The estimate of shortage cost was also difficult under the circumstances. Thus, it was realised that the coverage analysis approach would be quite appropriate for the analysis of ordering policies for stock.

Proposed Approach

For the coverage analysis, a random sample of 303 items was taken and their demand for previous 18 months were observed. The sample was so chosen that it covered the entire range of items from low-valued items to the high-valued items. It was not necessary for the coverage analysis to study all the items. In fact, on the basis of 10-20% of items, reordering policies for the entire range could be based. The data regarding average number of work

Table 1

Part No.	*Unit cost*	*No. of work orders*	*Average demand per month*	*Annual Requirement*	*Annual Usage*	*Std. Deviation of Demand*	*Coverage*
1480	86.90	5	36	435	37800	8	0.193
1481	81.79	4	20	244	19950	8	0.291
2011	4.76	1	11	131	623	8	0.810
2012	9.33	6	78	870	905	25	0.237
4017	54.47	6	128	1550	84450	29	0.113
4426	83.91	1	8	10	839	5	3.000
4748	0.88	8	715	8580	7740	273	0.195
5016	5.66	5	18	216	1220	13	0.398
4656	7.156	8	273	3280	23500	118	0.245
4504	114.74	3	6	80	8480	4	0.433

orders were collected. The lead time was taken to be five months and assumed to be constant. The allowable risk of shortage was taken to be 2.5% which corresponded to a value of K=2.24 and thus the coverage factor (C) could be obtained for each item as discussed earlier. The basic steps involved were as follows :

—(A) The first step was to determine the annual usage and the coverage. A sample of this is given in Table 1. The relationship between coverage and number of orders per year for items is plotted. This is collect coverage curve. This plotted curve becomes the basis for the entire analysis. Fig. 2 gives such a coverage curve.

—(B) The second step was to divide the items by value of annual usage into a number of class intervals and determine the optimal number of work orders per year for each class interval. The class intervals should be so chosen that the square roots of the mid point of intervals are, if possible, whole numbers. The larger the number of intervals, better will be the accuracy of results. Generally 14-16 class intervals are sufficient. Further, case study under discussion 14 class intervals were thought to be adequate. The results of entire coverage analysis are given in Table 2. Detailed steps to prepare Table 2 were as follows :

Columns 1, 2 and 3 show the division of items in class intervals by annual usage in such a way that the square root of the mid point is a whole number. Col. 4 shows the no. of items falling in each class interval. Col. 5 gives the total number of orders placed at present in a particular class interval. For example, in the class interval 51-150 the present practice is to place 87 work orders per year for the 46 items that fall in this class interval.

Column 6 gives the av. no. of work orders placed per item per year (Col. 5/Col. 4). Col. 7 gives the theoretical number of orders per items per year which are proportional to the

Table 2

Class of annual Usage (Rs)	*Mid Point*	*Sq. root of mid point*	*Total No. of items in each class*	*Total orders per year*	*Present average orders/ item per year*	*Theoretical No. of orders per item per year*	*Total Theoretical No. of orders per year*	*Proposed No. of orders per item per year*	*Present coverage from Fig. 2.*	*Proposed coverage from Fig. 2.*	*Annual usage*	*Estimated present capital*	*Estimated proposed capital.*
0 to 50	25	5	21	51	2.42=2	1	21	0.25=1	.440	.850	525	231	447
51 to 150	100	10	46	87	1.90=2	2	92	0.50=1	.440	.850	4294	1890	3650
151 to 300	225	15	31	61	1.97=2	3	93	0.75=1	.440	.850	6466	2845	5500
301 to 500	400	20	25	55	2.20=2	4	100	1.00=1	.440	.850	9826	4325	8350
501 to 1300	900	30	52	138	2.56=3	6	312	1.50=2	.350	.440	41369	14500	18220
1301 to 3700	2500	50	52	130	3.46=3	10	520	2.50=3	.350	.350	109441	38300	38300
3701 to 6100	4900	70	11	32	2.9=3	14	154	3.50=4	.350	.295	53732	18800	15840
6101 to 10100	8100	90	17	67	3.94=4	18	306	4.5 =5	.295	.260	144408	42600	37550
10101 to 14100	12100	110	14	48	3.43=3	22	308	5.5 =6	.350	.225	174020	60900	39150
14101 to 19700	16900	130	8	39	4.87=5	26	208	6.5 =7	.260	.200	128280	33350	25650
19701 to 25300	22500	150	8	41	5.12=5	30	240	7.5 =8	.260	.180	184650	48000	33250
25301 to 54700	40000	200	9	45	5.00=5	40	360	10.0 =10	.260	.160	336790	87500	53900
54701 to 125300	90000	300	4	25	6.25=6	60	240	15.0 =15	.225	.130	320200	72000	41600
125301 to 770700	448000	670	5	38	7.6 =8	134	670	33.5 =34	.180	.105	1930500	348000	203000
			303	907			3624						

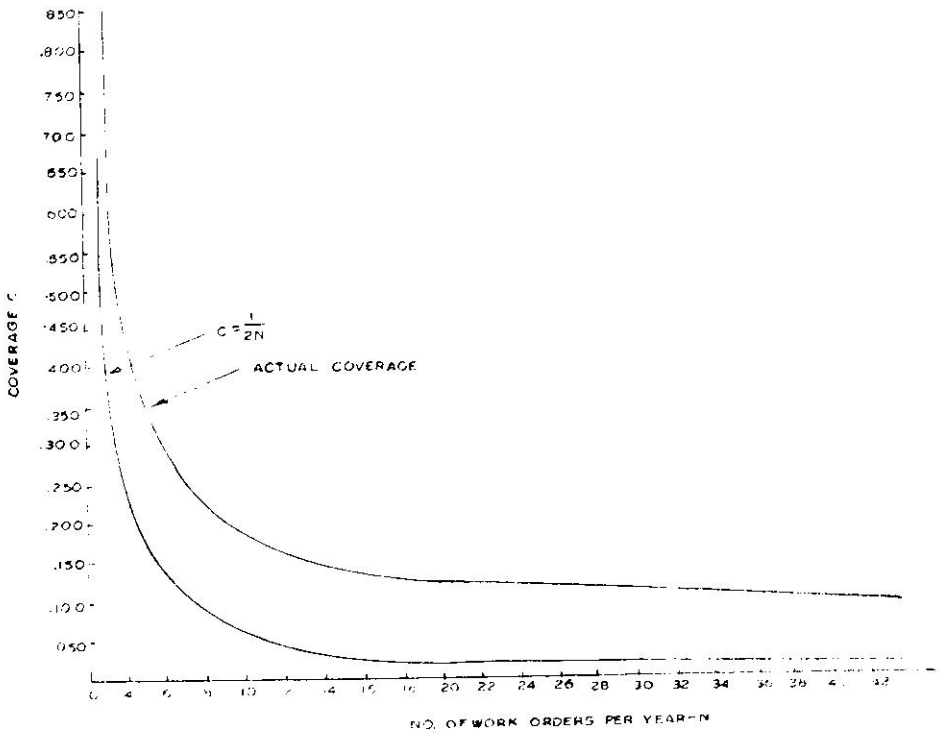

Fig. 2 : Coverage Curve

square root of the annual usage mid point. This is same as col. 3. Col 8 gives the total theoretical number of orders per year (Col. 7 × Col. 4).

The coverage analysis minimises the total inventory capital, keeping the number of orders per year for all the items same as existing at present. The existing total number of work orders placed was 907. For determining the optimal number of orders to be placed per item per year for each class interval we have to find a common multiplier 'M' so that a sum of Col. 8 times M is equal to the total number of orders placed per year at present. Thus,

$$3624\ M = 907 \text{ or } M = 0.25.$$

Col. 9 shows the proposed number of orders per item per year; the figures are rounded to the nearest whole number. In Cols. 10 and 11, the present and proposed coverage estimates are obtained for each class interval from the coverage curve Fig. 2. The coverage for present are read off from Fig. 2 against the present numbers of orders placed as read from Col. 6. Similarly Col. 9 helps in giving proposed coverage factors shown in Col. 11. Fig. 2 was obtained by plotting a scatter diagram of the no. of orders placed and the coverage and obtaining the best fit from that. Col. 12 shows the annual usage of these items in each class interval. Cols. 13 and 14 show the estimated present and proposed stock capital. These are obtained by multiplying the present and pro-

posed coverage values respectively by the annual usage given in Col. 12. Fig. 3 shows the flow diagram for coverage analysis.

It can be observed from Table 2 that there is an increase in the stock capital for low value items and decrease for the high value items. Thus, it automatically takes into consideration the value of the items and a selective inventory control (like ABC) analysis is not required.

The net reduction in stock capital for the 303 items studied by this approach was Rs. 2,48,834. Since there were about 10,000 stock items in the workshop, the savings could be projected to cover all the items. The potential reduction in the stock capital for all the items

$$= \text{Rs.} \frac{10{,}000 \times 2{,}48{,}834.}{303}$$

$$= \text{Rs. } 8{,}2{,}13{,}430.$$

This reduction of Rs. 82,13,430 in the Capital tied up would result in a saving of Rs. 6.57 lakhs annually at 8% interest rate. Thus, there is a great scope of savings in the capital stocked by applying coverage analysis.

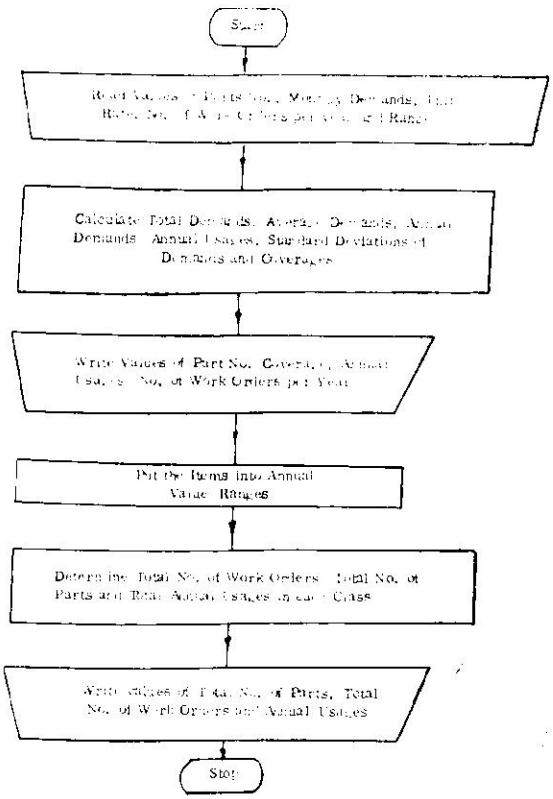

Fig. 3 : Flow Chart for Coverage Analysis

Inventory Policy

The coverage analysis gives the number of orders to be placed per year for items belonging to a particular class interval. To find the number of orders for a particular item, the item is first fitted into the existing class intervals, from which the number of orders per year can be found out. The quantity to be ordered every time can be determined by estimating the requirements using exponential smoothing. For example if the no. of orders placed is 4 per year then every order must be for 3 months' consumption and the consumption for next three months can be estimated using exponential smoothing.

Conclusion

The coverage analysis approach is very simple and does not require the use of any sophisticated mathematical model. This approach automatically takes care of value of the item and thus eliminates the need of ABC analysis. The approach is particularly useful if cost data are not reliable. Moreover just by studying a random sample of 10-20 % items the inventory policies could be found out for the entire range. This makes the coverage analysis to be a very simple and effective tool for materials management. In the case study reported in this paper the coverage analysis has indicated a reduction in the capital expenditure of Rs. 82,13,430 which may mean an annual inventory savings of Rs. 6.57 lakhs. □

Increasing Effectiveness of Budgetary Control

James C Stallman* & Donald R Nichols**

While performance control through responsibility reporting of budget variances is simple in concept its successful application is threatened by difficult practical problems any one of which may be capable of destroying the effectiveness of a budgetary control system. It is the purpose of this paper to discuss three major problems which often interfere with the effectiveness of budgetary control, to identify several common sources of these problems and to suggest some approaches which might be helpful in overcoming them. As this discussion is necessarily brief the appended bibliography is offered to direct the interested reader to selected discussions of various aspects of these problems which should provide a broader understanding of the ideas presented here.

THE budgetary control cycle can be described briefly in terms of a simple diagram. (see page 576).

Three Problems in Budgetary Control

The critical element of budgetary control through performance reporting is the feedback loop, whereby the performance of an activity or process is monitored to detect variances of actual performance from expected performance. The variances provide a basis for initiating the investigation and correction of the causes of the non-standard performance. The three major problems to be discussed tend to impair the ability of the feedback loop to function properly.

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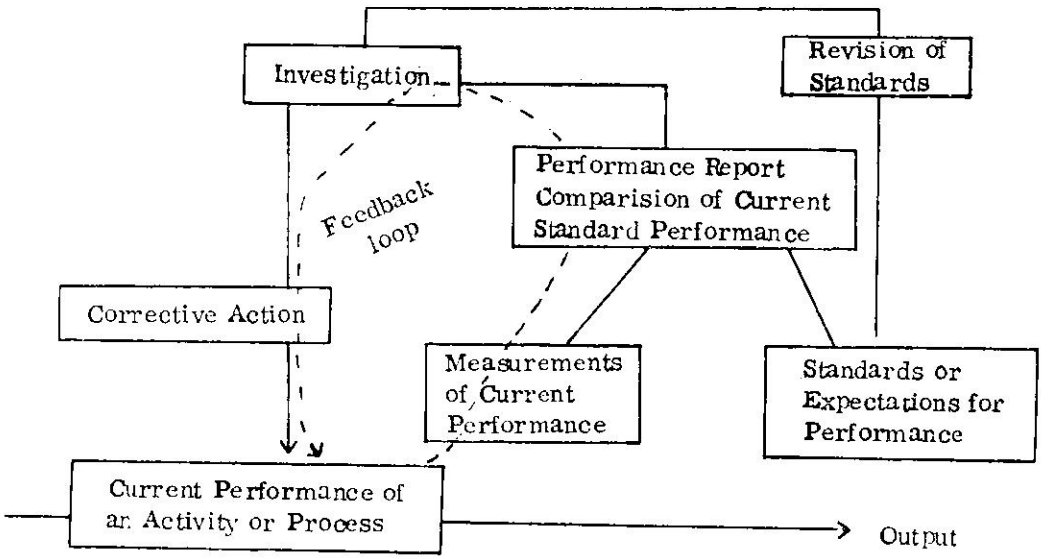
Problem 1: Difficulty in Interpreting Meaning of Variance

After a variance has been observed by comparison of a measure of actual cost with a standard, the reason why the variance occurred must be sought. Not every reason relates to an existing problem or situation which is correctable. Hence, many of the possible reasons do not justify the effort involved in performing an investigation of the process.

One source of the difficulty in interpreting the meaning of a variance is the inherent difficulty in determining appropriate or accurate standards. Setting standards for direct labour and direct materials is not easy. For the indirect items of factory overhead, the task is infinitely more difficult. These indirect costs respond to so many diverse influences that any expedient assumptions that they (even in total)



Budgetary Control Cycle

can be budgeted as the sum of a purely fixed component and a variable component which responds to a single independent variable, such as units of output, will almost inevitably produce budgeted overhead figures of questionable precision for comparison with actual costs.

Another source of variances, of course, is error in the measurement of actual costs. Misclassifications of cost by item, department, time period, etc., are not uncommon. In addition, cost measurements must be properly related to the independent variable in the budget equation for overhead costs.

These measurement errors in both actual and expected costs tend to produce variances which do not imply the existence of a correctable problem in the process. In addition there may be many problems which are not economical to attempt to identify and correct because their individual effects are small, they are extremely difficult to identify, or they are generally of short duration. These problems contribute to the random variances which should not stimulate investigation or an attempt to correct. The result of this is that when a problem or situation develops in the process which should be corrected, the variances resulting from it may be difficult to distinguish from those which do not require attention.

In some way, it must be determined which observed variances are likely to have been the result of correctable problems so that investigations can be initiated and these problems identified and corrected.

Problem 2: Difficulty in Locating Causes of Variances

This second problem results from two primary sources. The first is the fact that in the complex interrelatedness of activities and processes, the consequences of an operating problem in one area may affect the actual costs measured with respect to another activity far removed from the original cause. The removal

An essential requisite for an effective Budgetary Control system is that its objectives or intended uses be carefully defined and well understood by all parties involved.

of the consequences may be to the costs of another department in the same period or to the costs of another department in a later period. In either case, tracing the cause of a measured variance is likely to be seriously hampered by the transfer of the variance.

The second major source of the difficulty is in the accounting procedures utilised in the preparation of performance reports. Contributing factors here include the reporting lags caused by the collecting and processing of the data, the degree of aggregation of the cost data underlying the reports, and the extent to which cost allocations have been used in deriving the reported information. In its own way each of these factors operates to increase the logical distance between a reported variance and its cause.

Problem 3: Inability of Performance Measurement Process to Motivate Improved Performance

Again, there are many underlying sources of this problem. Primary among them are two interrelated facts. First, the objectives of performance of an activity may be numerous and in competition with each other for the attention of those performing the activity. For example, in a production process, optimum quality of the process output, minimum cost of production, minimum defective units, maximum output, minimum idle equipment time, etc., may be legitimate performance objectives which are not entirely compatible. The second fact is that personal objectives of organisation members do not always correspond with organisational objectives. In combination with the first fact, the situation often exists that the person primarily responsible for the performance of an activity is seeking one goal, such as highest quality output, while the performance reporting system is measuring his performance with respect to another goal—minimum (or at least satisfactory) cost of production. If that person feels he is meeting *his* goal he may not be motivated to respond to information that he is not meeting the company's goal (implied in the measurement process).

Even if the person primarily responsible for the performance of an activity feels the company objective is legitimate, he still may not be motivated to act in response to reported variances for a number of reasons. First, he may feel that the standards reflect unreasonably high levels of efficiency which are not attainable. Second, he may have little faith in the reliability of the cost information collected as a measure of his performance. Third, he may be frustrated by the ability of the variance to suggest that his performance was under par but its inability to determine why or to suggest how future performance might be improved. A fourth possibility is that reports are so delayed that when they are finally received, he may feel that whatever caused the reported variance has probably long since disappeared or been corrected.

Although the three major problems have been described separately, it is not suggested that they are independent. The careful reader may

have noticed that some of the underlying sources of the first two problems reappeared as possible sources of the third. The following approaches to eliminating these problems will, therefore, be directed at the underlying causes rather than to the specific problems.

Approaches To Improving Performance of Budgetary Control System

1. Perhaps the *first* requisite for an effective system is that its objectives or intended uses be carefully defined and well understood by all parties involved. This is critical for a number of reasons. First, the design of the system's procedures is affected. For example, if the detection of operating problems in a process or activity is the purpose rather than long term evaluation of performance (perhaps to reward or punish managers) then much more emphasis must be placed on rapid feedback of information, proper measures and classification of measures that help locate operating problems, etc.

Second, while clear definition of the objective of the system may not be sufficient to ensure acceptance of that objective by all parties involved, it probably is necessary. It will help to avoid mistrust by the operating personnel of the motives of the measurer in performing the various procedures necessary for the operation of his system.

2. There should be careful definition of and agreement as to the appropriate balance between objectives in the performance of an activity. Where more than one objective is important, the standard performance level defined in terms of any of these objectives must be set so that the proper balance of all is attainable, e.g., standard costs set high enough to allow quality standards to be met. It is often necessary and frequently useful to measure and compare with standard levels the performance of the activity with respect to each objective. This should convey to those performing the activity that one objective must not be sacrificed to attain another. It may also provide better clues as to the cause of any non-standard performance detected.

Correctable problems resulting in inefficient performance of an activity need to be quickly identified and corrected, while investigation of variances resulting from measurement errors or uncorrectable problems are costly and futile.

3. An appropriate method of measuring performance towards each of the desired objectives must be established. Procedures or techniques of such measurements probably do not need to be understood by all personnel engaged in the activity being measured (although frequently such understanding can stimulate suggestions for improvement) but the measurement process must be trusted. It should provide measurements which—

(i) improve noticeably with recognised improvements in performance, and conversely, reflect decreases in performance appropriately,

(ii) cannot be affected by performance of other activities,

Standard or expected levels of performance must be determined with careful delineation of any assumptions inherent in those standards such as assumed linear relationship between costs and activity levels or the attainability of the standard level, given assumed operating conditions.

(iii) cannot be manipulated by means othre than changing performance level.

4. Standard or expected levels of performance must be determined with careful delineation of any assumptions inherent in those standards, such as assumed linear relationships, between costs and activity levels, or the attainability of the standard level, given assumed operating conditions. This is critical because one class of causes of non-standard performance results from performance under (possibly unavoidable) conditions other than those assumed in defining standard performance. Standard performance levels other than those which are reasonably attainable should be used only after careful consideration of possible motivational affects.

5. The consequences of all economically correctable causes of poor performance of an activity (or the existence of an operating problem) should be carefully analysed so that the performance measures affected can be determined. In this way the range of possible correctable causes of non-standard performance of each measure can be noted. This may allow a narrowing of search procedures required to specifically identify problems detected.

6. An efficient and effective means of determining which reported variances deserve attention should be established. Correctable problems resulting in inefficient performance of an activity need to be quickly identified and corrected, while investigation of variances resulting from measurement errors or uncorrectable problems are costly and futile. Discrimination between these types of variances is, therefore, crucial if problem correction is an objective of the system. It is also crucial for the objective of long-run evaluation of the supervisor of the activity since uncontrollable variances (especially those resulting from measurement error) should not be allowed to affect the evaluation of his performance.

7. A careful study of the existing responsibility and authority structure should be made to enable—

(a) determination of appropriate classification of performance measurements to extract the maximum information out of comparisons with standards, and

(b) careful matching of performance comparisons (measured variances) in performance reports with the responsibility and authority structure.

This is essential if the feedback loop is to be complete because the initiation of investigation and corrective action requires that those in a position to make decisions with regard to the process or activity receive notice of non-standard performance resulting from a possible, correctable cause within their sphere of influence. If performance comparisons are mismatched, the person with influence may not receive notification and will have no reason to act, and persons without influence may receive notification and not be able to react with the appropriate

decisions. The person receiving the information, in fact, is likely to initiate activity within his sphere of influence and, when no effect results, may justifiably become mistrustful of the benefit of the information and any judgments which might be made about his performance based on that information.

Summary

Several major difficulties interfere with the effectiveness of a budgetary control system. Continued effective use of such a system requires a certain sensitivity to the possible sources of those difficulties and a means of responding to them.

In the previous discussion, three broad areas of difficulty were described, some sources of those difficulties identified, and some approaches to minimizing their effects suggested. The discussion was purposely made brief to convey a broad range of ideas rather than to pursue any specific ideas in depth. The following list of references should be helpful to the reader desiring greater understanding of these ideas.

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Emerging Pattern of Bank Credit and Role of Audit

BK Vora*

With the changed priorities, following nationalisation of 14 banks, the banks are to increasingly cater to the credit needs of hitherto-neglected and weaker sectors of the economy. In this context, the principle of supervised credit and scrutiny of the repayment's potential has acquired great significance. The author discusses the salient features of Bank's loaning policies, principles, procedures and other relevant aspects. He discusses the role of audit in being selective in detecting irregularities, and also enumerates the various points which are significant and require close scrutiny.

With the nationalisation of 14 major banks, banking concept has acquired a new meaning and significance. Conventional banking is yielding place to creative banking. New and challenging responsibilities have devolved upon banks to expand functionally and geographically so as to enable them to fulfil certain socio-economic objectives. It is one of their primary responsibilities to spread the banking habit among the poorest and render banking services in the remotest corners of the country. In assessing the credit-worthiness of the potential borrower, the emphasis has shifted from security to production. The purpose for which an advance is taken has become the most important consideration for a bank to lend money. Advances for unproductive purposes or for speculation or for hoarding and profiteering are to be totally discouraged.

As an effective instrument of economic development, the major responsibility of banks is to ensure equitable dispensation of credit among the various sectors. Until recently, banks confined their operations to financing big industry, trade and commerce with an urban-oriented branch network. The character of lending was, besides being security-oriented, profit-motivated. In this process, the agricultural sector which contributes about 50% of the national income and small industries sector which contributes about 40% of the total industrial production were neglected. Transport operators, artisans and a large number of other weaker sections of the community seldom had access to banking. With the changed priorities, banks are to increasingly cater to the credit needs of the hitherto neglected and weaker sectors of the community such as small borrowers like farmers, small business and industry, transport operators, professionals and self-employed persons. Further, the responsibility of banks does not end with dispensing credit; they are expected to ensure that borrowed funds are utilised for the purpose for which they were taken. The principle of supervised credit and scrutiny of

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the repayment potential have acquired great significance, the ultimate objective being to put these weaker sections on a viable and strong footing. Another area now engaging the attention of banks is generation of employment by financing more and more job-oriented projects.

Banking industry has made rapid strides in the recent past in fulfilling their varied functions and is now well poised to play a still more constructive role in the country's economic progress.

The salient features of banks' loaning policy, principles, procedures and other relevant aspects, are briefly discussed here.

LOANING POLICY AND PROCEDURE

Main Objectives

(a) Protection of depositors' interests
(b) Ensuring a fair rate of return with adequate prospects
(c) Bridging credit gaps and removing regional imbalances
(d) Dynamic role in overall economic development of the area of bank's operations.

Basic Principles of Sound Lending

(a) Safety
(b) Liquidity
(c) Profitability
(d) Purpose of lending
(e) Consistency with Government economic policy and the central banking policy
(f) Diversification.

Main Criteria of Creditworthiness

(b) Borrower (Character, calibre, past experience of the bank, value of the connection etc.)
(b) Business of the borrower
(c) Capital resources of the borrower
(d) Amount required
(e) Purpose of the loan
(f) Source of repayment
(g) Security
(h) Yield.

Different Categories of Borrowers

1. Large and medium scale industries
2. Wholesale trade
3. Agriculturists
4. Exporters
5. Small scale industries
6. Technically qualified entrepreneurs
7. Road-transport operators
8. Taxi, scooter, auto-rickshaw drivers and cycle-rickshaw pullers
9. Retail trade
10. Professionals
11. Artisans and other self-employed persons
12. Students.

Different Types of Borrowers

1. Individuals
2. Proprietorship and partnership firms
3. Limited Companies
4. Other unclassified borrowers.

Forms of Credit Facilities

1. *Loan*—This is an advance where the entire amount is paid to the debtor at one time and no subsequent debits are allowed except by way of bank charges.

2. *Overdraft*—Overdraft is a fluctuating account operated both ways, the balance sometimes being in credit and at other times in debit. Overdraft facilities are usually allowed in Current Accounts only.

3. *Cash Credit*—This is a drawing account ordinarily to be operated up to a certain specified limit which is granted against pledge, hy-

pothecation or against personal securities in the same way as Current Account.

4. *Bills Purchased and Discounted*—These advances are allowed by purchasing demand bills or discounting usance bills, which may or may not be accompanied by documents of title to goods such as R/Rs. M.T. Rs.' (Motor Transport Receipts), bills of lading, etc. The Bank makes the advance to the borrower (seller of goods) on presentation of such bills and collects the amount from the drawee (buyer of goods) on respective due dates.

5. *Term Loan*—This type of advance is allowed to industries for purchase of fixed assets (i.e. land, building and machinery) and is repayable by instalments over a number of years ranging from 3 to 7—sometimes even 10 years. The block is mortgaged to the bank as security.

6. *Participation Loan*—These loans are granted by two or more banks agreeing to advance jointly to a borrower in certain agreed proportions against common security in cases where the loan requirement (both fixed as well as working capital requirements) of the borrower is large.

7. *Deferred Payment Guarantee*—These guarantees are issued by banks on behalf of their customers in favour of their suppliers guaranteeing payment in agreed instalments (generally half-yearly) of cost of machinery purchased by them.

8. *Letter of Credit*—Letter of Credit is an undertaking given by the bank of a buyer to the seller that all documents of title to goods drawn in conformity with the terms and conditions of the L/C will be duly honoured by the bank upon presentation.

9. *Letter of Guarantee*—Letter of guarantee is an undertaking issued by a bank on behalf of its customer guaranteeing the performance of a promise or discharge of a liability in case of default on the part of the latter.

10. *Hire Purchase Advance*—These advances are allowed to parties engaged in the hire-purchase business relating to cars, radios, refrigerators, sewing machines etc.

11. *Multani Hundi Advance*—Advances are allowed to indigenous bankers by discounting clean hundies drawn by third parties (borrowers of funds from multani bankers) in their favour and duly endorsed by the latter in favour of the bank.

12. *Personal Loans*—These loans are allowed for limited amounts to customers for purchasing articles for their personal needs and are repayable by instalments over a period of 12 to 36 months. They are also known as 'Consumer Loans'.

13. *Packing Credit*—This is a short-term advance granted by banks to exporters for assisting them to purchase, process and/or pack for shipment the goods to be exported. These are granted against pledge or hypothecation of goods.

Various Securities

1. Goods, i.e., raw-materials, stock-in-process, finished goods, stores, spares etc. documents of title to goods (R/Rs. M.T.Rs., bills of lading, warehouse receipts, delivery orders etc).

2. Fixed assets i.e. land, building and machinery

3. Book debts.
4. Agricultural land, Agricultural equipment such as pump sets, ploughs, tractors etc., cattle and livestock, standing crop.
5. Shares and debentures, Government securities, Unit Trust Certificates, National Savings Certificates etc.
6. Life Insurance Policies
7. Misc. securities.

Various Charges

1. Pledge
2. Hypothecation
3. Lien, and
4. Assignment

EVALUATION OF LOAN PROPOSAL

In short, while evaluating a loan proposal the following points need to be answered :

1. Who is the borrower and what is known of his ability, professional competence, integrity and experience in the particular business or line of work ?
2. What are the general prospects of his trade or profession ?
3. Do the borrower and his business inspire confidence ?
4. What is the purpose of the advance ? Is it a project, which commends itself to the desired role of banking or is it a long-term capital outlay ?
5. Has adequate margin been allowed for possible increase in cost ?
6. What is the source of repayment and when is it likely to be made ?
7. Is the project a viable one which can be reasonably expected to give a meaningful return to the borrower, enable him to pay back interest and also the instalments for repayment of the advance ?
8. Is the relationship between the maximum advance and the existing capital resources of the borrower reasonable and is the customer expecting the bank to provide too large a stake in his business ?
9. What is the security available ?
10. Is the value sufficient to furnish the desired margin ?
11. Can a valid title be obtained without undue complications ?
12. Can the security be perfected before the advance is taken ?
13. What would be the proper rate of interest in consonance with the risk involved, keeping in view the desirability or otherwise of the project/business/profession from the national point of view.

Valuation of Security

Raw-material, stock-in-process, finished goods, imported goods, immovable properties, shares, government securities, debentures, life policies etc. at cost or market value, whichever is lower.

Priority Sector Advances

Certain important sectors of the economy which had not received adequate attention from banks in the past as did the large and medium size industries and wholesale trade and where large credit gaps still exist, banks as a matter of policy give them preference in the matter of extending credit assistance. The following types of advances constitute, by and large, what are commonly called 'Priority Sector Advances' :—

1. Advances to Small scale industries for fixed capital and working capital requirements including distribution finance.

2. Agricultural advances.
   Direct Finance :
   Production finance against seeds, fertilisers, pesticides etc.
   Equipment finance against pump sets, tractors and other implements.
   Plantation (development) finance—poultry farming, fisheries, piggery, etc.
   Construction—storage finance—processing finance.
   Indirect Finance :
   Fertiliser distribution and other inputs distribution finance, loans to Electricity Boards, loans to farmers through primary credit societies, loans to Agro-Industries Corporations, loans to custom service units.
3. Advances to road transport operators for purchase of trucks, etc.
4. Advances to taxi, scooter and auto-rickshaw drivers and cycle rickshaw pullers.
5. Advances to professionals and self-employed persons.
6. Advances to retail trade.
7. Export finance—pre-shipment and post-shipment.
8. Advances to students.

Post-Sanction Audit Irregularities

After having examined the various ingredients of decision-making that go into the final sanction of a loan proposal, the post-finance conduct of the borrower's account assumes very great importance.

In the course of audit work, one would have to be selective in detecting irregularities. Areas where more serious irregularities normally occur should engage the special attention of the auditor in view of the high risk element involved; otherwise it would be almost impossible to check each and every aspect of all borrowers' accounts. The auditor should be fully aware of the common irregularities that exist so that he may concentrate on those in his audit. It might, therefore, be useful to enumerate the various points which are considered significant and require close scrutiny.

Conventional Type of Advances to Large and Medium Industries and Wholesale Trade :

1. Overvaluation of the stocks pledged to the Bank.
2. Acceptance of stocks not approved as security by the Bank.
3. Under-insurance or non-insurance of stocks held as security.
4. Non-submission of lists of inventories of stocks hypothecated to the Bank.
5. Excess accommodation allowed beyond the permissible drawing power and/or sanctioned limit.
6. Improper and defective execution of loan documents.
7. CRs on borrowers/guarantors not reviewed in time.
8. Failure on the part of the Managers to conduct regular inspection of stocks pledged to the Bank.
9. Arrears accrued on account of non-payment of instalments in time in respect of term loans.

Irregularities Revealed on Analysing Financial Affairs of Corporate Borrowers

1. There is a tendency, particularly in case of Private Limited Companies, to keep the capital base very low. The Company's work is carried on by raising Unsecured Loans from Directors, their relatives and other acquaintances.

2. In the case of some companies, it has been observed, the Preference Capital is much more than Equity Capital. There must be a balanced inter-relationship. Moreover, in the case of Redeemable Preference shares, the companies should be able to redeem the same easily out of their own resources.

3. Companies raise term loans by issue of Mortgage Debentures or by mortgage of Block Assets. It should be ascertained that Block Assets are sufficiently adequate to cover such loans after keeping the requisite margin, which is generally 50%. Sometimes such loans are not used for the purpose they are raised, but diverted to meet working capital requirements. This tendency should be checked.

4. As regards short-term loans raised from Bankers against Stocks and Stores, it has been observed in some cases that the security is not sufficient after keeping the necessary margin. Funds acquired for working capital purposes should not be diverted towards acquisition of fixed assets and/or investment of a fixed nature.

5. There is an increasing tendency on the part of Companies to raise deposits and/or loans from public. Such deposits/loans should not be on the high side when compared with other liabilities and shareholder's Funds.

6. 'Sundry Creditors' for goods should be compared with the purchases made during the year to find out if the payment to creditors is regularly made. If not, Company might be in financial difficulties. 'Sundry Creditors' for expenses should generally not exceed one month's expenses.

7. It is sometimes observed that either the provisions for taxation is not made or such provision instead of being treated as liability is treated as Reserves. While assessing the financial position of a Company, this point should be kept in view.

8. Similarly, provision for dividends is not generally made and it is remarked in Directors' Report that the same would be paid out of Reserves, as and when declared. The amount of such dividends should be treated as liability at the time of assessment of the financial position of the company.

9. Fixed Assets should not include any obsolete items and adequate provision for depreciation should be made. Further the Book Value of Fixed Assets should not in any case be more than the aggregate amount of Shareholders Funds and long and medium term loans.

10. There is a tendency to make investments in the shares of other Companies under the same management or companies and firms in which directors are interested as directors or partners. Such investments are generally of a fixed nature and it becomes difficult to realise them when needed. This tendency should be avoided as far as possible.

11. Stores often constitute quite a good percentage of Current Assets and it should be ensured that they do not include any obsolete items. Moreover, they should not be more than the actual requirements for consumption over a reasonable period according to the need of Industry.

12. Stocks comprise raw materials, stock-in-process and finished goods. It should be ensured that the stocks are not accumulating. The quantum of Raw Materials held may be compared with their consumption during the year to find out whether or not the inventory is on the high side. Similarly finished goods

With the rapidly changing banking panorama, an auditor's role is not just routine checking and balancing of accounts but calls for a high degree of imagination, innovation and adaptability.

may be compared with total production or sales to find out that no accumulation is taking place.

13. As regards valuation, the stocks should be valued correctly i.e. at cost or market value, whichever is lower. There is a tendency to buy raw materials in bulk when the prices are lower. This results in increase in prices of such goods and also helps in hoarding and speculation. Such tendency can be effectively checked by banks by levying higher interest rates and higher margin requirements.

14. Debtors should be analysed according to the period of the outstanding debt and a relationship between credit sales and debtors should be arrived at to know whether the same are being realised according to the schedule. If any delay in realisation is observed, it should be probed into.

15. Loans and advances constitute quite a good portion of Current Assets. It should be ensured that these are in respect of genuine trade transactions and easily recoverable in cash or kind or adjustable against certain payments to be made by the Company.

16. Advances are at times made by the Company to firms and companies in which Directors are interested in one way or another. Such diversion of funds necessitates raising of loans by the Company from Banks or Public. This is not a good feature. Banks should see that such advances are not encouraged.

17. To find out whether the Company is working efficiently or not, the capacity of the plant and efficiency at which it can easily work should be gone into. These can be found out from Project Reports. The actual capacity at which the plant should work then be compared with the rated one. It is a normal feature that the full capacity is generally reached within two/three years of commencement of production.

18. Cost of Production should be thoroughly analysed and compared with the standards fixed, if any, Any variance in its composition should be thoroughly probed into. This would give an idea whether the Company is efficiently working or not. Moreover, where this would help the Bank's constituents to know their shortcomings, it would also discipline them. In the long run, such control would help the nation to raise its output and profitability.

19. The Company should make adequate profits to enable it to pay interest to lenders, taxes to the Government, dividends to shareholders and also leave sufficient amount to be ploughed back to strengthen the Capital base of the Company. In addition, the cash generation should be sufficient to meet the above obligations, as well as repayment of loans etc., and for incurring capital expenditure, if any.

The financial position and efficiency of the Company should be adjudged with the help of ratio analysis such as :

(a) Debt-equity ratio,

(b) Current ratio,

(c) Net profit to net worth,

(d) Gross profit to net worth,

(e) Stocks to sales etc.

Profile of an Auditor in the Changed Context :

An auditor has a duty to make an expert and independent appraisal of the fairness of financial statement of a business undertaking. In the changed context, it is all the more necessary to ensure that the accounting practices followed by the undertaking are adopted to the constantly changing environments. The auditor does not merely have to render service to the business undertaking but has to serve the society at large through proper performance of his functions. As the need for information about the trend of business operations is more important with the changed role of banking, it is imperative to ensure whether the banks have froged new techniques and introduced Scientific Management Information System. In other words, have the Reporting Systems of banks been improved, budgeting techniques devised and sophisticated cost computations introduced? How are the operations of banks planned and controlled? As the role of banking has become multi-dimensional, the trend towards constant use of financial and economic data will be more pronounced in future. The auditor would have to be innovative; for instance, with the large increase in the quantum of work, he would perforce depend upon a proper sampling method. This would involve selection of strategic functional areas for audit purposes. A critical evaluation of the working of a branch will have to be made in order to meet the amazing speed of changes. It will have to be ensured that the process of permeation of the changed concept and philosophy is all-pervasive, i.e. right from the Head Office of the bank in a metropolitan city to the smallest Office in rural area. This might entail effecting necessary changes in auditing procedures and techniques. An over-all view would have to be taken of the achievements of the banks in establishing correct goals and formulation of workable plans, accompanied by constructive action programmes.

Bank Management today can no longer be complacent about increasing costs, especially when they are hard pressed to ensure a certain standard of profit. Having regard to the fact that it is not always possible to compensate for the increasing cost through increases in interest and other charges, cost control and cost reduction become imperative in banks. The auditor would need to examine whether proper cost control or cost reduction techniques have been introduced in banks. It must be appreciated that the total cost of a system is the sum total of the cost of its component elements. It is necessary, therefore that the cost incurred at the grass-root level should be controlled. While satisfaction of customer's needs is most essential, it is equally necessary to have maximum returns. As customers cannot be expected to pay excessive service charges, cost control assumes great importance.

While examining the advances portfolio at branch level, the auditor will have to make sure that they are made in conformity with the policy of the bank. At the controlling office level, the auditor should ensure that proper returns and statements are being submitted in time by branches and advances objectively reviewed. The auditor will have to see that regular periodical inspections are conducted by the Head Office and necessary data reported to various authorities from time to time.

In order to diagnose the real ills by identifying weaker areas and thereby make audit effec-

tive, the auditor would be well advised to pose himself the following vital questions :

1. Are intensified efforts made by branches for greater mobilisation of deposits with a view to bridging the ever-widening credits gaps of the neglected sectors ?

2. Have adequate steps been taken to improve the machinery for processing large applications in order to improve the quality of loan processing ?

3. In order to meet the increasing needs of smaller borrowers, have branches brought into play their ingenuity and endeavour and ensured more effective supervision over small lending ? Do factors such as proper evaluation of small credit applications, utilisations of money borrowed for the right purpose and ability and willingness of the small borrower to repay the loan, when due, receive close attention of branches ?

4. Have concrete steps been taken to finance professionals and self-employed categories and thereby help employment-generation ?

5. Have branches falling in lead districts identified the growth centres urgently requiring banking facilities and taken quick action for banking development in those areas?

6. Have chronic problems of the backward regions been gone into and concrete plans of action formulated ?

7. Another area which has vital bearing on banking development is customer service. Have necessary measures been taken to improve work methods and procedures and ensure constructive involvement of staff in disposal of customers' business ?

8. As effective participation of employees in all-round development of business is most essential, has it been brought about ?

9. As profitability of branch operations is an important factor, have necessary economies been effected ?

10. Whether the cost components of banking operations arising from a variety of new functions assumed by the banks have been worked out ?

11. Are immediately identifiable and quantifiable variables taken into account ?

12. Have social costs or benefits of various operations been taken into account ?

13. Is the banker's judgement based on the totality of cost which should include the factor of social cost benefit analysis ? The validity of the basic concept of measuring costs against social benefits has to be recognised. The financial analysis should particularly take into consideration the social benefits arising from generation of employment in the country. Money cost alone need not guide one in appraising the performance of banks.

With the rapidly changing banking panorama, an auditor's role is not just routine checking and balancing of accounts of a branch, but calls for a high degree of imagination, innovation and adaptability. Banking not only provides him with a formidable challenge to his professional competence but also offers him abundant opportunities to display an astute awareness of his social obligations. □

Automatic Factory : Possibility *Vs* Desirability

Sumer C Aggarwal*

Automation is a philosophy of manufacturing. Its exact definition will vary from company to company and product to product. Basically it is substituting mechanical, hydraulic, pneumatic, electrical or electronic devices for the human organs required for physical effort and thinking process. Powerful social and attitudinal changes are brought about by mechanisation and automation. It is extremely important that before the management introduces automation, it must study the old existing organisational relationships, and remove major points of conflict between the new technology and the organisation. Problems created by automation are no doubt complicated. Introduction of automation requires business and government action to accomplish meaningful adjustments to automation. An immediate need arises for developing abilities, creating jobs and matching people and jobs.

KILLINGSWORTH[1] defines : "Automation is mechanisation of thought, sensory and control process." Automation involves substituting mechanical power for manpower, splitting jobs into smaller and smaller work elements, and developing mechanical thought process and control mechanisms. Wolfbein[2] states that, "Automation is a series of operational steps without human intervention." Friedmann[3] states that automation evolved through 3 stages: (1) the dependent machines were fed, controlled and regulated by men, (2) semi-automatic machines performed some operations automatically but were operated by men, and (3) with automatic machines the man got eliminated and functioned as supervisor or care-taker. Buckingham[4] states that automation is the third stage of continuous technical changes, which have been occurring slowly, starting with mechanisation of the 18th century through mass-production of the twentieth century, and leading to automation since post World War II. Dubin[5] says that "Automation eliminates human intelligence from production activities and substitutes machines in controlling and regulating

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production operations". John Diebold has even named automation as the Second Industrial Revolution.

Automatic Factory in no way means that everything is run by computers without men. Right at the outset it must be understood that each and every industry may never be fully automatised. The possibilities of automation are dependent on the nature of the end products. For example, petroleum products lend easily to automation, because they need to be mass-produced; automobile production can only be part-automation, because of heterogenity of thousands of parts of different sizes, shapes, materials and colours; whereas automatisation of shoe or garment industry will involve insuperable difficulties because of a large variety of sizes, styles, materials, etc. In many industries automation is not progressing rapidly, while in many others, the pace of automation is real fast; even service-industries are picking up, by using self-service devices, automatic elevators, etc. Electronic computer has introduced automation into the office as well, but still only a small portion of office and factory workers work in automatic settings.

Finally we can say that automation is a philosophy of manufacturing, its exact definition will vary from company to company and product to product. Basically it is substituting mechanical, hydraulic, pneumuatic, electrical or electronic devices for the human organs required for physical effort and thinking process. Automation principles involve mechanisation, continuous process, automatic control and rationalisation, and automation is a synthesis of all these four elements. From technological and managerial point of view, the basic elements of automation are: (i) mechanical-handling, (ii) machining or processing, (iii) sensing, testing or inspection, and (iv) automatic regulation and control.

Present State of Automation

Wolfbein[2] surveyed in detail the changes brought about by inventions and automation. There are 14 major fields or areas, in which the changes of great significance have occurred. Those are:

(1) *Agriculture*—Mechanised machinery increased productivity, it has resulted in great drop in farm employment (from 4.9 million in 1963 to 4·3 million in 1971).

(2) *Electronic Computer*—has accelerated processing of business data and solving of even the extremely complex scientific computations.

(3) *Instrumentation and Electronic Controls*—have greatly helped many industries in making progress towards automation.

(4) *Numerical Controls*—of machine-tools or metal-working equipment has greatly advanced automation of parts production.

(5) *Advances in Communication Technology*—have produced automatic telephone operations, TV and Satellite communications. These have also helped in facilitating rapid distribution and utilisation of data, and in centralising control of operations.

(6) *Improvements in Design of Machinery*—is contributing to growth of automation. For example, automatic transfer-lines have been built, which automate handling of in-process materials or parts in-between adjacent machines or process-centers. Other examples are harvesting machines, assembling machines, packaging machines, that introduce automation in their respective operations.

(7) *Automatisation of Materials-Handling*—is progressing at a fast pace, in transportation and other industries through use of more

efficient fork-lift trucks, conveyors, cranes, pneumatic conveyors, electronically-operated unmanned trucks, etc.

(8) *Developments in Metal-Processing*—such as oxygen-process of steel making and continuous-casting process are indications towards automation of entire iron and steel making process.

(9) *Technological Advances in Transportation*—by rail, air, water, highway and pipeline are introducing labour-saving devices. Methods of traffic-control and traffic handling are getting more and more automated. In water transportation containerisation and ships with automatic guidance systems are cutting-out manual operations.

(10) *Technological Advances in Power Production*—consist of automatic control systems. The recently set-up nuclear power stations mostly use automatic machinery and devices.

(11) *Development of New Materials, Processes and Products*—has been occurring continuously, and they have produced controlling influence on market demands, and thus on production and employment in several industries. There are great incentives for development of automated processes and they indirectly accelerate the process of automation.

(12) *Exploration of Oceans*—for offshore-drilling, deep-sea fishing and extraction of mineral deposits has become possible through automatic devices. It also promises sources of food in face of food shortages on land.

(13) *Space Flights*—and the age-old cherished dream of the man, landing on the moon has become reality through a large number of automatic devices, monitors and controls needed for such flights.

(14) *Advanced Weapon Systems*—to a great extent have been designed, making use of automation principles and devices.

The results of the last three areas are providing mankind with tremendous amount of research results, that are expected to help mankind in its most difficult problems of food, health, and probably of proverty.

As regards industries and professions, pace of automation has been fastest in agriculture, because its productivity has been rising by 5.7% per year as compared to overall productivity gain of 2.4% per year. Automobile industry has all the time been substituting automated processes in place of manual activities. Petroleum industry is nearly fully automated, and its per manhour output has been increasing by 6.6% per year. Banking and insurance has used automated electronic data-processing for their fast increasing volume of business with little addition to its number of employees. Automatic vending-machines and other self-service appliances like laundermats have greatly helped increasing retail trade and service levels with little increase in cost. Utilities, chemicals, telephone, coal, paper-making, cigarette manufacture, rolling mills, knitting machines, glass-bottle moulding, packaging, carpet looms, printing presses, screw-machines, mechanical strokers, plastic molding presses, die-casting machines, tyre manufacture, forging, stamping, shellmoulding, automatic core-making, spray-paintings, plating, cable-making and textile are other major industries with a high degree of automation. Continuous automatic assembly-lines are most common with cars, radios or television electronic components, cameras, watches, refrigerators,

air-conditioners, etc. Highly-automated machining is quite common for the manufacture of ball-bearings, pistons, engine-blocks, etc. Processing of huge amounts of paper-work in banks, insurance companies, hospitals, libraries are being automated to a great extent. There are hundreds of other smaller industries and products' manufacture that make use of automatic devices and automation principles in one way or the other. In spite of all this, service industries like restaurants and parks still have comparatively much less of automation.

Projections for the Future

Gradually information machines are getting substituted for human operator. In most cases machines are proving equal to or better than man's intelligence in controlling operations. Attempts towards automatic programming are in progress to substitute computer for man's logic and his tremendous memory capacity. Feedback systems are taking the place of thought-process of the worker through the available information for regulating future operations.

Automation of managerial decisions of well-structured problems is making headway at a rapid pace, whereas the poorly structured problems will surely take longer time before they can be programmed into computer, and some of them may never be automated. Simon[6] predicts that within the framework of automation, managers will have to understand organisations as large dynamic systems with complex man-machine interactions. Further he predicts that by 1985, US companies will have the technical capabilities to manage corporations by machines, and in particular the middle management functions will be completely automated. On the other hand, humans will even then be engaged in a large variety of occupations, as they are now. As machines will take over more and more of routine functions, managements will be preoccupied with preventive maintenance, breakdowns, designs and improvements. To some extent planning will be accomplished by machines, but mostly with the help of man. Operations Research or Management Science are progressively taking care of repetitive decision-making by way of computer programmes, and as time passes, unprogrammed and half-programmed decision-making will also be tackled by heuristic programming.

In future, in the factory and in office, the automation will make advances rapidly. In business and scientific spheres, the electronic computers will help to achieve supernationalism. Slocum[7] predicts that the impact of automatic factory (when realised) will not be equal on everyone, some will be unemployed, others will be working for short hours on low salary, some others will be adequately paid for short hours, and a few will have little leisure just like the present.

Organisational Changes Accompanied by Progress of Automation

Faunce study[8] reports that workers suffer social isolation on automated lines. The amount of supervision on workers gets considerably increased and significant changes occur in

6. Simon, AS, "The Corporation: Will it be Managed by Machines?" *Management and Corporation* 1958, edited by Anshen and Bach, New York; Mc-Graw Hill Co., Inc., 1960, pp. 39-55.
7. Slocum, WL, *Occupational Careers*, Chicago: Aldine Publishing Co., 1966, pp. 39-43.
8. Faunce, WA., "Automation in the Automobile Industry: Some Consequences For in-Plant Social Structure," *American Sociological Review*, Vol. 23, No. 4, August, 1958.

the informal social structures. Automation accelarates change towards rationalisation in terms of rules and regulations against individual (sometimes subjective) decision-making. Autonomy on work-place is lost and increases the need for coordination. Automated jobs require much more attention on the part of the worker and supervisor alike, and very few jobs require team-work settings. The quality of leadership does not offset productivity, except in case of maintenance men and other indirect workers. All automatic processes require the worker, who must be adaptable and flexible. Work in factory becomes lighter and cleaner. Automation enlarges jobs and promotes interdependence. It helps increasing communication horizontally and vertically. Mann and Williams[9] conducted a lognitudinal study over a period of several years in a single firm that was introducing electronic data-processing system and collected data from over 300 interviews. Their findings prove that, with automation, need for coordination becomes acute, job enlargement occurs and as a result flexibility in allocating manpower is achieved. Errors get easily detected and responsibility for errors can easily be traced, but the costs of errors increase tremendously. Workers get highly dissatisfied with their colleagues, who cannot perform up to the standard. Automation is really demanding for the individual employee. The level of decision-making and control moves up, and the operating costs get reduced.

Jasinsky[10] states that automation technology cuts across superior-subordinate relationships. It requires that managers must deal effectively with equals, subordinates and superiors. Conflicts between technology and organisation are not uncommon; these conflicts can force changes either on the organisation or on the technology. Management can bring about integration between technology and organisation in several ways: (1) by changing the technology, (2) by changing the organisation and (3) by introducing the automated mechanisms. It is extremely important that before the management introduces automation, it must study the old existing organisational relationships, and remove the major points of conflict between the new technology and the organisation. On the whole, changing technology increases production and promotes organisational integration.

Shifts in Industrial Relations

In some major industries, like automobile, petroleum refining, chemicals, communications, etc., where automation has progressed at a rapid rate, job displacements do occur, but may not be immediately known, because of fast increasing volume of demand for their products or services. In certain other industries job-lines are rigid and introduction of automation that is accompanied by reassignment of work is strongly resisted by the unions in fields such as maritime trades, the construction industry, railroads, entertainment fields, metal trades and printing trades. Therefore, automation has made very little progress in these areas.

Killingworth[11] states that often automation alters the job-content and the existing man-machine relationship, and in turn forces reconsi-

9. Mann, FC, "Observations on the Dynamics of a Change to Electronic Data-Processing Equipment, "*Administrative Science Quarterly*, Vol. 5, September, 1960, pp. 217-256.
10. Jasinsky, FJ, "Adopting Organization to New Technology, "*Harvard Business Review*, Vol. 37, No. 1, 1959, pp. 79-86.
11. Killingsworth, CC, "Industrial Relations and Automation" "The Annals 340, March, 1962, pp. 69-80.

Automatic Factory in no way means that everything is run by computers without men; each and every industry may never be fully automatised.

deration of wage-determinants and wage-payments. When jobs get eliminated and no residual duties remain to be allocated, the collective bargaining problems are less difficult. Introduction of automation gives rise to borderline cases in job-classification and such types of vagueness makes collective bargaining cases most difficult to negotiate. Automation transfers control over rate of production from the worker to the machine, and thus has completely destroyed the rational of incentive payments. As automation spreads, the incentives will disappear. However, some companies now-a-days base their incentives on the percentage of utilisation of automated equipment to optimise utilisation. In an aggregate analysis, automation has decreased job security, and has created a trend towards white-collar and professional workers' unions. There may be some validity in the theory of reabsorption of displaced labor, but inefficiency of labour-market redistribution cause extreme difficulties and hardships for many workers.

Seligman[12] reports that as automation proceeds, the jobs gradually disappear, because the companies do not fill vacancies when the employees get transferred or retire. Automation increases the demand for higher and higher skilled employees. No doubt, it increases the productivity, but at the same time adds to the number of unskilled unemployed persons. Workers in automated environments, who control, all the time, panels and lights, develop neurotic fatigue, and irritability. For the workers, jobs like that of programmers and computer operators take up a managerial look, but promotions into their ranks from the workers level become nearly impossible.

Kassalow[13] establishes that automation redistributes labour-force between white-collar workers and production (or blue-collar) workers. New labour-management system becomes necessary, because the problem arising out of automation are extremely complex, such as severance pay plans, supplementary unemployment plans, retraining of workers, etc. Collective-bargaining is now-a-days considering more and more of worker's inherent property rights in his job. In this way, cost of automation is not totally borne by the workers, rather the fruits of automation get genuinely distributed. Government Programmes (Manpower Development Act of 1963). and increased acceptance of public responsibility thesis are greately helping to mitigate the hardships and dislocation of workers.

Optimism and myth about "more automation, more jobs" stands completely shattered. Increase in productivity and displaced workers, at times both, cannot be easily absorbed by the growing economy. Automation does not upgrade skill levels, it only introduces more complex machinery. Job-enlargement is in the form

12. Seligman, BB, *Most Notorious Victory : The Man in an Age of Automation*, New York: The MacMillan Co., 1966, pp. 339-358.

13. Kassalow, EM, "Labor Relations and Employment Aspects, "*Automation*, edited by M Phillipson, pp. 319-333, Random House Publications, 1961.

of greater variety of machinery rather than complexity of job-skills. A study showed that in the office, for every five jobs eliminated by automation, only one new job got added.

Friedmann[3] stresses that automation does create unemployment, and Ford's theory of labour mobility now stands totally refuted by the facts. Therefore, he suggests that economic benefits of automation must be shared by those, who actually get badly affected, i.e., by the workers.

Automation, Social Environments and Alienation

Powerful social and attitudinal changes are brought about by mechanisation and automation. Moore[14] discusses that automation has greatly reduced the worker's liberty and accelerated the obsolescence of his skills. Wolfbein[2] describes that automation has considerably changed problems of working and living. Most major occupations and industries have been affected by advancing automatisation, but still the productivity of service industries like restaurants, parks, bathing pools, etc. has been affected only a little.

In fact, automation has many stages and types. Much of debate over the changes wrought out by automation is due to this diversity. That is why Faunce[15] and a few others have somewhat different views and state that automation reduces the variety of tasks to be performed. According to them, automation dictates recombination of tasks; they give the example of the operator, who must possess a combination of mechanical, hydraulic, electrical and other skills. This way automation seems to be reversing the historic trend towards division of labour and specialisation; and is producing job-enlargement and lesser number of job-classifications. They state that it also reduces the amount of alienation and anomalies created by mechanisation (many others disagree with them as in the following).

Blaumer[16] discusses four types of alienation caused by automation: (i) meaninglessness, (ii) isolation, (iii) self-estrangement, and (iv) powerlessness. Under such circumstances, the individual becomes an object rather than a person. Alienation varies from industry to industry. In automated situations, workers often lack control over the work-processes. They become alienated from their inner self while performing tasks. Their labour is not voluntary but of coerced type, and they feel being of low status and of little worth. Alienation splits values, behaviour, expectations apart, whereas they in reality make the person a whole. Merten[17] cites that automation creates requirements for the increased discipline and inflexible individual behaviour. At times automation has been used for subduing the worker by threatening to displace him. Faunce[18] attributes alienation to automation. Alienation breeds apathy, low aspirations, over conformity and non-purposeful life-style amongst workers. The best example of alienated workers is to be found on the assembly-line. Assembly-line worker does not identify himself with his job. The range of wages on the line is very narrow,

14. Moore, WE, *Industrial Relations and the Social Order*, New York: The MacMillan Co., 1951, pp. 241-249.
15. Faunce, WA, "Automation and the Division of Labour, "*Social Problems*, Vol. 13, No. 2, Fall, 1965.
16. Blaumer, R, *Alienation and Freedom : The Factory Worker and His Industry*, The University of Chicago Press, 1964, pp. 24-34.
17. Merten, RK. "The Machine, the Worker and the Engineer, "*Science*, Vol. 105, June 24, 1947 pp. 79-81.
18. Faunce, WA, *Problems of Our Industrial Society*, New York : McGraw Hill, Inc., 1968, pp. 100-115.

All automatic processes require the worker, who must be adaptable and flexible. Work in factory becomes lighter and cleaner. Automation enlarges jobs and promotes interdependence.

hardly ±50 cents per hour, and as a result his opportunities for advancement are very few. He feels trapped by his comparatively higher wage-rate and lack of alternatives.

Widespread automation can create problems in families and communities, because it forces 3-shift working by rotation on most factory workers. Accelerated occupational changes caused by automation would require greater emphasis on general education of very broad nature, that would allow flexibility in adjusting to unforeseen changes. Ogburn and Nimkoff[19] sum up that auotmation has affected modern social life in a big way. They cite city as the direct result of mechanisation and automation in manufacturing and transportation. City in its turn breeds crime, suicide and divorce. Continually advancing automation has greatly influenced the social institutions, such as family, birth and death rate, and religion. Even the state functions have been strongly influenced by automated manufacturing production and automatised transportation and communications.

19. Ogburn, WF and Nimkoff, MF, Sociology, 3rd ed., Houghton Mifflin Inc., 1958, pp. 670-695.

Changes in Management Thinking and Decision-Making Processes

Hill and Harbison[20] link progressing automation to the rate of increase in the effective utilization of high-talent manpower. Shills[21] notes that automation reduces flexibility. Labour costs do not change with rate of output, because most employees are salaried technicians or maintenance men. For managers, managing of automated plant can be very tough, because it needs precise planning and integration. Decision-making levels get reducedand decision-making gets centralised. Automation forces closer contact between management, technical personnel and maintenance staff and thus provide better human relations. Managements need to be of high standard with personal characteristics like adaptability and versatility. They must constantly reeducate themselves about new methods of work and also initiate new and creative studies about the on-going factory operations. Killingworth[21] stresses that the hypothesis "Automation does not eliminate jobs" is based on the assumption of full employment and mobility of labour. Automation must come slowly because the business managers cannot scrap billions of dollars worth of existing equipment overnight, but sometimes they may be compelled by the competitors to automatise their operations at a real fast rate.

Seligman argues that stories about reduced prices because of increased productivity from automation are not wholly true. Prices of new products like TV sets, washing machines, va-

20. Hill, SE., and Harbison, F, "Manpower and Innovation in American Industry," Industrial Relations Section, Princeton University, 1959, pp. 59-69.

21. Shills, EB, *Automation and Industrial Relations* Holt, Rinchart and Winston, Inc., 1963, pp. 1-14.

cuum cleaners, airconditioners, etc. will surely be high in the initial pilot-plant and demand growth stages, because till then their processes of manufacture are new and cannot be optimum. Slowly the prices get stabilised, after that there are no price-reductions. In industries like iron & steel, metal-working machinery and chemicals, prices remain same or keep increasing in spite of thier continuously-increasing level of automation.

Terbourgh[22] thinks that persons perturbed by unemployment due to automation are alarmists. He highlights that automation process improvements lead to product improvements. He cites that several studies on manufacturing industries have indicated that there is no correlation between productivity changes and changes in employment levels, rather historically the technological progress and full employment have remained compatible. The main thing is that full-employment economy must be maintained.

Management decision-making depends upon economic, institutional and technical factors. Their main objective for introducing automation is always cost-reduction, and another criterion has been the payback period. Demand-growth can be easily absorbed by the built-in capacity of automated machines. Persistently rising wages and fringe benefits can be kept under control, because of cost stabilisation possible with automation. Automation improves product quality, accuracy of work, customers' service-level, and image of the company.

Disappointments with Automation

Often automation imposes a burden on the company in the form of compulsory unemployment, and compulsory workmen's compensation, which in turn get transferred onto investors and consumers. Automation always requires large amounts of capital investments, and for some companies it can be hard and constraining. Automatic machines generally have limited flexibility as regards change of product. When companies do not expect business growth, this factor works strongly against automation, except in cases of fight for survival. At times, managers develop undesirable enthusiasm for automation and introduce it, whereas increase in productivity of the factory operations may have been achieved through improvement in operation methods and in the existing organisation. This has been proved in several studies on warehouse order-filling operations, materials-handling, etc.

At times, automation has proved itself disappointing, when estimates about cost-savings and increased productivity were found wrong after having worked with it. Automation often makes underutilisation a serious problem. With automation followed by alienation, workers accept passively their inability to influence the conditions of participation. They lower their aspirations and some of them get tempted to use illegitimate means to achieve their goals or objectives. During times of recession, abundant supply of cheap money may accelerate automation and thus may cause additional unemployment and further complicate the recession. Slogans like "Automation represents progress," "Automation helps meeting the foreign competition" are not proved by empirical facts. In reality, productivity gains have been accompanied by unjustifiable wage-increases only for the employed ones. Theory and factual data prove that automation requires high level of real wages, otherwise marketability of goods and capital accumulation come to a halt. In most industries increases in productivity have been from 3 to 10

22. Terbourgh, G, *The Automation Hysteria*, Washington, D.C.: Machinery and Allied Products Institute, 1966.

per cent per year and employment has decreased from 1/2 to 8 per cent per year; which means lower efficiency per manhour together with the increase in unemployment. There have been optimistic projections about increases in employment, but the labour market all the time during the last decade has only been waiting for the vast new industries to come up. When with the increasing output, demand also expands, then new jobs indeed are created. In times of high unemployment even government monetary and fiscal policies help temporarily, but cannot correct all the harmful effects.

Conclusions

In spite of increase in productivity and demand growth, automation increases unemployment because of silent firing—not filling the new vacancies, not hiring additional hands as production expands. A large number of workers get dislocated and suffer from the occupational shifts. This requires private business and government action to accomplish meaningful adjustments to automation. An immediate need arises for developing abilities, creating jobs, and matching people and jobs. Only then we can realise the full economic and social benefits of automation.

It is well accepted that all the members of the society must get goods and services; then why individual workers only should get penalised by automation. Therefore, it will be highly desirable that a centralised national employment agency is set-up and the national programmes to relocate workers, dislocated by automation, are made permanent.

With further automatisation, there is likely to be a decline and eventual disappearance of human labour from production processes. If such a thing ever happens, each member of society must be kept supplied with goods and services, just because he is a human being and member of the society.

In 1966, National Commission on Technology, Automation and Economic Progress recommended several changes in government programmes for relocating displaced workers: (1) provide education to all, (2) provide work on community enterprises, (3) guarantee a minimum family income, (5) set-up central computerised service to match men and jobs, and (5) make the programme for relocating workers permanent.

In summary it can be said that the problems created by automation are extremely complicated, than what the proponents of automation think and argue. Many questions remain unanswered and are still being debated. What is the optimum rate of innovation? How progressing automation in one segment of economy affects other segments? How geographical dislocations affect regional economies? Can the demand always keep pace with output? How capital accumulation can be regulated, so that a balance between savings and investments is maintained? Should companies pay unemployment wages to unemployed (that are earned by the machines)? In fact, there are no straightforward answers.

If and when the automatic factory stage is obtained, then how desirable will be the unemployment! It is most likely that the wealth and power will then be possessed by a few only. Under those circumstances, majority will remain unemployed. Will the unemployed ones remain satisfied with a little of unemployment compensation? Slocum[7] suggests that some of them might become aggressive activists, or turn themselves into "Bully Boys of Hitler"—a situation that horrifies everyone. □

PRODUCTION MANAGEMENT — TEXT AND CASES by BK HEGDE, Melvyn R Copen, R Balachandra and CNS Nambudiri, Published by Prentice-Hall of India Ltd., New Delhi, Pages 456, Price Rs 23.75.

The book under review contains cases and textual material related to Production Management. The prime objective of this book is to serve as an effective teaching aid by dealing with both concepts and their situational application. The book provides text and cases on following aspects of Production Management : costs for decision, operations efficiency and improvement, layout of facilities, planning of production, quality and cost control and human elements of production. The last section of the book contains integrative cases which bring out inter-relationship between production system on the one hand and marketing and financial systems on the other.

The text is clear and concise and, wherever possible, concepts have been clarified with numerical examples. The cases are well written. The fact that these cases have been drawn from Indian situations will go a long way in exposing our students to the climate of Indian business and the problems of Indian managers.

It must be mentioned here that this book does not deal with sophisticated quantitative techniques, like PERT/CPM, Linear Programming, etc as it purports to be a text for an introductory course.

The authors should be congratulated for bringing out such a useful book and it is hoped that this book will prove to be a stimulus for similar publications from other management institutions. Those who have perused this book will surely be eagerly waiting for the supplementary volume, now under compilation by the authors, which will be more quantitative oriented.

—TA SADASIVAN

MANAGEMENT AND ORGANISATION DEVELOPMENT : A BEHAVIOURAL SCIENCE APPROACH by Abad Ahmad, Published by Rachna Prakashan, New Delhi, 1972, Price Rs 18.

Developments in the intellectual disciplines of management and organisation and in the practices followed by enterprises in these contexts have been so rapid and complex in the advanced countries that to catch up with them appears to be an impossibility. The literature

on the subject has grown at tremendous pace but Indian publications on these subjects have been very few and far between. Students of management in Indian universities have to a large extent to rely on foreign textbooks. In the circumstances, the present study by Dr Ahmad is a welcome addition to the meagre Indian literature on the subject. It is welcome also from the point of view of the fact that it gives a fairly competent summing-up of the different strands of thought in these fields and a critical appreciation of authors and their works covering a wide area of management and organisation. Behavioural implications of management and organisation have a pattern that is required to be discerned by every manager and student of management. The author gives a competent account of all these developments in a fairly short compass easy to assimilate and interesting to follow.

Starting with the distinct features of managerial role in a modern organisation, the author stresses the importance of behavioural sciences in management, the concepts that have evolved in this field and the prospects that have led to a better understanding of both structural and functional roles of management. He traces the theory of organisation as it has evolved from practice as also from the contribution of different intellectual disciplines. The importance of leadership and motivation and the elements that comprise leadership have been discussed with reference to the contribution of different authors on the subject. He succinctly puts the prerequisites for leadership effectiveness, as leader behaviour, situational requirements, personal characteristics of the leader and the group. The requirements of sensitivity and behavioural flexibility suggests themselves as key features of leadership effectiveness. The new discipline of organisation development has been dealt with by the author in respect of the various characteristics of this area of study, the contributions of research in different countries and the status of the subject in India. Acceptability of OD has been affected adversely by the non-acceptance of the modern concept of the role of an external consultant. The author is right that expectations from consultants run too high in our enterprises. Our managers expect that an external consultant should and will provide the panacea for all ills from which an enterprise suffers at a point of time. Indeed OD, as the author stresses, has a lot of future in this country, provided our enterprises show an intelligent appreciation of what it can deliver.

In the chapter on Problems and Challenges Before Indian Management, the author shows his awareness of the typical problems from which management in India suffers. He pleads for professionalisation of management and chalks out the ways in which the Indian manager should approach his problems. He requires to be more sensitive to the social environment of the organisation, so that his leadership function remains in harmony with the social ends. He cautions that the professional manager does not wield a magic wand. Systematic and persistent efforts in this direction are, therefore, called for. In the last chapter, the author emphasises the need for closer rapport between the university and industry to stress their complementary role. He makes some relevant introspection about the quality of materials to be dealt with in the universities in order to achieve the ideals before them. A clearer idea of what is sought to achieve and a greater stress on maintaining high standards in selection of teachers, students and teaching materials would lead to making university education more relevant for management. Where knowledge is business it has to be qualitatively acceptable

from the point of view of the extremely trying conditions in which such knowledge is tested over time and with all knids of kicks arising from failures. He is right in suggesting that in the long run, the universities with their vast inter-disciplinary resources and academic traditions can provide the right environment and setting for developing knowledge and programmes that will strengthen and enrich education for management.

—P CHATTOPADHYAY

DIMENSIONS OF INDUSTRIAL RELATIONS IN INDIA edited by BS Bhir, Bombay, Published by United Asia, Bombay, Pages 169, Price Rs 20.

This volume edited by Dr BS Bhir is based on the set of papers contributed to the special number of United Asia, published on the occasion of the Golden Jubilee of the International Labour Organisation. The papers contributed to the special number along with some additional ones constitute the contents of this book. The book is divided into two sections. Section I deals with the theme India and the ILO, while Section II is deveoted to Dimensions of Industrial Relations in India. There are six papers in the first section and fourteen in the second. Contributions to this volume are from senior people drawn from among the politicians, practitioners as well as academicians.

The editor, in his preface, mentions that this publication is a "symbolic expression of tribute" to the contributions of the International Labour Organisation. Papers in Section I report the familiar facts in relation to the ILO, incorporating some appreciative comments for its contributions. On the occasion of the 50th anniversary of such eminent an organisation as the ILO, which was the recipient of Nobel Prize for Peace recently, it is natural to be sentimental, and accordingly liberal in one's appreciations. It is nobody's case that the ILO has not been contributing enormously in the labour and social fields. But one would have thought that the ILO would like to benefit from some critical observations from such eminent a group as the contributors to this volume. Hopefully, the ILO would have liked: (a) that its contributions are noted, (b) that the gaps in its activities are identified and (c) that suitable guidelines are suggested to help towards its greater effectiveness in the fields of its activity. Unfortunately none of the papers have touched upon the last two areas indicated above. Dr Bhir in his paper has taken note of the ILO activities: (a) in setting voluntary standards in labour and social fields, (b) in extending technical assistance to member countries, (c) in promoting human resources development and (d) in adopting the World Employment Programme. Two questions need to be legitimately asked in the context of the ILO's activities. First, how far the standards set by the ILO Conventions are operationally effective? Second, how far the developmental programmes under various categories are really contributing to development? Any casual observer of the labour scene in large number of member-countries would know that there is much to be desired in terms of implementation of the ILO Conventions. As far as the developmental assistance programme is concerned, Dr Bhir notes that during the period 1950-65, 2830 experts and 4050 fellows were available through the ILO. Similarly, he notes that by 1967, 2090 management development, productivity and small scale industry experts were working in the field under the auspieces of the ILO. These are certainly impressive figures, but somebody at the ILO must ask the question

one hand and of not institutionalising it on the other.

To the management, the study endeavours to show, in quantitative terms, the conducive influence of the participative management on the organisational health of an industrial undertaking, measurable in terms of increased productivity and profits and reduced rate of absenteeism. Even more, it calls upon the management to recognise participative management as way of industrial life and to this end gear management policies in such a way so as to help the development of a strong and responsible trade union within the unit—a pre-requisite for effective participative management.

To the trade unions it urges that collective bargaining and participation are not mutually exclusive; if anything, they reinforce each other. The introduction of participation both vertically and horizontally will immediately bring to the trade unions the benefit of a more enlightened, more knowledgeable and more committed trade union cadre and at the same time a better opportunity for improving wages and working conditions of their members through improved industrial relations and thereby improved productivity. Trade unions should, therefore, shed off their fear that participation contributes to either a weakening of the capacity or an undermining of the will of the unions for collective bargaining.

It may be true that this book on 'Participative Management' may not contain any new theory but since it has behind it the support of a field research, it makes a significant contribution to the already existing knowledge that we have on the workers' participation in management.

—VK GOEL

SMALL INDUSTRY PROCEDURE HANDBOOK by KK Mehan, Revised Edition (Nov.72), Published by Productivity Services International, Bombay, Pages 249, Price Rs 27.

As in the first edition, in the revised edition also, Mr Mehan has given useful information about the procedures to be followed in setting up SSI units. In view of the fact that the Government is attaching great importance to the programme of small scale industries development in the country, a large number of entrepreneurs are coming up to set up Small Industrial units. These do not belong to the class of conventional traders alone, rather there has been a welcome change in the thinking of the agriculturalists, the retired servicemen, the qualified engineers and others, to adopt small scale industries as their career. As such, any attempt made to widen their knowledge about the procedural exercise they have to undertake in setting up SSI units is a useful addition to the work already bing done by the Small Scale Industries Development Organisation, the State Directors of Industries, Federation of Associations of Small Industries of India and some of the State Industries Corporations in this regard. More so, when a multiple of institutions are involved in processing the applications of the entrepreneurs, who intend setting up SSI units otherwise, a layman feels a bit confused and worried if he is ignorant of the procedural exercise. To this extent. by putting together all the information needed by the small scale entrepreneurs, Mr Mehan had indeed done a commendable job.

The revised edition is divided into seven parts and latest information and Government policies have been included for the benefit of entrepreneurs. The author himself intro-

duces the book as a 'design to fill a need' i.e. providing guidance and knowledge to those who want to know about small scale enterprises. The book deals with the definition, advantages and material facts about small industries in the first part. While project planning and details of general pattern of assistance specifying various agencies—their functions and facilities available with them—have been discussed in the other six parts. Part VII deals specifically with legal obligations of the entrepreneurs.

On the whole, this handbook will not only be found useful by the prospective entrepreneurs but it will also add to the knowledge of existing industrialists.

There is, however, still scope for making it more useful by giving details of financial assistance now being offered by nationalised banks, Financial Corporations, Agro-Industrial Corporations and other agencies under their special schemes. No mention has been made of liberal concessions available for entrepreneurs who want to set up their projects in backward areas or rural industries projects. Cooperative pattern of setting up industries in rural areas also deserves more attention. Likewise, the entrepreneurs are interested in knowing the sales prospects of the item they intend manufacturing. A section on the market surveys, importance of demand analysis and identification of locally available raw materials suitable for industrial processing would have, no doubt, added to the value of the book.

The book has been written in an assuring manner and had got a direct appeal to the reader. The author has presented an optimistic picture of setting up small scale industries. He speaks with confidence because he has got sufficient practical experience of dealing with small scale industries and is fully aware of the bottlenecks likely to be faced by entrepreneurs.

Lastly, the book requires little more editorial exercise as besides duplication (which perhaps is unavoidable from the view point of the author), factual information with regard to the limits within which certain institution can function needs revision. These aspects may perhaps be taken care of by the author in the next edition of the book. In spite of this, the book will be found useful by not only the prospective entrepreneurs but also by the existing ones who may be planning to expand or diversify their production activity.

—JD VERMA

A HANDBOOK OF QUALITY CONTROL AND ITS TECHNIQUES (JUTE) VOLUME II by SC Mital and AP Asopa, Published by Tara Publications, Agra, Pages i-viii—228, Price Rs 20.

A Handbook of Quality Control and its Techniques (Jute), Volume II is an excellent treatise on the testing procedures and the instruments required for controlling various quality characteristics which ultimately determine the quality of the final product. This handbook is written in a simple and lucid manner, and even a layman can appreciate the technology involved in Jute Industry and various quality characteristics that need to be tested and controlled. This volume will be equally valuable to those who are concerned with Jute Industry, either as technologists, researchers, managers or professional.

The handbook includes three chapters each on Electronic Data Processing, Inventory Control and Work Study. While not disputing important contributions of these techniques in improving the productivity of Jute Industry, these chapters do not appear to have direct

bearing on quality control. Instead, treatment of control charts, sampling inspections, analysis of variance and design of experiments in aid of controlling and improving quality of jute fibre and products would have enhanced the usefulness of this book immensely.

—RS GUPTA

TRADING WITH THE WORLD (Country Profiles) Revised Edition—Published by Indian Institute of Foreign Trade, New Delhi, Pages 722 Price Rs 40.

The revised edition "TRADING WITH THE WORLD" (Country Profiles) recently released by the Indian Institute of Foreign Trade, New Delhi, is an attempt at presenting a reference material relating to economy and trade of 109 countries, including recently-born Bangla Desh. The compilation of this edition has been completed by a team of officers of the Institute under the guidance of Mr NS Marwaha, Deputy Chief.

The publication provides a quick reference material regarding geographical, economic and trade conditions in the countries concerned, especially covering imports and exports, imports policy, trade agreements, trade opportunities, tariff concessions offered under GSP (General System of Preferences). Besides, valuable information relating to population, official languages, natural resources, transport and communication systems, banking institutions, passport and visa requirements, health regulations,etc., provided in a symmetrical manner may prove useful as a "ready-reckoner".

The publication is of immense use to business executives dealing with exports, Government officials and academicians devoted to the work relating to foreign trade. It will be more self-contained in case some details relating to Import-Policy, Trade Agreements and Trade Opportunities in the countries concerned are also added in the form of Appendices.

—NAU NIHAL SINGH

THE MANAGEMENT REVOLUTION : MANAGEMENT CONSULTANCY AND COMPUTER-AIDED DECISION MAKING by Richard Armand, Robert Lattes and Jacques Lesourne, Translated by George Ordish and Caron Shipton, Macdonald and Company (Publishers Limited), St. Giles House, 49 50, Poland Street, London W 1, 1972, Pages XVI+319, Price £ 8.

Management consultancy is essentially concerned with aiding decision-making by management in the context of different problems faced in industry. The consultants help in improving the quality and character of decisions taken with a certain degree of confidence derived essentially from the depth of pre-decision analyses which are made of different factors and forces grasped in the decision-making process and the impact that the decisions create over time and on different spheres of functioning in the enterprise. In short, the decision aids help enhancing managerial productivity and improving quality of managerial performance. Its present and future role and the services-mix that it can render to industry are factors that have as yet hardly been studied closely in the situation created by computers and the management tools and techniques contributed by different intellectual disciplines. Decision-making has become a highly complicated and multi-faceted science and art of selecting from alternatives, on bases only partially objective. Living in

future as dynamic management is, major decisions are taken on the basis of information which is scant, to say the least, and which suffers from inadequacies of different kinds.

The authors of the present volume hold top management positions in a leading consultancy firm, *Metra International*. They bring to bear analytical insights into the process of consultancy aid to industrial management which should be relevant generally. The authors stress the development of management consultancy to its present shape and scope, having a wide range of activities within its purview. The consultancy services cover the entire range of management tools and their application in confronting different types of problems faced in industry with an eye to growth and profitability and keeping up with the revolutionary changes taking place all around—in the art of production and distribution, in the field covered by behaviour of managers and employees within the organisation, consumers and customers outside, government and public and private agencies seeking to regulate the affairs of business and industry and the need for looking into the future with confidence which seems to be singularly lacking in the absence of a mastery over whatever is going to happen. The consultancy services have undergone a dynamic change with the advent of the computer and the highly sophisticated tools and techniques fitted into it for interpreting phenomena only hunched before.

The books is in five parts. Part I deals with decision-assistance, its performance and its involvement with multiple intellectual disciplines and also synergy through heterogeneity. Part II describes the explosion in the context of decision-assistance. In this part, the revolutionary changes in industry and the techniques of management are dealt with in the background of the functions in which the consultants have engaged themselves. The third part underlines the economics of decision-assistance. The value of decision-assistance in different contexts, the decision-assistance industry itself and the organisation involved in decision-assistance are dealt with in the light of the authors' experience in different spheres of consultancy services. The case studies included in this part will be found relevant by consultants in general. The role of decision-assistance in economic growth and the far-reaching changes that have been taking place are discussed in part IV, in which the authors project their vision, to the year 2000 AD for measuring up the changes in different spheres of employment, the professions, the relationships between individuals and groups and the area of uncertainties in the context of decision making. Part V brings the discussion down to earth, offering an action plan and the lessons of experience learned from countries like the United States, the USSR Japan and Europe.

The authors deal with the topics chosen by them in an assured manner and link up the past with the present to project into the future in the area of consultancy services. In this process, the canvas they have drawn is quite wide and the contours showing up on the canvas come into bold relief to suggest the shape of things in future in the field of industry, organisation and management. The topics chosen are difficult in themselves and the prescription that the authors make sounds logical and realistic. The manner of dealing with individual topics, however, appears to be rather skimpy, albeit scholarly. To an Indian reader, it is interesting to note a reference by the authors to a survey carried out by McKinsey in the United States which has shown that new applications of computers to firms are proliferating, but the value of the results is diminishing.

The survey has shown that the main cause for this is the insufficiency of capital invested in "brainware". Perhaps the organisations using the computer have been expecting the impossible without investing in employment of high quality manpower to make the best use of them.

Perhaps a parallel experience will be found in many Indian organisations in which the computer has been installed but the changes that were to occur in the quality of the work done and in the mechanism of interpretation of the details thrown up by the computer do not appear to have come about.

—P CHATTOPADHYAY

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PRODUCTIVITY
SUPPLEMENT
Vol. XIII No. 4

Multiplicity of Trade Unions and Its Effect on Industrial Relations and Productivity

SEMINAR REPORT

Multiplicity of Trade unions has existed in the country for various reasons and in various manners. During the last few years, however, the fragmentation and atomisation of the trade unions have gone on unchecked. About 25 years back, the number of registered trade unions in the country was about 3,000 and at the moment it is nearly 15,000; the average membership of the registered unions about 25 years back was about 1,000 and today it may be even below 500. The inter-union and intra-union rivalries have considerably reduced the viability and strength of the trade unions. It has also retarded the industrial democratisation processes and the industrial growth in the country.

Recognising the importance of the subject and the need to explore solution to the problem, a two-day Seminar on 'Multiplicity of Trade Unions and its effect on Industrial Relations and Productivity' was organised by the National Productivity Council in collaboration with the Mysore State Productivity Council at Bangalore during June 1972. The Seminar was inaugurated by His Excellency Mr VV Giri, President of India. His Excellency the Governor of Mysore, Mr Mohanlal Sukhadia, Hon'ble Chief Minister of Mysore, Mr D Devaraj Urs, Hon'ble Minister for Industries, Mr SM Krishna and Hon'ble Minister for Labour, Transport and Tourism, Mr Azees Sait addressed the Seminar. Messers G Ramanujam, P Ramamurthy and SCC Anthony Pillai addressed the gathering from the trade unions points of view and Messers Air Marshal OP Mehra, GA Acharya, T Shamanna, NR Seshadiri, MD Shivananjappa, K Eswaran and Prof KV Subramanyam from the managements' points of view. Mr NN Wanchoo, Chairman, National Productivity Council and Dr GR Dalvi, Executive Director, National Productivity Council, also addressed the Seminar. Mr K Kannan, MLC and a prominent trade union leader, who was also the convenor of the Seminar, introduced the subject matter of the Seminar.

Inaugural Address by the President

The President, Mr VV Giri, in his inaugural address put forward the slogan of 'one union in one industry'. Among the various reasons for the multiplicity of trade unions, he stressed : "Very often the reason for their existence is not that the unions differ significantly regarding the basis of the solution of the economic problems but it is the injection of political ideologies in the trade union movement invariably to the detriment of the real and genuine economic interest of the working class that is responsible for the tardy growth of the movement. I do not, for a moment, suggest that the worker should not be politically conscious, but the use of the trade union movement as a pawn in the political chess board will never help the cause of workers nor can it promote healthy trade unionism". In his opinion, one of the other important reasons for the situation was the presence of compulsory adjudication machinery in the Statute Book which discouraged the initiative of the workers who tried for a settlement by themselves and also involved many costly litigations. The present law regarding the registration of trade unions also encouraged the multiplicity of trade unions.

President Giri, from his vast experience in the trade union field and also from his experience in the government holding various important positions, suggested several steps to solve the problem of multiplicity of trade unions. They are summarised as follows :

(1) The disputes at plant level should be settled by the plant level unions. To check the strength of the different unions, a method of secret ballot may be employed. Till the union accepts the idea of secret ballot, we may continue with the verification of bonafide membership by the Chief Labour Commissioner with the representatives of the different trade unions. It will also weed out bogus membership.

(2) To secure the much-desired need of one union in one industry, the government should authorise the Chief Labour Commissioner to scrutinise carefully the bonafide membership of the various unions in the central sphere with the respective trade unions assisting him in this task. Thereafter, a representative body should be formed through election, with proportional representation of all the trade unions concerned. The duty of this representative body should be confined to fundamental and basic issues affecting the interest of the working class — those relating to conditions of service, hours of work, fixation of bonus, fixation of work-norm, rationalisation, etc. This representative body would be in a better position to negotiate with the employers. Similar mechanisms may also be set up at various state levels.

(3) The craft unions should be totally discouraged and plant level unions should be formed as part of industry-level unions. The plant level unions would be in a better position to cope up with the regional and plant level variations. The plant level unions would settle the disputes at the plant levels.

(4) The government should assist in establishing in various industries a panel of conciliators from among whom both the workers and employers could choose a single conciliator or a Board of Conciliation. In addition to conciliation to solve the disputes, tripartite machinery of the Indian Labour Conference should play a more important role. This machinery should have an adequate staff and technical experts to collect and furnish facts and figures relating to the working conditions in all the industries. With specialised wings of experts working under the Indian Labour Conference, it would facilitate to deal with specific issues of strikes and lock-outs and bring about an amicable settlement.

(5) If the above machinery could not solve any particular problem, it should be left to be settled through voluntary arbitration.

President Giri pointed out the exemplary system to voluntary method adopted in Kerala where they had set up the Industrial Relations Board consisting of the representatives of employers, various trade unions subscribing to different idealogies and the government. They had also formed a Voluntary Arbitration Board. He was happy that the representatives of the trade unions always took a practical approach and many of the issues were settled across the table through direct negotiations and discussions at the Industrial Relations Board. Even if the disputes could not be settled by the various machineries suggested, we need not be perturbed by the fact that it should be solved ultimately by strikes or lock-outs. A desire to avoid substantial loss due to production stoppage, including the risk involved in the strike, constitutes the most effective inducement ever devised for compromise and agreement around conference table. Ultimately public opinion would play a decisive role in inducing the parties to honour and accept the decisions arrived at by the expert bodies.

Summary of Discussions

Mr K Eswaran, in his speech, pointed out that one of the major reasons for the multiplicity of trade unions was the policy of divide and rule adopted by the management during the earlier days. The competition among the labour leaders was encouraged by the management with the expectation of making the unions weak. The labour laws also were framed with short-term objectives which accelerated the increase in the number of trade unions. He agreed with the suggestions made by the National Commission on Labour for reducing the multiplicity of trade unions. They were—

1. Eliminating party politics and outsiders and building up healthy, educated internal leadership in trade unions;
2. Promotion of collective bargaining through sole bargaining agents of trade unions ;
3. Improving a system of union recognition ;
4. Deciding the majority union ;
5. Encouraging union security; and
6. Empowering Labour Courts to settle inter-union disputes.

In addition, he suggested that the Registrar of Trade Unions should be made the adjudicator instead of Civil Courts to deal with the disputes in union elections so that the delay in justice could be avoided. He commended the Bill for recognition of trade unions and prevention of unfair labour practices recently enacted by the Tamil Nadu Government. The Bill stipulated the requirement of 30% membership in a plant for recognition of the union by the industry.

Mr GA Acharya expressed the view that the crux of the problem lay in bringing better understanding between management and labour and that it could be carried out only by the educational process and through experience.

Mr G Ramanujam emphasised that we had to be pragmatic and had to accept the fact of multiplicity of trade unions. He agreed that it was not only the interested political parties that had resulted in the multiplicity of trade unions, it was also personal interest of the leaders that multiplied the trade unions. Everytime when a political party had a split, the trade union controlled by it also followed suit. In a parliamentary democracy where votes counted, it was futile to expect any political party to say 'hands off from trade unions'. According to Mr Ramanujam, "One union in one industry" was not the most ideal thing to be accepted. The most ideal one was 'no union for any industry'. The instrument which made the two parties fight was not an ideal to be aspired for. The ideal should be such as there was no need for a fight and thereby there was no need for a union. If there was no exploitation by the management, then there was no need for a union either.

According to Mr Ramanujam, there was also another factor much talked about, i.e. the outsiders' interference in the trade unions. The outsider had come in the trade union field because of the conditions prevalent in our industries and the manner in which the workers were treated by the management. It was not a question of either an outsider or an insider; it was a question of good leadership from whereever it might come. The enlightened and responsible management as well as the leadership of trade union could come up only if all concerned got educated and recognised the realities of partnership in the attainment of common objectives. Now-a-days, there was much talk about participation of labour in management and 'the new role of labour in industrial growth'. Again here, just by talk it would not be possible to have the participation of labour. It was accepted by all in principle but not practiced and applied. It might be only a question of getting reasonable return on investments from the point of management but as far as the workers were concerned, industrial prosperity was their very life. Hence, there was no question of labour not cooperating or participating in the development of industrial growth. If the management really wished to have the participation of labour they could get it if they treated the labour as real partners in the common endeavour and did away with mistrust, unfair treatment, etc.

The multiplicity of trade unions could not be tackled by legislation; it had to be solved by voluntary understanding and enlightenment on the part of management, Mr Ramanujam added. On the part of trade union a beginning was made at the national level by the decision taken by INTUC, AITUC and HMS to set-up a National Council of Trade Unions and they were all working towards the success of the council. Trade unions had realised that there was need to change the attitude of the workers too. To

achieve the unity of the trade unions or 'one union in one industry', a mental change should first take place.

Mr Ramanujam said that the suggestion for the formation of a composite negotiating committee with proportional representation for all unions at the plant level, regional level and National level was not at all practicable and that it would only intensify the inter-union and intra-union rivalries, because the weakest union in the committee would make the loudest noise and the majority union could not behave in a responsible manner and if they did, they could be made weaker. The various mechanisms could not be made practicable in the absence of the necessary will. The solution to the problem of multiplicity of trade unions lay in the change of attitude on the part of the Union leadership, the management and the government. This could happen only through long-drawn processes of reeducation of all concerned. The problems had to be tackled simultaneously with multilateral effort.

Mr Azeez Sait, Mysore Minister for Labour, Transport and Tourism, expressed the view that multiplicity of trade unions had led to a lot of industrial unrest which in turn caused low productivity. In his opinion, the multiplicity of unions was the consequence of the influence of outsiders. In the earlier period of trade union movement in the country, outsiders identified themselves with the labour and they had done tremendous lot for it. However, after Independence, a number of labour leaders had smuggled into the union to exploit the labour for their own end. Labour must realise that its salvation lay, in building up strong internal leadership. The facility of workers' education must be fully availed of to build up such leadership. That would be the first and possibly the most important thing in terms of attaining the ideal of 'one union in one industry' and eliminating multiplicity of trade unions.

Mr PN Krishna Pillai advocated adoption of a business-like and pragmatic approach to the problem of multi-union which was a burning industrial relations problem in the country and finding a solution in the light of our own experience and the experience of other countries. He felt that our basic structure of labour-management relations was legalistic and judicial in character. There was seldom collective bargaining relationship. No industry could achieve better productivity unless the relationship of the two partners in an industry was based on dialogue and reasonable compromises. This could be achieved only if inter-union rivalry was removed and a genuine collective bargaining agency was determined. He shared the views of the other speakers that the problem was aggravated by the negligence and shortsighted policy adopted by the authorities in the field of industrial legislation. The existing legislation encouraged more of labour litigations than strengthening of democratic institutions of trade unionism.

Referring to the problem of multi-unionism, Mr Pillai said that it was there in all countries. Only in our country it had assumed such an enoromous dimension which was hampering industrial growth. In this context, it might be worthwhile learning from the experience of other countries. While in India, according to the National Commission on Labour, 73.2% of the unions had a membership of below 300 and accounted only for 12.4% of total membership, in other democractic countries, the tendency was just the opposite. According to the Donovan Commission Report in the UK, there were only 574 unions and 4/5ths of the membership was in 38 large unions. The unions were in the process of merging with each other to make

the organisations strong. The same process of mergers was going on in the USA and also in Japan.

In India also, from time to time, there were attempts made to encourage stronger trade unions. Mr Krishna Pillai was of the opinion that if the Trade Union Amendment Act of 1947 and Industrial Relations Act 1954 had been implemented the situation would have been stabilised by now and the rigour of multi-union problem would have been mitigated to a large extent. He also expressed dissatisfaction over the fact that no serious attempt was made to implement the recommendations of the National Commission on Labour towards finding solution to multi-union problems even though the report was submitted before long. The lack of urgency on the part of the government and the authorities was worsening the situation, he said.

Mr Pillai said that in the present situation one of the important problems faced by the management was to pick up the genuine collective bargaining body to deal with. The management should develop skills to deal purposefully with the unions that were representative in character. For that, there should be a basic law to enable majority unions to be recognised as the sole collective bargaining agent.

'One union in one industry' was the desired goal but as the conditions existed in the country and as suggested by the President, Mr VV Giri, we have, in the present situation to take into account the regional and plant level variations and differences. In a vast country like India, the industry-wise unions without allowing the plant level unions to operate would not be able to deliver the goods. Even in UK, with a long tradition of industry-wise bargaining, they had positively tilted to plant level bargaining to achieve productivity-oriented contracts. In India, the pattern of industrial relations was varied in nature from industry to industry and from region to region. Hence, from the experience it could be seen that a plant-based or undertaking-based bargaining yielded better harmony and better productivity. Referring to the observations made by Mr Giri that "plant level organisation of unions puts a heavy responsibility on the trade unions, for the latter should have a full grasp of the plant level problem and also the wider and bigger industry level problems", Mr Pillai said that only such realisation of responsibility not only by plant level unions but also by plant level management would ultimately lead to purposeful and collective bargaining. We could not completely ignore the craft-wise unions. Separate craft-wise unions for white collared workers were a growing feature in many industries in our country. The realistic management had to grapple with the problem of craft-wise unions existing in the industry and at the same time they should not allow further proliferation of unions. As long as there was a representative union for bargaining purpose, whether it was plant-wise, industry-wise or craft-wise, it should not pose much problem.

The real questions, according to Mr Pillai, were the criteria to determine the representative union and the method by which it could be made the sole bargaining agent. In his opinion, the representative union should be the one which was a majority union in the industry and the majority union should be determined by secret ballot by the National Commission on Labour as recommended by the Industrial Relations Commission. There could be a combined system of verification of membership along with secret ballot to determine the representative union for purposes of recogni-

tion and collective bargaining. The system of verification of membership would automatically reduce the claims of small unions to contest to become representative union. However, ultimately the bargaining agent had to be selected by secret ballot where disputes existed. He was sceptical about the formation of negotiating team with proportional representation of all contesting unions in an industry. A single bargaining agent, he thought, would be the most effective. It was necessary that the government, with a sense of urgency, should bring forward necessary legislation for the healthy growth of trade unionism and implement them without any reservations. Till such time the legislation was enacted, progressive management should recognise and bargain with unions which were representative in character according to their assessment. No discrimination or favouritism should be shown to unions because of any particular central affiliation. Above all, they should not in any way encourage creation of rival unions. On the part of the unions, at least those affiliated to central organisations which had constituted the National Council of Trade Unions, between them should enter into a non-interference agreement which would encourage the principle of 'one union in one industry'.

According to **Air Marshal OP Mehra,** the basis on which the trade union should be organised was a matter to be determined by workers themselves in the light of their own needs, aspirations and experience. The unions had to function according to the dictates of their members, but within the constraints set on them by the law of the land. Unity in the trade union movement had to come from within through building up of internal leadership. It was perhaps true that there were political pressures and also the alleged manoeuvering of certain managements in aggravating the problem of inter-union rivalries. But it was for the enlightened trade union leadership to avoid the pitfalls and build up through unity the trade union movement into an effective instrument which could voice their views to the mutual advantage of workers and the industry and could build harmonious industrial relations for the prosperity and growth of the national economy.

Mr SCC Anthony Pillai differed considerably from the previous speakers especially with regard to the solution to the problem of multiplicity of trade unions. In his opinion, the rival units existed in the industries largely on account of the system of compulsory arbitration and adjudication. To talk of compulsory arbitration and simultaneously of collective bargaining was to talk in terms of something which was absolutely contradictory. Good collective bargaining could not be promoted so long as there was a compulsory arbitration. With the power available in the hands of the government, at any stage of the collective bargaining process, the government could interfere and refer the matter for compulsory arbitration. Because of the compulsory adjudication, the whole pattern of trade union behaviour was entirely politicalised. Many weak trade unions survived because of the government interference. Many times the trade unions ran to the government and the Ministers for settling disputes ignoring the Conciliation machinery. According to Mr Pillai, there were not many competent arbitrators and the Industrial Tribunals in the country were filled by persons drawn from judiciary who did not know much about the industry. Hence, the above machinery was more or less ineffective in achieving harmonious industrial relations. The Industrial Legislation in the country also encouraged the form of small sectorial unions in an industry or plant. Some of the small unions in a key

section of a plant could hold the whole work in the factory at ransom even though the union might represent only 1% of the total working force. For example, a very small number of Pilots in the major ports or a small number of workers in the IAC could paralyse the whole operation of their organisations.

To check this type of fragmentation and unhealthy growth of sectorial trade unionism, it was necessary that there should be some determined process to decide the most representative union in an industry for the purpose of collective bargaining. The best bargaining agency was that organisation which could deliver the goods. The proportional representation in a collective bargaining committee could not reduce the intra-factional rivalry. On the other hand, it would only encourage them. The legislation should be such that the government's interference should be brought to the minimum. In his opinion, every strike and every lock-out should be fought to the finish till a settlement was reached without the interference of the government. This process of the survival of fittest would enhance the chance for the growth of healthy trade unionism. The unreasonable and the weak unions would have their natural death. In any industry where there was a rival unionism no one would be willing to make an intelligent and rational approach to solve the problems facing the workers so long as there was a chance for weaker and unreasonable trade unions to survive. It was also necessary on the part of the government to have a common approach to the problem of collective bargaining and meeting the demands of the workers. If the government adopted different measures—one for private sector industries, one for public sector industries and another for departmentally-run industries—it would not encourage healthy trade union movement. Mr Pillai said that he would welcome a scheme of industrial relations which completely eliminated governmental interference altogether. The working class should be self-reliant and should rely on its own organisational strength and rational negotiations. If this policy was adopted the good unions which could deliver goods would survive and the bad ones would die a natural death. Thus, the problem of multiplicity of trade unions would get solved.

Mr T Shamanna was in complete agreement with the points raised by Mr Anthony Pillai that compulsory adjudication and arbitration must be given up and the disputes between the labour and management should be settled by collective bargaining and negotiations. However, he did not approve of taking recourse to strikes and lockouts as the ultimate weapon. He felt that in the changed economic and social conditions in the country, responsible trade unions and matured leadership should be developed. With the growing acceptance of participation of labour in management, the concept that the management and labour were antagonistic and fighting parties was disappearing. The labour must also shoulder the responsibilities of economic development. In the bargaining between labour and management it was also necessary to protect the interest of consumers and the society at large.

Mr NR Seshadiri in his address enumerated a number of principles for the development of harmonious industrial relations. Firstly, a strong, united and independent trade union alone could efficiently serve the interest of workers. For this purpose, the political and governmental interference in the trade union movement should be eliminated. The second principle of industrial democracy was that only one trade union in an industry should represent the interest of the working class and that the

majority union should have the right of a sole bargaining agent. The third principle of industrial democracy was that ownership of industries was irrelevant to industrial relations. Nationalisation could not alter the basic relationship between the employees and its employers. Nationalised industries were not primarily for the benefit of employees alone.

According to Mr Seshadiri, the only way for the employers to discourage proliferation of the trade unions was not to recognise and discourage such ineffective unions. The code of discipline evolved at the 16th session of the Indian Labour Conference in 1958, if put into practice, would lead to recognition of the majority union as the representative one. It would also encourage the growth of industry-wise strong national unions. He felt that the central unions should not be concerned with collective bargaining, settlement of disputes and calling off strikes at the plant levels. Their sphere of action had to be largely legislative, policy, promotional and defensive activities. In the General Tripartite Conference they should provide a certain proportionate representation. The problems concerned at the factory and plant level should be settled by the region-wise or plant-level unions which might be affiliated to the national unions. It was heartening to note that a modest beginning was made by the representatives of leading central trade unions, i.e. INTUC, AITUC and HMS to set up a National Trade Union Council to eliminate inter-union rivalry, he said.

One of the important problems confronted by trade unions was their financial weakness. Mr Seshadiri suggested that a system of check-off as practiced in some of the Western countries might be introduced in our industries also. Under the system the dues were collected at the time of salary payment itself and given to the trade unions. This would also help to verify the strength of the trade unions.

Mr P Ramamurthy traced the history of trade union movement in India and enumerated the stages and reasons for the split in the trade union movement in the country. He was of the opinion that multiplicity of trade unions was the result of the historical background and the social and political developments in the country. There was the fundamental conflict of interest between the working and capitalistic classes. The political struggles in the country and the struggle of the working class were interlinked and due to the conflict of interest between the various parties and the classes they represented, it was but natural to have the working class movement divided by the capitalistic class. However, in his opinion, the multiplicity of trade unions did not very much affect the industrial relations as well as productivity. If it had affected productivity, it was only marginal. At the same time, multiplicity of trade unions had reduced the bargaining power of the working class. In spite of the division in the trade union movement in the country, it was not possible to prevent the growth of trade unionism. The unrest that existed in the industrial sphere was not due to multiplicity of trade unions but it was mainly due to socio-economic problems that were inherent in the society. Even according to the National Commission on Labour, during 10-year period before 1966, the productivity in the country per worker had increased by 66%, while during the same period, the real wages had decreased by 2%. Under this condition, it was natural that the workers could not be induced to increase production and they had to struggle for geting injustice.

Mr Ramamurthy was in complete agreement with President Giri on the measures he had

enumerated to bring about unity in the trade union movement and also to evolve proper bargaining agency. He was of the view that industry-wise and plant-wise negotiation committees should be set up on the basis of proportional representation to all trade unions which had more than 10% of the workers as members. The arguments put forward by the other speakers against the proportional representation in a negotiating committee on the basis that it would not be workable was untenable, he added. It was not correct that the weaker unions with high sounding promises would swing away the workers when represented in the negotiating committee. The workers themselves would realise the capabilities of their leaders and unrealistic and incapable leaders would be thrown out by them. He supported the secret ballot system for determining the strength of the trade unions. Building the unity of the workers irrespective of their trade union affiliations from the rank and file over the heads of their leaders on the basis of common objectives to solve the most burning problems of the workers was enunciated by Mr Ramamurthy. He pointed out several examples where such an approach for building unity from the bottom had paid rich dividends. The joint agitation and the common struggle would naturally develop the working class unity, he felt.

Mr MD Shivananjappa referred to certain instances where the existence of multiple unions had prevented the management to take right course of actions even when majority unions agreed to the decisions. Such situations affected considerably the productivity of the industry. He was of the opinion that the weakness in the trade union movement as well as in the management lies in the Indian society and our character. Unless attempt was made to improve the character and attitude of the working class as well as the management, it was difficult to achieve better results.

Valedictory Session

Mr Devaraj Urs, Chief Minister of Mysore, in his presidential address at the Valedictory Session of the Seminar remarked that a certain measure of politicalisation of trade unions was inevitable in our present conditions. A large number of workers could not be isolated from the influence of political ideologies. However when legitimate trade union activity was subordinated to political activity, the interest of workers was bound to suffer. In a large country like India with several political parties—national as well as regional—it was bound to lead to multiplicity of trade unions. Perhaps the most significant method to tackle the problem was to educate the workers and to build up a cadre of 'inside leadership'. An educated labour force, aware of the implications of multiple unions, would be the best answer to this question. There was an urgent need to reconsider the legislations concerned with the recognition of the trade unions, he added.

Urging the need for the development of constructive industrial relationship, Mr Urs said that one important point that must receive attention was the participation of labour in management. Ours was a parliamentary democracy where every citizen had to involve

himself in the great task of reconstruction of this country. The free exchange of ideas, closer coordination of working and elimination of class consciousness between the management and labour would be achieved through labour participation in management. It could also bring forth more responsible trade union leadership. The social, economic and political forces released by such a body of educated workers and their responsible participation in management would, to a great extent, solve the many problems that beset the trade union movement today.

Dr GR Dalvi, Executive Director, National Productivity Council, in his valedictory address said that they had to accept the fact that the multiplicity of trade unions was likely to continue in India for some time to come. At the same time, they had to strive for the ideal of 'one union in one industry'. In his opinion, one union in one unit could emerge only as a result of constant and continuous dialogue and amity between the management and the employees at plant level. This had to be established through constructive day-to-day relationship between the employers and the employees. In that context it was necessary for the management as well as the unions to adopt a practical approach and evolve over a period of time a viable relationship.

Dr Dalvi said that it had to be realised by all concerned that a rapid improvement in the standard of living of large number of people in the country could be achieved only by rapid increase in productivity and by distributive justice. While discussing economic development and industrial relations it should not be forgotten that majority of our population was living in rural areas. The benefit of industrial production had to reach them by making available goods and services at reasonable prices. For the above purpose, both management as well as workers must voluntarily come forward to preach and practice the gospal of dedicated and disciplined work. If we wished to enjoy political and economic independence, we must accept the consequential responsibility of self-discipline. It was a sad commentary that in the prevailing situation neither the management nor the unions had shown any understanding of the basic requirements.

Dr Dalvi said that we should get away from the victorian concept of the dichotomy between management and labour. The surest way of getting away from this paralysing dichotomy was to create conditions for participative or joint management in place of unitary management. The success of such a scheme of participative management would no doubt greatly depend upon the establishment of effective channels of communication at the various levels of enterprise, provision of adequate information and data to the representatives of workers and the willingness to share the gains of productivity among all concerned. It also depended upon the education of workers in the tasks and methods of management.

What should then be the role of trade unions in such a system of joint management? Dr Dalvi felt that in any system of joint management, the trade union should take active interest and give support with a view to ensuring the success of the system. Then alone would the trade unions be able to set up appropriate organs to reinforce the process of joint management and be in a position to make positive contribution not only to the welfare of their members but also to the all round progress of the economy. In his view, the problem of multiplicity of trade unions could be solved by good industrial relations practices which could be achieved through the participative management.

Mr SM Krishna, Mysore Minister for Industries, in his concluding address congratulated the National Productivity Council and the Mysore State Productivity Council for organising such a seminar and focussing the attention of the various interests concerned towards this burning problem and bringing together eminent people in the field to share their views. In the present context of multiplicity of trade unions, the important problem to be solved in introducing labour participation in management was to determine who should represent the labour. Was it to be decided by proportional representation or was it to be decided by direct vote ? Mr Krishna was hopeful that a solution to that question would be found out roon. He said that his government and his party fully subscribed to the labour participation in management and were working towards evolving a practical scheme to introduce the same in various industrial undertakings in the state. He exhorted the workers ana trade unions to play a more positive role for the success of the public sector undertakings.

Mr K Kannan summed up the proceedings of the seminar. There was a consensus among the participants that the multiplicity of trade unions at national level was due to politicalisation of trade unionism. At plant level it was caused either for political or for personal reasons or for both. Some managements also contributed towards the multiplicity of trade unions. Whatever the reasons for the multiplicity of trade unions, all had agreed that it was having a bad effect on industrial relations and productivity. Most of the speakers offered widely varied solutions to the problem. Although lhis problem was expected to continue for some time to come, yet, there was a realisation among all concerned that concerted effort should be made to find a solution. This realisation itself was a step forward in the direction of establishment of better industrial relations leading to higher productivity. ▭