Trade Unions and Productivity : A Theoretical Construct

Ramjas

The author argues that the traditional notion of trade unions as forums for collective bargaining does not reflect the full range of functions they perform. In particular, their role in providing a collective 'Voice' which looks into all aspects of worker-welfare is very important. This article is a review of the extensive literature dealing with this aspect.

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Trade unions wield considerable influence at the national level as they command the loyalties of millions of workers. The behaviour of trade unions and employers as economic agents and the interplay of forces associated with them, determines the allocation of resources, the reward to factors of production and the welfare levels of the labour force.

The traditional line of argument about the impact of unions on productivity is that with an increase in the wages of unionized workers through collective bargaining, labour becomes relatively costly. In response to a rise in the relative wage, firms seek to raise the marginal product of labour by factor substitution i.e. by raising the capital-labour ratio. The effect is an increase in measured labour productivity; also an increase in the unit cost of the product and a misallocation of resources. With a relative increase in the pay of the workers, employers are compelled to adjust the quality of labour hired. The employer will recruit higher quality workers as a response to union induced pay increases. So over a period of time as incumbents are replaced, the average quality of the enterprise's labour force will improve (Ashenfelter and Johnson, 1972). There is no rigorous way to measure the independent effect of collective bargaining on the quality of the work force. The effects are clearly not the same in all managements and unions. Bok and Dunlop (1970) contend that there is a reason to believe that the net effect of collective bargaining is to increase productivity through a higher quality of the labour force. The traditional economic reasoning, therefore, limits the influence of the union on productivity through a rise in the capital labour ratio and

recruitment of higher quality labour induced by the union wage effect.

Negative Effects on Productivity

In the popular mind unions are not usually thought of as raising productivity; at best they are thought of as keeping the pace down to acceptable levels. Even unorganised labour force is supposed to withhold labour. At the turn of the century, F.W. Taylor emphasised the existence of a systematic tendency to withhold effort : "The greater part of the systematic soldering, however, is done by the man with the deliberate object of keeping his employers ignorant of how fast work can be done. So universal is soldering for this purpose that hardly a competent workman can be found in a large establishment, whether he works by the day or by piece work, contract work or under any of the ordinary systems of compensating labour, who does not devote a considerable part of his time to studying how slowly he can work and still convince his employer that he is going at a good pace" (Taylor, 1947, p. 33).

The impact of the organized work force is perceptibly distinct at the work place. Its collective power has the potential of affecting diverse aspects of the production environment viz., work rules, regulation of machinery, work stoppages, managerial decisions on technological changes, promotions and lay off. Unionization also brings about beneficial changes in the compensation packages (i.e. wages and fringe benefits) of employees over and above the prevalent market rates of compensation, leading to a misallocation of resources. Unions are supposed to stifle enterprising management, constricting its operations with enormous work rules and engaging in immoral behaviour often characterised as 'featherbedding' (Bok and Dunlop 1970, p. 261). Featherbedding is defined as a labour working rule which causes the firms to hire more of labour units of a particular type than it would at the existing wage, assuming technology and social norms to be given. Social norms are included in the definition to cover such items as vacations, rest periods etc. which are in the category of reasonable union rules (Weinstein, 1960, p. 379).

There is a subtle difference between featherbedding and work restriction. Examples of the former are : limits on the board handled by workers, restrictions on the tasks performed by employees in given occupations, requirements that work be done twice or that unnecessary work be done, requirements for unnecessary standby crews or crews of excessive size, enforcement of loose production standards or limits on work pace and interference with technological changes sought by management (Brown and Medoff, 1978, p. 359). The consequences of such type of practices will be to force management to hire more labour than it would otherwise choose, the wage bill will be normally increased and resources will be used less productively than what management would prefer. Unions are also seen as an interference in hiring the most able workers, seniority as blocking the promotion of best qualified employees and worker solidarity as a force turned against management and production (Brown and Medoff, 1978, p. 360). So far as the empirical evidence of non-wage inefficiencies introduced by trade unions are concerned, systematic empirical evidence is sparse, the bulk of the material taking the from of case studies of establishments (Slichter, et al, 1960).

Positive Effects of Unions

The conventional approaches to the study of the impact of unions on productivity through wage effects assume wagerelated implications like factor substitution and better quality of workers but do not allow for the possibility of more dynamic effects.

But there exists an alternative view which holds that the introduction of unions and collective bargaining invovles fundamental changes in the enterprise and its surrounding product and labour markets. The introduction of unionism typically involves a wholesale transformation. According to this view, unions are both economic and social institutions firmly embedded in the large fabric of a constantly changing and evolving society. Unions belong to a class of institutions—families, firms, schools and the like—having decision-making characteristics distinct from the individuals who belong to them. Groups of

individuals within a union when they make decisions about wages collectively, do so differently from what they would individually. According to this broader view, the existence of unions is not simply a matter of economic costs and benefits. "Unions may be concerned with the distribution as well as the level of economic benefits achieved through bargaining, their economic policies may induce a wide range of adjustments and innovations at the work place and they may devise economic policies to alter the market context within which they bargain" (Doeringer, 1984, p. 316).

Recently some empirical work has challenged the conventional view by arguing that unions produce X-efficiencies through the expression of 'collective voice'. This new view associated with the work of Freeman and Medoff, and their students at Harvard, while not denying the monopolistic role of labour unions, maintains that the monopoly view of unions (i.e. an organisation whose main function is to raise wages) is seriously misleading. Unions, according to this view, have significant non-wage effects that influence diverse aspects of modern industrial life. By providing workers with a 'voice' at the work place, unions can and do affect positively the functioning of the economic system. The central idea of this new view is that unions have the potential to more than offset via enhanced productivity, the cost increases that result from wage and non-wage inefficiencies.

The essence of the Harvard view is contained in Freeman (1976), Freeman and Medoff (1979) and Freeman and Medoff (1984). This analysis draws heavily on the exit-voice paradigm of Hirschman (1970). According to this, societies have two basic mechanisms for dealing with social and economic problems. The first is the classic market mechanism of exit and entry, in which individuals respond to a divergence between desired and actual social conditions by exercising freedom of choice or mobility. In the labour market, exit is synonymous with quitting while entry consists of new hirers by the firm.

The second mode of adjustment is the political mechanism that is called 'voice'. This refers to the use of a direct communication to bring actual and desired conditions close together. For example, if a customer is not satisfied with his shopkeeper, according to the first mode, he will quit and go to the other. According to the second mode, the customer, instead of quitting the first one, will complain and explain his desired quality of the product or behaviour.

Out of these two modes of adjustment, Freeman contends, the 'voice' is the efficient one. The advantages claimed by the 'collective voice' mechanism can be the following. First, unions can induce managers to alter the methods of production and adopt more efficient policies. Second, unions collect information about the preferences of workers, thus, permitting the firm to choose a better (i.e. more efficient) mix of wage and personnel policies. Third, unions improve the communication between the two sides leading to improved decisionmaking. Finally, unions improve morale and cooperation among the workers.

Information about the conditions and preferences of workers can be collected through free market 'exit' consisting of 'quits' and related behaviour and/or by 'voice' consisting of the collective bargaining system by which workers elect union leaders to represent them in collective bargaining. Employers can learn about worker preferences and the causes of discontent from individual quits either inferentially or by exit interviews. Inferences about the preferences of workers who quit, may, because of 'selectivity bias', yield incorrect information about average evaluation or evaluations of the possible quitters (Freeman, 1976, p. 362).

Exit interviews run into a different difficulty because it is difficult to motivate the worker who leaves to detail work place conditions. There is no gain to quitters by providing management with desired information about dissatisfaction and there may be possible losses via bad references. On the other hand, collective rather than individual bargaining with an employer is necessary for effective voice at the work place for two reasons : first, many important aspects of industrial settings are 'public good' that is, good which will affect the well being (positively or negatively) of every

employee in such a way that one individual's partaking of the good does not preclude someone else from doing so i.e., the consumption of many of the working conditions is non-rival. Thus, safety conditions, lighting, heating and the firm's policies on lay off and promotions etc. are shared by all the workers. Individuals connot bargain over plantwide conditions (Freeman and Medoff, 1984, p. 8). Second, collective action is necessary because workers who are tied to the firm are unlikely to reveal true preferences to an employer, for fear of victimisation. The danger of job loss makes expression of voice by an individual risky.

The collective nature of trade unionism fundamentally alters the operations of the labour market. In a non-union setting the predominant form of adjustment by firms depends on the preferences of the 'marginal' workers whereas in the case of unionized settings, the union takes account of all workers in determining its demands at the bargaining table. It is likely to respond to a different set of preferences from those that prevail in a non-unionized setting. In sum, taking account of all workers and appropriately considering the sum of preferences for work conditions that are common to all workers, can be economically more efficient than the contract that would result in the absence of unions.

Workers, prior to their organisation into unions, tend to establish job control and output restrictions through 'informal groups'. These workers use crude methods of job control as they have no direct channels of expressing complaints. When union organisation supersedes informal groups (i.e. institutionalise) they allow for complaints and grievances to be directed against the causes of discontent. The result may be less attention to restrictive attitudes, unless the grievance mechanism is unavailing. "Trade unions do not create conflict between employer and his employees. Conflict is inherent in the situation. They merely give an institutional expression to the conflict which would assume chaotic proportions in their absence" (Sinha, 1981, p. 12).

Trade unions institutionalise the system of determination of acceptable bargaining packages and the elicitation of preferences of the common worker. These are the major tasks of the trade unions and critical components in the successful operation of collective bargaining.

The major advantages of unionization are that it provides a direct channel of communication between workers and management and an alternative mode of expressing discontent than quitting, with consequent reductions in turn-over costs and increases in firm—specific training. In a large enterprise, the union 'voice' provides central management with information about local conditions and operations that is likely to differ from that obtained from the organisational hierarchy. Collective voice is also likely to yield a better mix of wages, working conditions, rules of the work place and increased firm-specific human capital than otherwise.

Why No 'Voice' in Non-Union Settings?

Can the 'voice' mechanism work and its advantages be availed of in the absence of unions ? If this were so the firm will be able to keep itself aloof from the inefficiencies caused by unionization. Is it possible that the need for unions will disappear if human relations techniques like profit sharing, employees' representation, formation of small groups and cultural centres are introduced? In such a scenario, even if unions come into being, they may be made to become an integral part of a programme of team work, communication and participation.

The reason for the general absence of 'voice' or industrial jurisprudence practices in the non-union sector is that the essence of 'voice' is to reduce managerial power and create a dual authority channel within the firm. Such a change in power is difficult to obtain in the absence of an independent union. During the 1920s many firms experimented with the so-called 'employee representation' plans designed to provide a non-union 'voice' mechanism for workers. Freeman (1980), observed that many of these plans ended in failure, despite their best intentions, as workers were unwilling to express their views for fear of retaliation by the management and because of their own lack of power to affect decisions.

This is not to say that no non-union firm will have a grievance or arbitration system; some may have such systems, in part to reduce workers' desire for unions. The point is that it is more difficult to institute an effective system in the absence of unions. Freeman and Medoff (1984) have offered a very apt analogy. The problem, they say, is akin to that of operating a democratic parliament in a monarchical or dictatorial regime. As long as the monarch or dictator has the final word, the parliament cannot truly function. Free expression just cannot be there in a dictatorial regime even if the regime desires it on certain issues.

Shock Effect

The presence of unions stimulates rational and productive use of labour and other resources. This is true even in the context of management as a resource (Slichter, et. al, 1960). Unionism can improve efficiency by putting pressure on management to institute more efficient methods in the utilization of labour, improve the training and methods of assignments and work measurement and better supervision, This pressure on management or 'shock effect' can improve efficiency by tightening job production standards and accountability in order to preserve profits in the face of higher wages. This plainly means that a union-shocked management is able to extract more output from a given amount of inputs than a management which is not confronted with the union stimulus (Brown and Medoff, 1986, p. 359).

The thesis of shock effects is based on the assumption that there are opportunities within the firm for removing slack and inefficiency i.e. X-inefficiency. The implications of X-efficiency are that firms maximise profits and minimise costs only as a special case. "Firms do not operate on an outer bound production possibility surface consistent with their resources. Rather they actually work on a production surface that is well within that outer bound and, thus, the amount to be gained by increasing X-efficiency is significant" (Leibenstein, 1966, p. 413).

Given that there is, in most situations, vast potential for X-efficiency, the question of motivation and woker morale assumes significance. Workers can be 'induced', 'energised' or 'motivated' even in non-union settings. It is possible that the costs of avoiding the union are more (considering the covert benefits of unionization) than in the event of a compromise with the existence of unions. Unionized workers, because of better pay, fringe benefits and the 'voice' factor develop 'interest' in the firm which attaches them to it for a comparatively longer duration. This is dispite the finding that unionized workers may be more dissatisfied than non-unionised workers (Freeman and Medoff, 1984). Workers in unionized firms can be better 'activated' than in non-unionized firms.

Gellerman points out that a union might discover that its strongest lever in bargaining with management is the maintenance of discipline over its members (monitoring services) in exchange for concessions on wages, fringe benefits and other financial gains. Thereafter, the union will attempt to take over the enforcement of work standards, attendance and punctuality requirements and above all to prevent slowdown and work stoppages. It can accomplish these functions far more effectively than management can. For this reason, management will probably learn to appreciate the union despite its militancy. A bargain is, thus, struck between the two sides (Gellerman, 1970, p. 280).

The other behavioural variables viz. morale and job satisfaction are also influenced to a great extent by unionization. With better pay and other material rewards, promotion and layoff through seniority and other voice-based transformations of the work place relations, morale of the workers is expected to be high. And it is possible that high morale may lead to an increase in worker productivity.[1]

Herzberg, Mausner & Synderman (1959) have developed a distinction between motivation and what they call hygienic factors. 'Motivations' are those which are intrinsic to the job such as achievement, recognition, the nature of work, responsibility, advancement and growth. 'Hygienic' factors are not job-

1. But the evidence of the relationship between morale and productivity is not always positive. With high morale the productivity can be lower or vice-versa; see Vroom and Deci (1970).

related, but comprise such variations as company policies, salary, co-worker relations and supervisory style. They argue that eliminating the causes of dissatisfaction (through hygiene factors) will not always result in a state of satisfaction. Instead it will result in a neutral state (i.e. passive acquiescence). Satisfaction and motivation would occur only as a result of the use of 'motivators'. It is highly controversial that the so-called 'hygienic' factors will not motivate. Individual perceptions of the significance of these factors differ to a great extent. However, it should be the business of management, according to this theory, not to try to sell employees on the beauty of benefits they already take forgranted but to anticipate where their needs become strongest and to plan an active programme of harnessing the motives that these needs will ignite (Gellerman, 1970, p. 54).

So far as the anticipation of the needs of the workers by the management is concerned, it can more conveniently be determined in a unionised setting than in a non-unionized one, considering the diversity of industrial perceptions. The union will help in determining such average needs after considering the perceptions and priorities of its members.

The impact of 'voice' on enhancing labour productivity is summarised in Fig. 1; it also illustrates that the other 'route' to higher productivity, which along with increasing wages, leads to a misallocation of resources.

Conclusion

In brief, the positive effects of unions on productivity are the following :

1. Reduced turnover and consequently higher human capital retention by the firm. Training costs are reduced.
2. High morale and motivation.
3. Shock effect on management.
4. Better informal relations amongst the workmen, less rivalry through introduction of seniority and higher informal training of workers.
5. Improved and effective channel of communication between workers and management.

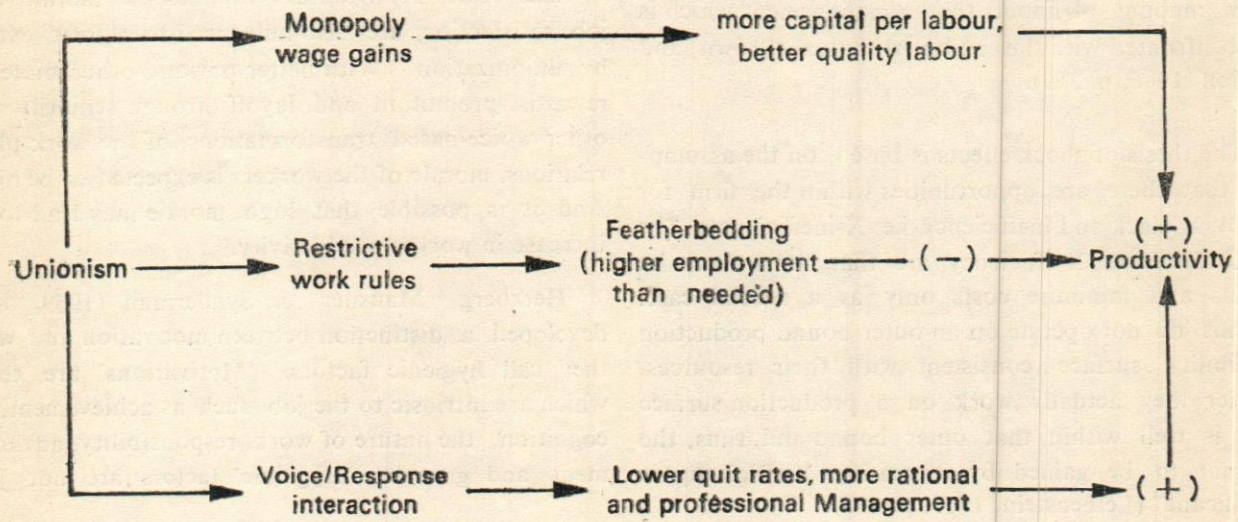

Fig. 1 Impact of 'Voice' on Productivity

Source : Freeman & Medoff (1984, p. 163).

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Status of Quality Circles in India

Ajit Singh

Quality Circles have been employed in Japan since the early 1960s but in India they have a much shorter history, and it is only in recent times that interest in them has intensified and become widespread. Quality Circles are, sometimes, seen as the fashionable quick-fix solution to shop floor problems and there have been many failures in practice because of a lack of understanding of "What quality circles are about". The attitudes, expectations and experiences of companies that have employed quality circles, are examined in this study and results are presented on the basis of a survey of Indian organisations.

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The development of quality control in Japan since the 1950s has relied heavily on absorbing, adapting and refining methods and concepts such as statistical quality control (SQC), Zero Defects (ZD) and "Right-first-time" developed in the west, principally in USA. Though SQC was a success in many ways in Japan, apparently the onus of quality rested with the Quality Control Department during the early days (Chu, 1987). To resolve this problem, the Japanese developed Total Quality Control (TQC) which meant that every employee in the organisation had a responsibility for quality. Quality Circles were employed as a part of Total Quality Control system (Pacific Information Digest, 1984). The first quality circle were registered with the Union of Japanese Scientists and Engineers (JUSE) in May 1962, which established a special organisation to promote and coordinate quality circle activities. The quality circle has been defined by the Union of Japanese Engineers and Scientists (JUSE) as :

> "A small group to voluntarily perform quality control activities within the workshop to which they belong. This small group with every member participating to the full carries on, continuously, as part of company wide quality control activities, self-development and mutual development, control and improvement within the workshop utilising quality control techniques." (International QC Circle Proceedings, 1981).

The basic philosophy, attitude and the way of operating Quality Circles are now well-established. These activities have been proved successful in Japan to upgrade quality and to secure improvements in products or services. Initially, it was believed that Quality

Circle activities could not possibly be implemented outside Japan unless considerable modifications were made. However, attempts made in Taiwan and South Korea were successful and implementation was extended to American, Asian and European Countries (Mohrman, 1983).

In India, about 158 companies are registered with Quality Circle Forum of India (QCFI) and an equal number of companies are practising Qrality Circles though they are not yet registered with QCFI. The results presented here are based on a survey carried out by the author and responses received from 112 companies registered with QCFI. A semi-structured questionnaire was circulated to collect data and a few visits to four selected companies were made. The survey included engineering industries, heavy machinery, shipyards, port trusts, process industries, rubber and automobiles.

Survey Results

The bulk of the quality circles have been introduced during 1984 and later (Figure 1). The growth of quality circles indicates the increasing participation rates which doubled in three years and is expected to be six times in 1988 as compared to 1984. It is interesting to note that 56% of the companies reported their Quality Circle programmes as successful and only 12% reported failures. However, 32% of the companies reported that they could not yet say anything about the outcome. There was no evidence to suggest that success or failure was in any way related to the type of industry which the company was engaged in.

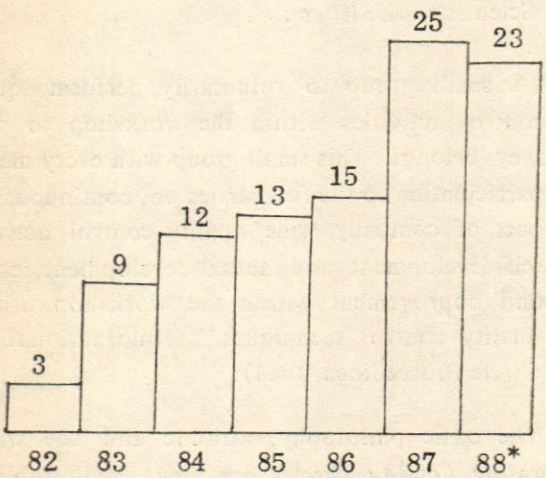

Fig. 1 Year wise Percentages of Quality Circles introduced by companies in the survey

*Figures for 1988 are upto April only (4 months)

The problems or factors that were assessed as having impeded the implementation of quality circles programmes are shown in Figure 2.

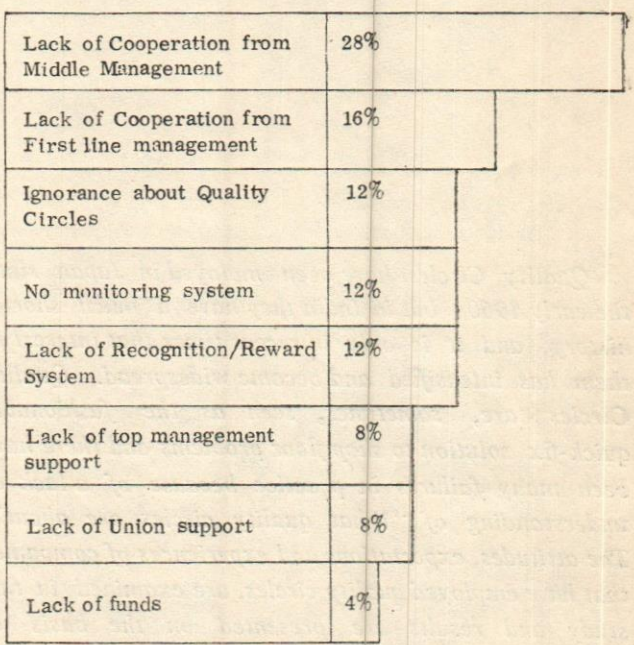

Fig. 2 Problems or factors that impeded the implementation of Quality Circle programmes in unsuccessful companies

For the unsuccessful companies lack of cooperation from middle management was considered to be of overriding importance. Lack of cooperation from first line management, although the next most important issue, was seen as being of much less significance. Ignorance about quality circles, absence of monitoring systems and lack of recognition/reward systems were considered comparatively of less importance. Neither lack of top management support nor the lack of union support was thought to be a major obstacle to the introduction of quality circles and the question of lack of funds was hardly considered a problem at all.

It will be worthwhile to mention here that the

survey carried out by King and Tan on Quality Circles (1986) also showed lack of cooperation from middle management' and first line management, as the two topmost reasons for failures.

For the successful companies, the factors which contributed to the effective introduction of quality circles, are given in Figure 3.

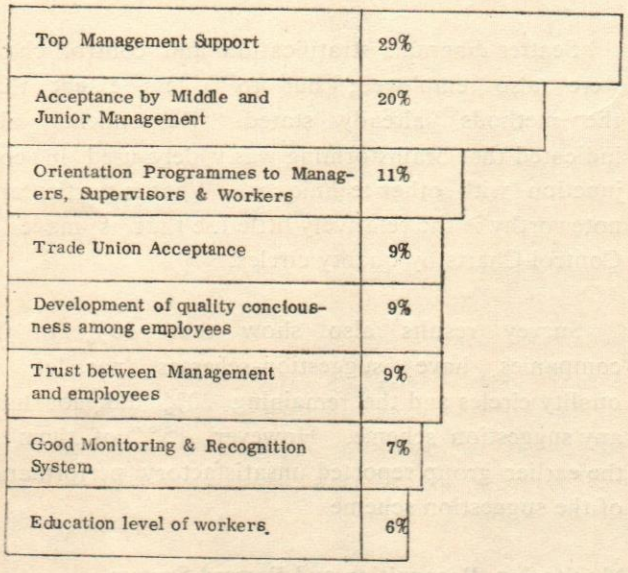

Fig. 3 Factors contributed to the success of Quality Circles in successful companies

A very interesting inference can be drawn from Figure 2 and Figure 3. For those companies which are successful, the top-ranking factor for success is "Top Management Support" and for those companies which have failed the top-ranking reason of failure is "Lack of Cooperation from Middle Management". This is typical of Indian organisations.

The reasons for adopting quality circles were examined for both successful and unsuccessful companies together and the results are presented in Figure 4.

The need to develop problem solving attitudes and improve employees' motivation have been ranked as the two most important objectives/reasons for introducing quality circles. The third in ranking was the requirement to develop quality consciousness. Both the need to improve productivity or output and the need

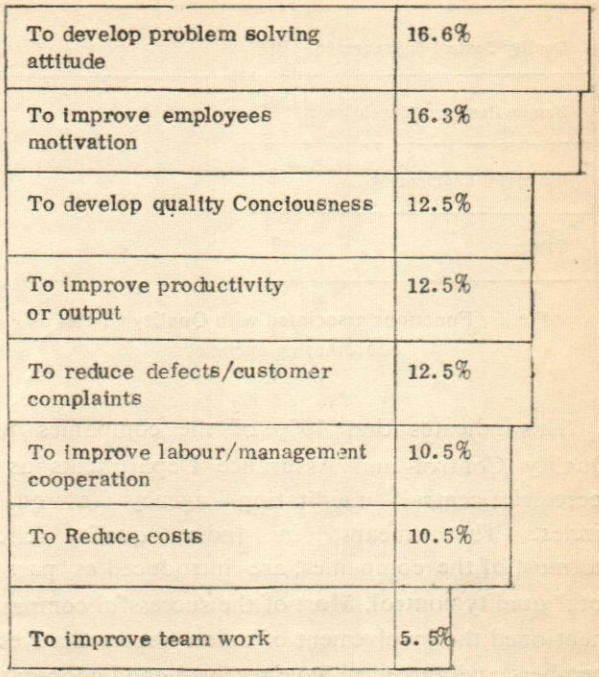

Fig. 4 Reasons for adopting Quality Circles

to reduce defects/customer complaints were also ranked equally. This may be regarded as the important and measureable consequences that could be expected to flow from improvements brought about by quality circles. The expectations of companies to improve labour/management cooperation and to reduce costs ranked next. This means that managements in general do not expect a direct reduction in costs through quality circles, though they hope to achieve it indirectly. Surprisingly the improvement in team work has been ranked the last. Most of the successful companies reported that the objectives as envisaged in the introduction of the quality circle programme have been achieved to the extent of 50% to 80%.

All the successful companies indicated a continuing future commitment to the employment of quality circles. The unsuccessful companies were yet undecided about the continuance of the QC programme.

Out of the total companies surveyed, 6% did not have any formal Steering Committee and no formal QC coordinator. Full-time coordinators were employed by 14% of the companies while 80% utilised part-time coordinators. The part-time coordinators belonged to the functions as mentioned in Figure 5.

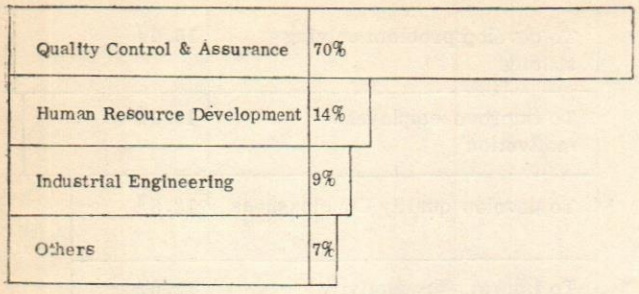

Fig. 5 Functions associated with Quality Circles as coordinating agencies

This indicates that 70% of the companies used Quality Control and Assurance Departments as the secretariat/central facilitating agency in quality circles. That means, in India, quality circles in most of the companies, are introduced as part of total quality control. Most of the successful companies mentioned the involvement of union representatives as members and agreed to have received good cooperation from trade unions. However, none had any union representatives on the Steering Committee.

There were mixed views about the role of the facilitator; the most prevalent view being that of coordinator. Some viewed them as trainers/counsellors and change-agents. Figure 6 gives the role as perceived by the companies.

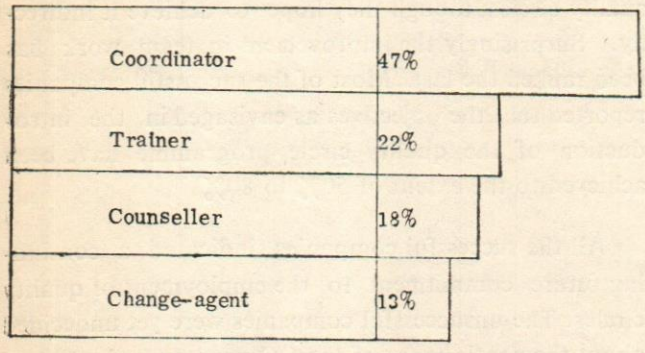

Fig. 6 Role of Facilitator as perceived by surveyed companies

Quality circle leaders were chosen in a variety of ways which ranged from being elected by the circle members to being appointed by the management. About 84% of the companies surveyed reported that the members elected their leaders, in 10% of the companies they were chosen by consensus and in another 6% they were appointed by the management.

Figure 7 shows the ranking based on the frequency of usage of quality aids/techniques employed by quality circles in the successful companies. The most used teehniques are, as may be seen, the cause-effect or fishbone diagram, check sheet, Pareto chart and histogram.

Scatter diagram, stratification and control charts were also employed; but to a less extent than the methods already stated. Respondents also indicated that brainstorming was widely used in conjunction with other techniques. What is particularly noteworthy is the relatively little use that is made of Control Charts by quality circles.

Survey results also show that 80% of the companies have suggestion-schemes parallel to quality circles and the remaining 20% did not have any suggestion scheme. However, 15% of them in the earlier group reported unsatisfactory performance of the suggestion scheme.

Monitoring, Recognition and Reward System

Many companies have developed an effective system of monitoring progress to sustain quality circles activities on a long term basis. One of the successful companies reported that the management constantly monitored the activities and gave Blue colour to circles rated as good, Green to satisfactory, Yellow to fair and Red to those circles which needed attention.

Most of the companies monitor the number of meetings held, the number of suggestions put forward and the number of presentations and their implementation, the total number of circles and other such parameters.

The recognition system consists of monetary rewards and non-monetary rewards. For example, one company has linked the monetary rewards directly to the savings as a result of implementation of suggestions. It varies from 10% to 15% of the

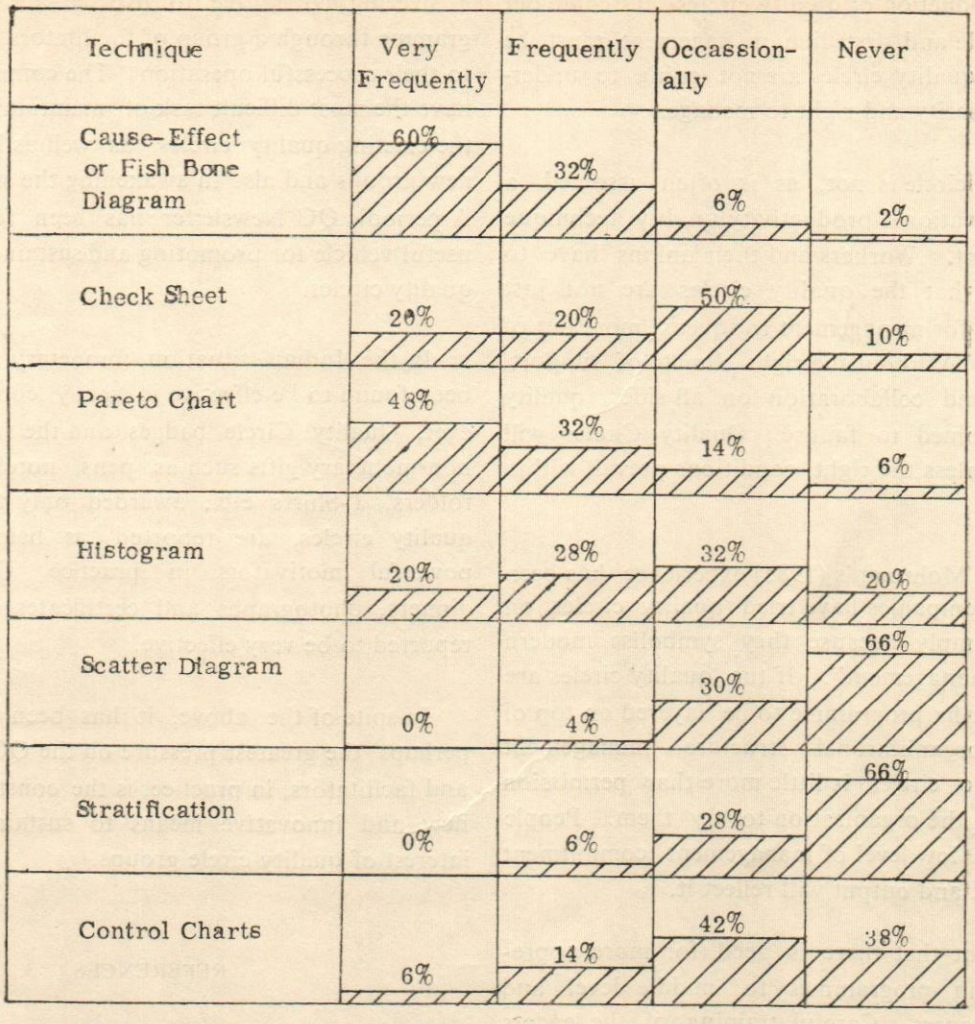

Fig. 7 Frequency of usage of aids/techniques by Quality Circles in surveyed companies

savings. Others have worked out different non-monetary methods which are mentioned in brief as under:

* A rosewood plaque with brass plate names of all members of a circle for outstanding circles
* Certificates to members with their names
* Rolling Trophy/Shield for best circle in the company
* Best Facilitator award
* Inter-unit competitions and complimentary gifts
* Photograph of members in House Journal/News Letter of the Company
* Publishing of the Case Studies
* Participating in seminars/conventions
* Sending the best circle to tourist places
* Sending the best circle to international conventions

Conclusions

It has become clear from the study that quality circles can be successfully employed in every kind of industry. The QC activities are not always successful; failures may be due to various causes, the principal one being, as already discussed, the lack of cooperation from various levels of management and to a lesser extent, union opposition.

The importance of middle management in the

successful introduction of quality circles has come out clearly. Middle and first line management must be reassured that quality circles are not going to undermine their authority and right to manage.

The quality circle is not, as is often assumed, a quick-fix motivational/productivity/quality technique for improvement. Workers and their unions have to be convinced that the quality circles are not just another device for management to squeeze more out of the workforce. Without the right climate of support, commitment and collaboration on all sides, quality circles are doomed to failure. Quality Circles will not succeed unless the right conditions prevail within the company.

Lawler and Mohrman's (1985) experience has been that : "some companies have tried quality circles on a trial basis simply because they symbolise modern participative management". If the quality circles are seen as a quick-fix programme to be layered on top of the existing organisational structure, management commitment to circles is little more than permission for someone in the organisation to try them. People will sense the low level of management commitment and their effort and output will reflect it.

It is evident that there is need for more appreciation training programmes to middle level and front-line managers. Careful training of the leaders is important, as well as that of the members, for quality circles to succeed and become a way of life in Indian organisations.

The results from the survey also indicate that there are variations in the successful employment of quality circles. There are instances where quality circles are successful without either a steering committee or even facilitator. But how long these companies will sustain quality circles is open to question. The majority of the companies found that a steering committee to oversee and direct the programme through a group of facilitators is fundamental to their successful operation. The committee members have the most difficult task of maintaining interest in the existing quality circles, as well as in encouraging new groups and also in awakening the sleeping circles. A periodic QC Newsletter has been found to be a useful vehicle for promoting and sustaining interest in quality circles.

In the Indian situation, monetary rewards have been found to be effective in many companies. However, Quality Circle badges and the small, inscribed, non-monetary gifts such as pens, notebooks, diaries, folders, T-Shirts etc., awarded only to members of quality circles, are reported as being surprisingly powerful motivators in practice. Quality circles dinners, photographs and certificates have also been reported to be very effective.

In spite of the above, it has been observed that perhaps the greatest pressure on the QC Coordinators and facilitators, in practice, is the constant search for new and innovative means to sustain or revive the interest of quality circle groups.

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Productivity Measurement in a Multiproduct Multiplant Engineering Company

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This paper demonstrates through the case study of a multiproduct, multiplant engineering industry in India that the conventional productivity measurement models such as Kendrick-Creamer, Craig-Harris and Taylor-Davis which are based on output-input type relationships are inadequate and inappropriate for measurement of productivity based on the published balance-sheets or annual accounts. The paper makes a plea for using a more appropriate model for productivity measurement based on a systems approach such as PO-P approach.

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Productivity, as an indicator of the overall efficiency of an organization, helps in setting goals for improvement. A large number of concepts and models to measure productivity have been evolved; yet productivity measurement remains beset with several problems. There are inadequacies, inconsistencies and fallacies inherent in the approaches proposed as pointed out by Sardana & Vrat (1987) and Sink (1983). Non-availability of suitable and appropriate data complicates the issue further. Kendrick-Creamer (K-C), Craig-Harris (C-H) and Taylor-Davis (T-D) models are among the three major contributions in the literature on productivity measurement. This paper attempts to critically examine the applicability of these three models to measure the productivity of an Indian company by restricting the source of data and information only to the published annual accounts of the Company. The objective is to investigate whether the annual report is a useful measure of productivity. The paper, then, highlights the inadequacies inherent in the application of these approaches.

The Company Profile

Heavy Electro-Mechanicals Ltd. (HEML),[1] chosen as the company for the case study, is an affiliate of a multinational and has several plants located at various places in the country, but publishes one common companywide Annual Report and Balance Sheet. It is

1. The actual name is not disclosed in the paper.

a large organization employing over 3000 persons and is engaged in the design and development, manufacturing and marketing of heavy electro-mechanical equipment for use by public utilities, industries and bulk consumers of electrical energy. The company is known for its professional outlook, quality of products, precision engineering and public image and has a sustained growth-oriented performance. For the study, the period of analysis is 1980-81 through 1984-85. The year 1980-81 has been considered as the base year.

For purposes of the present study, all needed information from the Profit and Loss Account statements has been tabulated in Annexure-I. This includes information on Income and Expenditure and Profits before taxation. Information on total funds employed and their application on fixed assets, inventories, current assets etc., as obtainable from the Balance Sheet statements has been summarized in Annexure-II. Annexure-III provides detailed information on various classes of inventories such as raw-materials, components, finished goods, work-in-progress etc., as noted from the explanatory schedules of the Annual Report.

All the three models recommended that the output and inputs be corrected to base year values through the use of deflators. As the balance sheet does not furnish the deflators, recourse has been taken to the use of "Index Numbers of Wholesale Prices in India" valid for electrical machinery for deflating the output and inputs of materials and capital. "Consumer Price Index Numbers for Industrial Workers" has been used to correct the labour input. These indices as detailed by Nair and Burman (1988) are reproduced in Annexure-IV.

Kendrick-Creamer (K-C) Model

Three types of indices have been recommended by Kendrick and Creamer (1961) :

1. Total Productivity Index $= \frac{\text{Output}}{\text{Input}}$

where Output = Measured-period output in base-period prices

Input = Measured-period input in base-period prices.

2. Total Factor Productivity Index

$$= \frac{\text{Net Output}}{\text{Total Factor Input}}$$

where Net Output = Output — Intermediate goods and services, Total Factor Input = Labour Input + Capital Input.

3. Partial Productivity Index

$$= \frac{\text{Output}}{\text{Input of Labour or Capital or Materials}}$$

Depending upon the use of the input factor, the productivity index is referred to as the productivity of labour or capital or materials. Kendrick and Creamer (1961) have demonstrated the computation of productivity indices through five case studies. It is only in the case study of Mideast Manufacturing Company that the computation of Total Productivity Measurement has been demonstrated. This particular case study is followed while computing the productivity indices of HEML. The individual components are defined and used as shown in the following paras.

Output The output is taken as the deflated value of "net sales and other operating revenue". Dividend and interest income from portfolio holdings of stocks and bonds has not been included. The value of the change in semifinished and finished goods inventories does not form a part of the sales. On the other hand, the "amounts attributable to production for inventory" are to be excluded from the inputs. The model has suggested use of a "chain index procedure" to arrive at a price deflator for sales.

Labour Input This is the total labour compensation allowable to production of goods sold, deflated by an index of average hourly compensation. The model recommends that compensation on account of non-production activities such as construction workers, long range research and development etc should be excluded. Similarly, deduction should also

be made for the portion of labour compensation spent on semifinished goods, work-in-progress and inventories of finished stock. The annual report of HEML does not furnish any information about the extent of completion of work-in-progress, labour content in other inventories, the extent of manufacturing effort in the component inventory and also the actual labour hours worked to generate output. Certain assumptions have therefore, been made. Work-in-progress has been considered to be 50% complete; component inventory has been counted as 100% manufactured inhouse; 100% labour compensation has been assumed on components and finished goods inventory and no labour compensation on inventories of raw materials and stores-spares, being assumed as 100% purchases. No deductions have been made for non-production work.

Purchased Materials and Services This represents the cost of materials and services responsible for sale of goods. In the context of the Mideast Manufacturing Company, the K-C model treats the above components as "residual", i.e., the figure arrived at by deducting the labour compensation, depreciation, federal taxes etc. This information is available under the heading "Cost of Material and Erection Services" in Annexure-I. This requires to be deflated to base year prices. The model recommends the use of weighted average of prices of all quantitatively significant types of materials used for deflating to the base year.

Capital Input It has been proposed that the total value of capital assets in constant dollars be estimated and the capital input be arrived at by applying the base period gross rate of return on invested capital at replacement value to the real stock estimate. Cash and other securities are to be deflated by 'Cash Use' index; accounts receivables are to be deflated by 'Sales Price Index'; materials by 'Index of purchased materials prices' etc. The output, inputs and productivity indices so arrived are summarised in Table 1.

Craig and Harris (C-H) Model

Craig and Harris (1973) considers productivity as the efficiency with which outputs are produced. The indiscriminate use of partial productivity measures is discouraged. The model defines Total Productivity

TABLE 1 **Productivity Indices Under K-C Model**

	1984-85	1983-84	1982-83	1981-82	1980-81
Output					
Net Sales (Rs '000)	656,068	403,810	384,904	489,656	424,514
Input					
Labour (Rs '000)	46,824	48,860	41,673	48,685	44,076
Materials (Rs '000)	443,371	237,253	235,712	292,914	244,082
Capital (Rs '000)	53,041	46,794	47,432	44,682	38,874
Total input (Rs '000)	543,236	332,907	324,817	386,281	327,032
Total Productivity	1.21	1.21	1.18	1.26	1.29
Factor Output (Rs '000)	212,697	166,557	149,192	196,742	180,432
Factor Input (Rs '000)	99,865	95,654	89,105	93,367	82,950
Factor Productivity	2.13	1.74	1.67	2.11	2.18
Labour Productivity	14.01	8.26	9.24	10.06	9.63
Material Productivity	1.48	1.70	1.63	1.67	1.74
Capital Productivity	12.37	8.63	8.11	10.96	10.92

(P_t) of a company as :

$$P_t = \frac{O_t}{L_t + C_t + R_t + Q_t}$$

where L_t = Labour input factor

C_t = Capital input factor

R_t = Raw material and purchased parts input factor

Q_t = Other Miscellaneous goods and Services input factor

O_t = Total Output

The model has been described as a service flow model. The model is elaborated and its application to HEML explained in the following paras.

Output The C-H model recommends that all outputs should be weighted so that these can be added together. The selling price has been suggested as the most suitable weighting unit. The emphasis is on units "produced" and not units "sold" since productivity has been viewed to be concerned with efficiency of converting inputs to outputs. Following this rationale, work-in-progress inventory suitably weighted with percentage completion, as measured in cost terms, is also required to be included in the computation of output. The model also brings out that the output value should be arrived in base year terms. New products are to be valued using an adjustment method based on the ratios of established costs of new and old products. As a "short-cut", it is also recommended that value of output in any year after the base year can be corrected by deflating (or inflating) the same by a suitable price index. The model also recommends that income derived from other sources (except windfall profits) should be included in the output as it is the outcome of a portion of the input factors. As in the case of K-C model, it is assumed that work-in-progress and component inventory is manufactured totally inhouse; the raw materials and stores-spares are totally purchased inventories.

Labour The labour input is calculated by summing up the wages/salaries and the fringe benefits. The model recommends that the manhours worked times an appropriate wage rate (per hour) of the base year provides the labour input. In case of HEML, data pertaining to wage rate of each job classification and number of hours worked by each labour classification are not available in the annual accounts. The total personnel compensation comprising wages, salaries and benefits is, therefore, taken as the labour input.

Raw Materials and Purchased Parts All purchases of production material after adjustment for inventory changes times base year material prices represent the input. The C-H model also stipulates that appropriate price indices can be used to adjust the current year prices in case the base year material purchase prices are not available. Components and work-in-progress inventory are assumed to have been produced totally inhouse, whereas raw materials and stores-spares are considered as totally purchased inventories.

Miscellaneous Goods and Services This category covers all other input resources (except labour, capital and materials) such as utilities, advertising, office supplies etc. These are also required to be adjusted to base year prices. Interest payments are not counted as inputs. The basic expense data under this category are given under the head "Other Expenses" in Annexure-I.

Capital The C-H model views that the "service value of capital" represents capital input. It is assumed that the stockholders and debtors lease out the land, buildings and equipment and supply current assets and therefore, expect a return. The required rate of return is the cost of capital in the base year. The model recommends that the current year costs of buildings and equipment should be first deflated to base year. The contribution of the assets is calculated by multiplying the base year value of the assets by the cost of capital, which has been assumed to be 15%, being the current bank rate for borrowings from financial institutions. The output, inputs and the productivity indices are detailed in Table 2.

Taylor and Davis (T-D) Model

Taylor and Davis (1977) Model measures "Total Factor" Productivity. The model lays emphasis on output as value-added and therefore, recommends the exclusion of raw-materials as input.

TABLE 2 **Productivity Index Under C-H Model**

	1984-85	1983-84	1982-83	1981-82	1980-81
Output (Rs '000)	781,943	544,450	523,378	610,331	514,553
Input					
Capital (Rs. '000)	45,963	40,550	41,102	38,726	33,692
Material (Rs '000)	453,362	225,025	231,073	317,048	391,218
Labour (Rs '000)	55,363	56,757	51,897	58,592	51,694
Others (Rs '000)	99,587	87,286	75,352	91,645	83,950
Total Input (Rs '000)	654,275	409,618	399,424	506,011	560,554
Productivity	1.20	1.33	1.31	1.21	0.92

The model differs from K-C and C-H variants in its treatment of working and fixed capital. The total factor productivity model is formulated as follows :

$$TEP = \frac{(S+C+MP)-E}{(W+B)+[(Kw+Kf).\ Fb.\ df]}$$

where S = Sales
C = Inventory Change
MP = Manufacturing Plant
E = Exclusions
W = Wages & Salaries
B = Benefits
Kw = Working Capital
Kf = Fixed Capital
Fb = Investor Contribution Adjustment
df = Price Deflator Factor

The explanation and computation of each component of output and input is detailed as follows.

Output It is a value added measure. It covers sales, manufacturing plant, adjusted inventory but excludes purchased materials, services and rentals. The exclusions are, supposed to be the output of other firms and fruits of someone else's labour and not a direct outcome of ones own efforts. The sales figures of the company are represented under the head "Sales and Services" in Annexure-1.

Inventory Change The T-D model emphasises that the output should reflect total production efforts of a firm. As inventories are also the result of the efforts of an organization, any increase or decrease in net inventory should be added or subtracted respectively from the output. The company has categorised its inventories under the head of rawmaterials, components, finished goods and work-in-progress which get added to the output for conversion to sales and hence only inventory change of these categories are to be added or subtracted. Furthermore, the productive efforts of the company are only reflected in the inventory categories of finished goods, components and work-in-progress where certain value-additions has already taken place. It is assumed that the entire component inventory has been manufactured in-house. The inventory change is arrived at by subtracting the opening inventory from the closing inventory. The closing inventory of the previous year is the opening inventory for the current year.

Manufacturing Plant This includes items which could be purchased from outside sources but are produced internally. This encompasses items such as components, spares, equipment produced for maintenance, repairs, research and development, trials, development of process, technology of product, tool trials, jigs, fixtures etc. Only a limited information is available under the head "Repairs : Building, Plant & Machinery and others" of HEML's annual accounts. In the absence of information as to what

extent the same have been carried out internally, it is assumed that one-half might have been done internally.

Exclusions The model recommends that factors which do not represent results of production efforts must be subtracted from total output. The items include externally purchased materials and supplies, depreciation on buildings, machinery and equipment and rentals. In HEML Annual Accounts, depreciation and rentals do not appear in the sales figures. It is therefore, only the value of purchased materials deflated to the base year which is to be subtracted.

Labour Input Wages and Benefits cover the compensations to all classes of employees in any form including wages, salaries, incentives, bonuses, overtime payments, vacation benefits, insurance and all types of allowances such as dearness, house, dress, medical etc. For HEML, the labour input is taken as "Personnel Expenses" in Annexure-I.

Working Capital and Fixed Capital Working capital includes cash, notes, accounts receivables, inventories and prepaid taxes. Fixed capital covers investments in land, buildings, machinery, equipment and deferred charges. Both working and fixed capital (except portfolio investment) are available for generation of output.

Investor Contribution The concept introduced in this model is to "annualize" capital. Investor contribution has been defined as "real net capital", that is, capital after depreciation for each year weighted by the rate of return in the base year. For HEML, profit before tax as detailed in Annexure-I has been computed as a percent of the total assets for the base year. Using this as a weightage factor, the investor contribution has been computed for each succeeding year. The output, inputs and productivity indices as computed are given in Table 3.

K-C, C-H, T-D Models : A Comparison

All the three variants are essentially output-input models. These are based on the hypothesis that an input results in output or a change in input leads to a change in output on a proportionate basis. Yet, there are differences in the approaches followed and in the interpretation of the outputs and the inputs. Under the K-C model output is "Sales and other operating revenues". The unsold finished stock is not a part of the output. C-H model, on the other hand, considers output as total units produced irrespective of whether these are sold or remain as inventory. The model recommends that even the work-in-progress inventory weighted appropriately, should be added to output. T-D model, as a major departure, recommends output as value added to be arrived at by the exclusion of all purchases. All categories such as sales, changes in inventory, production of maintenance spares, tools etc. are required to be included in output as these are the results of productive efforts. There are also marked differences in the definition of inputs. Under the K-C model, labour, materials and capital as related to the production of goods sold form the inputs for

TABLE 3 **Productivity Index Under T-D Model**

	1984-85	1983-84	1982-83	1981-82	1980-81
Net Output (Rs. '000)	231,216	154,557	175,027	236,536	209,232
Input (Rs. '000)					
Labour	55,364	56,757	51,897	58,592	51,694
Total Capital Input	53,041	46,794	47,432	44,682	38,874
Total Input	108,404	103,551	99,329	103,274	90,568
Productivity	2.13	1.49	1.76	2.29	2.31

arriving at the total productivity index. In the case of the C-H model, besides labour, material and capital, other input resources such as utilities, advertising expense, office suaplies etc. are also included. Besides, all inputs are related to the production. Inputs under the T-D model cover only labour compensation and capital; the materials as inputs are excluded. Labour and capital as inputs are to be related to the total production, inclusive of work in-progress.

Similarly the treatment, interpretation and computation of capital as an input factor is found to follow different methodologies in the three models. The K-C model recommends the criteria of return on invested capital at replacement value to be deflated by a suitable index. The C-H model, on the other hand, compares the same to the available rate of return as if the capital inputs were leased out by stock holders. The T-D methodology has introduced the concept of annualising the capital as investor contribution. The techniques suggested for the computations are quite complex.

It is very interesting to note that the resultant productivity indices are quite at variance in the case of HEML. 1983-84 is the year of lowest productivity using T-D model whereas 1980-81 and 1982-83 are the years of the lowest productivity respectively when C-H and K-C models are applied. It is often said that the models are particularly useful when these are used to ascertain the trends in productivity. In this context also the three models provide results at variance with each other. The T-D model shows rising productivity from 1983-84 onwards. The K-C model however, depicts declining trends in productivity. The C-H model depicts declining productivity for one year followed by an increase in productivity in the following year.

K-C, C-H, T-D Models : Limitations and Inadequacies

The three output-input models have basic conceptual inadequacies making it difficult to apply them to real life situations. In addition, there are problems of measuring inputs and outputs. The models imply reliance on a stimulus-response model of causality, that an input causes an output. It is presumed that the organisation is a simple, static and mechanistic system and its output is regulated by inputs. The K-C model has also advocated the use of factor productivity and partial productivity indices mainly to meet objectives of diagnostic analysis for productivity improvement. This approach has serious shortcomings and may lead to misinterpretations and misleading analysis. In a complex system, inputs interact and impinge on each other. A change in output because of one input can sometimes be at the cost of output from another input factor. It is known for example that output per labour hour can be increased through a capital intensive hi-tech plant or through the use of materials with higher technical inputs; but increase in labour productivity would be at the cost of material or capital productivity.

Gold (1983) points out that the intended use of such an index is to measure changes in efficiency level, the ratio of deflated total revenue to deflated total cost and product price indices relative to factor price indices. However, changes in these ratios can be on account of several reasons, such as variations in quantity or price, shifts in input factor proportion, differential changes between factor and product prices etc., so that total productivity index is hard to interpret. It hardly meets the objective of developing productivity indices for identification of areas to bring about improved performance.

The focus on output-input ratio has a bias towards the production function. As a matter of fact, C-H and T-D models have advocated inclusion of unsold finished stocks or products and work-in-progress in output on the ground that these represent the efforts of production and should not be excluded. But there can be several other outputs besides production of goods and transactions of sales.

These models have restricted the input to labour, materials and capital. Similarly, outputs considered are essentially goods manufactured or sold. Mali (1978) has dealt with the issue of inputs and outputs in a detailed way and it is pointed out that input variables also encompass budgets, space, land, payroll, costs, time, supplies, work-orders, rent and equipment. Management attitudes, organisational ingenuity and

creativity are the other inputs. Similarly, output variables also comprise services rendered, cost benefits reports completed, failures generated, deliveries made, tasks completed, responsibilities met, machine utilization standards reached, work completion etc. Besides, as Mohanty (1983) points out, there can be intangible outputs such as service to clients, free repairs, service to society etc. and also negative value outputs such as effluents, pollutants, wastes etc., which must be accounted for as these are also generated by the same efforts of an organization responsible for positive outputs.

All the three models have proposed that the output be measured in terms of sale value of the products sold or produced/value added. Selling price itself is a function of several variables such as cost of production, market environment, demand and supply and other company objectives such as achievement of a specified market share of a product or a minimum return on sales in a specified territory, strategic selling at low sales value etc. In a market oriented economic system, a customer chooses a product which satisfies his requirement of "fitness for use" and is not concerned as to the efforts spent by the organization. In a free economy the selling price of the same product may vary depending on the status of demand and supply, thus, projecting different "output" though efforts of production remain unchanged. Similarly, sale value of different products need not be in proportion to the efforts spent in their production.

In the case of measurement of inputs, there is an additional problem of integration of inputs. For measurement of labour alone, it calls for integration of efforts, skills, time, and machine plant and equipment. The qualitative aspects of the inputs do not find a place in these models. This issue becomes more complex where inputs of heterogenous nature are required to be integrated. Besides, productivity is a synergetic process and the basic phenomena related to synergy are interdependence and interaction. The inputs interact with each other; the concept of equivalent conversion implies that the interaction is predetermined and follows a linear relationship. This is a basic incongruity. Another problem lies in arriving at the "deflator factors". The approaches suggested are complex and deflator factor arrived for one organisation is not applicable to another.

Limitation of Annual Accounts

The inadequacy of the Annual Accounts of HEML for productivity measurement is reflected in several ways. It is apparent in non-availability of information as well as in the improper definition or interpretation of the data available. Many assumptions had to be made in the application of the conventional output-input models.

In the case of application of the K-C model, certain assumptions became necessary for want of information on: change in semi-finished and finished goods inventories attributable to production; state of completion of semi-finished (work-in-process) inventory; price-deflator for sales; extent of labour spent on semi-finished goods, work-in-progress; actual labour hours worked; average hourly rate of labour compensation; weighted average prices of all quantitatively significant types of materials; price index for purchases; replacement value of invested capital; real stock estimate; "cash use index", "sales price index", and "purchased materials price index".

Non-availability of following information from Annual Accounts led to assumptions while applying C-H model; selling price per unit of each product, state of completion (percentage) of work-in-progress, established costs of new and old products, base year selection, index of inflation, wage rate of the base year, manhours worked, base year material prices, price index for purchases, expense on office supplies, advertising, cost of capital (annuity), cost of capital (liquid assets), and lease value.

In the case of application of T-D model, the following information is not available in Annual Accounts : deflator factor for sales correction, degree of completion of work-in-progress, extent of manufactured plant produced, price inflation rate, inventory change on account of production efforts, rate of return in the base year and price deflators.

These models have referred to productivity as the

conversion efficiency of inputs to outputs. The only "output" which the Annual Accounts refer to are the realised sale value or the profits; the other outputs are not mentioned. Even information on goods unsold or work-in-progress is not detailed enough so as to know the productwise status in terms of percentage completion. The detailed and accurate impact of inflationary trends in prices, change in product mix, changing market profile or change in product pricing policy cannot be ascertained from the Annual Account statements. *The Annual Account statements are indeed meant for objectives other than that of productivity measurement.* The principal objective of these statements is to project the financial health of the company to shareholders and other investors. With this objective, the profit and loss statement proceeds to establish profit. The shareholder has little desire to know if the profits have resulted from the production efforts or from other means (such as marketing strategy). The balance sheet lists down the liabilities and the assets again with a view to generate confidence amongst investors on sources and disposals. In case the principal objective of productivity measurement is to identify areas for improvements to bring about increased effectiveness, the published accounts serve only a very limited purpose. The data available for the exercise of productivity measurement are incomplete with reference to both inputs and the outputs.

Concluding Remarks

The statements of Annual Accounts of the company pose serious limitations in carrying out the exercise of productivity measurement. The data available are inadequate and suffer from definitional and interpretation problems. Data on a number of vital items are not listed under any statement of explanatory schedule. Any subjective interpretation of this data make the exercise unscientific. The output-input models therefore have a very limited scope of application if only the data from the Annual Accounts are to be used. Besides, the output-input models have severe limitations in concept as well as in application. These include: defining the concepts of productivity, outputs and the inputs, measurement of output and the inputs and selection of deflator factors to account for inflation or conversion to base period values. This establishes the need for interpreting productivity in a broader perspective and the development of a more general model to measure the productivity of an organization. System-based productivity models such as PO-P by Sardana & Vrat (1983, 1984, 1987) may be more appropriate for measurement of productivity, since the balance sheet is not a very appropriate tool.

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ANNEXURE I **Data from Profit & Loss Account**

(Rs. '000)

	1984-85	1983-84	1982-83	1981-82	1980-81
Income					
Sales & Services	795,234	489,467	424,370	518,703	424,514
Other Income	9,800	11,164	14,138	16,975	15,435
	805,034	500,631	438,508	535,678	439,949
Expenditure					
Cost of Materials & Erection Services	537,420	272,391	259,881	310,291	244,082
Personnel Expenses	77,215	75,374	62,003	63,756	51,694
Other Expenses	120,712	100,214	83,078	96,521	83,950
Depreciation	10,965	8,792	7,561	5,469	4,360
Interest (on Debentures & Fixed Loans)	13,076	14,784	12,172	9,908	6,075
Others	26,417	22,892	21,472	15,489	11,361
	785,805	494,447	446,167	501,434	401,522
Less Overheads Capitalised	1,023	1,273	853	709	477
	784,782	493,174	445,314	500,725	401,075
Profit Before Taxation	20,252	7,457	6,806	34,953	38,874

ANNEXURE II **Data from the Balance Sheet**

	1984-85	1983-84	1982-83	1981-82	1980-81
Total Funds Employed	375,045	313,572	305,306	276,458	226,169
Fixed Assets					
Gross Block	161,058	141,737	124,422	115,369	94,718
Less : Depreciation	69,816	59,406	50,877	43,363	38,097
Net Block	91,242	82,331	73.545	72,007	56,621
Capital Work-in-Progress & Advances for Capital Expenditure	2,268	13,207	13,603	7,227	10,530
	93,510	95,538	87,148	79,234	67,151
Investments	3,628	3,198	3,198	2,969	1,555
Current Assets, Loans & Advances					
Inventories	205,426	179,377	199,214	185,171	136,325
Sundry Debtors	318,071	219,153	161,796	198,170	161,786
Cash & Bank Balances	6,248	4,384	8,628	8,660	3,294
Other Current Assets	3,082	3,789	4,760	2,717	2,105
Loans & Advances	40,841	39,832	23,186	28,157	36,327
	573,668	446,535	397,584	422,875	339,837
Current Liabilities & Provisions					
Current Liabilities	281,541	220,349	171,651	196,578	148,527
Provisions	14,220	11,350	10,973	32,043	33,847
	295,761	231,699	182,624	228,621	182,374
Net Current Assets	277,907	214,836	214,960	194,255	157,463

ANNEXURE III **Data on Inventories**

	1984-85	1983-84	1982-83	1981-82	1980-81
Stores & Maintenance Spares	9,386	8,494	8,104	9,544	6,717
Raw Materials	43,464	35,264	38,437	47,793	39,569
Components	81,205	69,632	87,597	68,883	51,464
Finished Goods	11,807	11,004	11,613	25,562	15,554
Work-in-Progress	59,564	54,983	53,463	33,389	23,021
	205,426	179,377	199,214	185,171	136,325

ANNEXURE IV **Price Index Numbers**

	1984-85	1983-84	1982-83	1981-82	1980-81
Index Numbers of Wholesale Prices	253.2	239.6	230.3	221.1	208.8
Consumer Price Index Numbers for Industrial Workers	586	558	502	457	420

The R&D Process and Productivity—An Enquiry into the Critical Factors

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A.D. Damodaran

The R & D Process is responsive to a number of psychological, social, organizational and structural factors. This has been borne out by many studies. Significant differences may exist among the countries as regards R & D management practices, organizational settings, work climate etc. Nevertheless, the relation between these factors and performances of research tend to show the same directional pattern, as proven by comparative studies. This finding is of considerable importance in science policy formulation. The paper enquires into these patterns and the critical factors influencing productivity in research.

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It is often said that in research one should not emphasise output measurement; it nevertheless becomes essential to have a productive research group so that the heavy investments are justified in the long run. Just as definite factors, qualitative and quantitative, contribute to industrial productivity, so do certain elements to research effectiveness. Creativity and innovativeness are the bases of productivity in research; though creativity cannot be made to order, it can be fostered by appropriate measures and institutional mechanisms. This paper dwells on these elements and their linkages with productivity in a research unit and is culled from the findings of some of the recent studies in this field (Andrews, 1979 & Nag Paul, Krishnaiah and Chawla, 1987). Wherever deemed necessary quantitative indices to perceptive or subjective factors are indicated so as to correlate with measures of research efficiency. It has also been observed that more than objective factors, it is the subjective factors that influence productivity in the R & D process.

Factors of Effectiveness

There is a fallacious faith in the linkage between material endowment and the quality of research performance. However, it has been observed in studies that there is no significant relationship between indicators of economic and physical resources and research unit efficiency (Nag Paul, Krishnaiah, and Chawla, 1987). Once the resource base is sufficient to keep a research unit viable, there need be no such linkages. R & D effectiveness is not a continuous

linear function of capital input. A rich unit can be ineffective whereas a poor unit can make great contributions. This has great implications for science policy in that it reveals that financial resources are not to be reckoned as number one in the national investment in R & D. In fact socially relevant research is more effectively undertaken by a relatively poor unit. Needless to say that this excepts such high funded basic research areas as high energy particle physics or similar sophisticated equipment-based frontier areas.

However certain other factors do show a notable relationship to various aspects of effectiveness. These include characteristics like (1) position of the research group leader in the social system of the R & D unit (social factor), (2) size of research group (organizational factor), (3) communication among scientists (socio-psychological), (4) morale, motivation and statisfaction with supervision and resources (psychological), (5) work plan, configuration and research methods (technical). Of these, the psychological and technical factors are of primary importance as corroborated by some of the recent studies (Andrews, 1979 and Ginn, 1986). According to Ginn (1986) organic forms of management systems contribute a positive psychological environment as against mechanistic forms the characteristics of which are as below.

Organic	*Mechanistic*
Employees contribute as colleagues.	Sub-tasks are distinct from larger tasks.
Tasks are adjustible and can be interactively redefined (flexibility).	Tasks are rigidly defined.
There is a low level of hierarchical structure and rules are few.	There is emphasis on formal authority and rules are many.
Project control is by adhocracy.	Project control is by top-down management.
Lateral and informal communication is common.	Vertical communication prevails.

It is further observed that an organic structure is more conducive to innovation and creativity. An overwhelming body of research evidence indicates that apart from an organic structure the most direct route to increasing R & D productivity is through developing good technical communication within the R & D organization. This ensures that the scientific and engineering staff of a project remain current. This contributes to improved work plan, configuration and research methods. Organic forms positively influence internal technical communication (Allen, 1986). Summary findings of the various studies are as given below.

Study	*Results*
Allen (1964)	Positive correlation between internal technical communication and technical quality of proposals.
Baker, N.R., Siegmann, J. and, Rubenstein, A.H. (1967)	Successful ideas for new products originated primarily within the organization.
Goldhar, J.D., Bragan, L.K. and Schwartz, J.J. (1979)	Award winning innovation cited most important source of information in developing innovation as communication with colleagues within the organization.

The dynamics of R & D leadership have been explored by IRI's research-on research committee where a majority of the research managers agreed that leadership is a very important factor. As far as technological science groups involved in applied and development activities are concerned, the managing and integrating functions of the leader is an important variable (Wolff, 1986). The IRI expert panel identified the key tasks of an R & D leader as below:

- —create an environment that allows for freedom of action and openness in technical discussions
- —encourage researchers to have internal and external professional contacts
- —stress the importance of cross-discipline interaction

—avoid excessive paper work and unnecessary presentations to management

—be willing to accept high risks.

The psychological factors pertain to perception rather than reality. Subjective perceptions need not always concur with objective reality. This cognitive dissonance between the two can significantly affect performance. A research unit should have enough resources in the form of material, men, and information to undertake its functions effectively. But it is not the actual quantum that is important but the perceived adequacy and the degree of satisfaction with these resources.

An objective measure of the material resources can be obtained by considering items like funds and space on a per unit basis, equipment and raw material inputs for the group, delay in procurement etc. The number of research scientists per project, academic training and experience of scientists and technical staff etc. all objective measures of human resources. The objective measure on information as a resource is derived from data on visits to and from other units, library and documentation inputs and facilities, group meetings within the research unit and the number and frequency of innovative ideas or modifications suggested.

Subjective measures for resources are based on a five-point scale rating of the level of satisfaction with the availability of resources. The level of satisfaction with human resources (subjective measure), actual delays in the procurement of low cost equipment (objective count) and the level of contacts of the unit (subjective measure) are the three factors having the strongest relationship to research unit efficiency (Patchen, 1970 and Andrews, 1979).

Communication

Communication in science and technology may be looked at from the point of view of negentropy. Communication can be recorded as a signal or as a channel. Communication as a signal is represented by the composite output measure which is developed from counts on :

(1) published written products

(2) patents, prototypes, instrumental techniques/ new devices etc.

(3) reports and programmes.

Qualitative measures on channels of communication are based on perceptions regarding the following, by unit heads as well as staff scientists : (a) Contacts between units (b) Contacts within the unit with respect to frequency of meetings, (c) Participation of supporting staff, (d) Acceptance of ideas from junior staff, etc. Countable measures are based on the number of science and technology visits, number of papers prasented or published, number of unit members providing useful information like novel ideas or administrative help, etc. An index is developed representing the average ratings by the head and the staff scientists and this is reckoned along with the countable measures to derive a composite index for communication effectiveness.

A comprehensive measure for signal communication (index for R & D effectiveness) can also be derived based on a combination of quantitative and qualitative counts. In addition to the quantitative measure, it is essential to have a measure based on the qualitative aspects. In an R & D laboratory, the usual measures of output are quantitative in nature. The quantitative measures are:

(i) Publications

(a) No. of books published in the country or abroad

(b) No. of papers in Indian journals or foreign journals

(ii) Patents (within the country or abroad)

(iii) New devices, prototyes, instrumental techniques etc.

(iv) Reports, reviews, algorithms and programmes

However, these quantitative measures do not reflect the quality dimensions, there being no standards or generally acceptable yardstick to differentially rank the output measures or compare the quality. Hence,

in addition to a measure based on the above factors it is also important to index the qualitative dimensions of effectiveness. It is possible for these quality factors to be quantified by obtaining ratings on a 5-point Likert Scale (1-Low, 5-High). Each of the performance criteria (outlined below) is rated by all or a few of the relevant decision-making centres in an R & D organisation. These centres correspond to four hierarchic levels as below:

(a) Scientist or engineer working in the unit or group (Core members who are working in the unit/project for more than 50% of their time including supporting officers)

(b) Leader of the group or the unit

(c) Organisational Management which includes, besides Director and the Scientific Committee, other important internal advisory committees and the planning and monitoring group (internal evaluators)

(d) External evaluators consisting of consultants, outside agencies with whom the laboratory has interaction and user agencies. The rating for each of the performance criteria (enumerated below) is derived from the median ratings of the decision centres.

The median ratings are combined to get an index on quality. This is coupled with the said output measure.

Needless to say that there is a relationship between channel communication and signal communication. The six critical channel communication parameters that could be identified as having the most profound mpact on research unit efficiency (signal communication) are:

1. Unit heads ratings regarding contacts among units
2. Contacts with the users as rated by the head and staff (average)
3. Contacts within the unit as rated by the staff scientists
4. Number of science and technology meetings and visits
5. Number of publications/presentations

Signal (Criteria of performance effectiveness)	*Evaluating levels or decision centres (most critical to the signal)*	*Signal (Criteria of performance effectiveness)*	*Evaluating levels or decision centres (most critical to the signal)*
1. General contribution to Science and Technology	(a, b, c & d)	7. Strategic importance	(c & d)
2. Recognition for the work	(a, b, c & d)	8. Social effectiveness (social value of the application of the work viz-a-viz ability or potential to solve some current social problems)	(c & d)
3. Level of (interdisciplinary) efforts	(a, b, c & d)		
4. R & D effectiveness (ability to fulfill laboratory charter and goals, degree of innovation in work and overall productivity of the group)	(a, b & c)	9. Training effectiveness (expertise build up, know-how gain and familiarity with methods in areas of sophistication or frontier areas)	(a, b & c)
5. Application effectiveness (the extent to which the results are utilized or followed up)	(a, b, c & d)	10. Administrative effectiveness (ability to meet plans and schedules and leadership in resolving conflicts and proper co-ordination)	(a & c)
6. Application potential (economic or industrial importance and market for the product)	(b, c, & d)		

6. Number of unit members actively participating in discussion and providing useful information.

It has also been noted that for units in applied settings, ratings on contacts among units as well as with users is very important or rather critical to unit performance whereas countable channel measures (Nos 4. 5 and 6 above) as well as ratings or contacts within the unit are of paramount significance to basic research groups.

Job involvement and diversity

Communication levels within the unit are conditioned by the innovative spirit, dedication to work and sense of cooperation among group members. These are in turn related to morale and job involvement. The concept of job involvement is very important to science and technology activities (Patchen, 1970). A person should be able to identify psychologically with his job and this is a measure of his strength of motivation. An atmosphere of great dedication to work as opposed to an attitude of 'working for a living' should prevail. Satisfactory perceptions about human and material resources significantly contribute to this. The involved team member will do a great deal of overtime work and that too interestingly. Further the motivation and dedication of scientists is more important to performance than that of technical supporting staff.

Dedication and job involvement are significantly enhanced by operation diversity (Pelz and Andrews, 1966). A scientist who spends his time among several R & D functions like basic research, applied research, development work, consultation, training and even administration is more productive revealing the importance of diversity. This could be explained in terms of the fallow periods or 'lows' that even the best of scientists and research groups experience, and diversity ensures survival. The following main factors contribute to diversity in a research unit. (a) Interdisciplinary orientation, (b) diversity of staff specialization, (c) diversity in the nature of projects, and (d) diversity in funding sources and project linkages.

Organization and Control

Productivity is intimately interlinked with organizational dynamics. In addition to communication and motivational factors, OD is also concerned with influence or control. Deriving from the studies on organization (Likert, 1967 and Tannenhaun, 1968) the recent trend is to define an organisation in terms of control and its distribution. Control graphs are plotted for this purpose. Such graphs show the degree of control on a Likert Scale [low (1) to high (5)] along the Y-axis and the decision or responsibility centres along the X-axis. The decision centres are, as already mentioned, (1) scientists and other core members in the project and related infrastructure, (2) project leader/group leader, (3) institute leaders, consisting of director advisory and management committees and monitoring groups, (4) external evaluators consisting of consultants and outside experts associated with the research unit.

Distribution of control among the four levels is determined for the following decisions (Nag Paul, Krishnaiah and Chawla, 1987):

1. Planning decisions

a. Determining general research themes
b. Preparing proposals for new projects
c. Choice of specific research tasks
d. Choice of methods in research

2. Operation decisions

a, Work allocation within the unit
b. Publication and circulation of results
c. Pursuing the application or utilization of research themes
d. Coordination/cooperation/interaction with other units

3. Logistic decisions

a. Use of training and career improvement facilities
b. Hiring or recruiting personnel for specific periods

c. Disciplinary action for non-performance

d. Acquisition of low cost and other essential equipment (low cost means equipment costing less than Rs. 50,000/-)

A control curve can be plotted on the ratings provided by the first three levels.

The control graph represents the structure and influence in an organization. The total control is indicated by the average height, and distribution by the slope of the curve. The slope of the curve is of less criticality vis-a-vis research efficiency as compared to the totality of influence. This implies that the difference in the influence exercised by the unit head and the staff scientists is irrelevant with respect to performance though it may be egoistically important to the unit leader. In the case of research units in applied settings the predominance of external centres of influence lead to enhanced performance whereas productivity in basic research or academic settings was better correlated with within-the-unit control predominance.

Conclusion

Productivity in research depends considerably on the level of creativity among the participants. A creative scientist is less affected in his performance by the organizational dynamics, though he may benefit or suffer from extreme situations as the case may be. Creativity has been found to be a sort of buffer against the vagaries of the environment as it would impinge upon his work situation. Studies in organizational psychology show this to be true. A creative individual profile is characterised by:

1. An impatient, aggressive and overcommitment-to-work type of behaviour.
2. A feeling that he is in control of the situation despite the odds against him.
3. A need for achievement which is positively correlated with a lack of desire for continual external feedback on project performance.

A creative profile to a great extent, thus, offsets the disadvantages of a handicapping organizational climate and communication pattern. Studies in organizational behaviour (Wanir, 1950) also point to the fact that 'motivators' (factors responsible for motivation) are related in general to job or work content, and hygiene factors (factors necessary for basic organizational health but which are not capable of inducing motivation as such) to the work context. For highly creative people the job context is of no concern and all that matters is the job content, and hence their prowess for motivated performance even in the relative absence of hygiene factors in the work context. But this is true only for highly creative people who are always in the very minority. For most of us productivity is a derivative of the combination of motivators and hygiene factors.

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Wages Criteria in Collective Agreements in India

Subratesh Ghosh

This paper examines the principal wage criteria which have influenced collective agreements and collective bargaining in India since the fifties. It shows that wage criteria in collective agreements in India have been dictated by multiple factors—political, social and economic as well as the relative strengths of the parties in the course of bargaining. In this sense, wage determination through collecntive agreements has been neither a predominantly political process nor an economic one, but an amalgam of both, mixed with social and ideological factors as well.

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Barring some exceptions, origanised sector wages are determined by mechanisms like collective bargaining, quasijudicial machinery for wage fixation and legislative bodies (Wooton, 1953). In this sense, wages in most areas of the organised sector have ceased to be market-determined costs and hence, are genuinely administered costs (Ghosh, 1975). The factors which are taken into account (of course, with varying weights by different participants in the wage-setting process) by the parties in collective bargaining and by other agencies like tribunals are what go by the name of "wage-criteria". These criteria are economic as well as non-economic. Market forces and the economic environment do influence the wage-criteria, but so do the non-economic factors to a considerate degree (Hicks, 1955). The present paper seeks to examine the prinicpal wage-criteria which have influenced the collective agreements signed in India since the fifties. The term "wage" is used here in a wider sense to refer to all components of employee compensation for work e.g., basic wages, dearness allowance, bonus, fringe benefits etc.

Criteria for Wage Determination in India

Wage-criteria have been classified in various ways. Jules Backman divided them into six categories : economic environment, wage comparisons, cost of living, workers' budgets, productivity and ability to pay (Backman, 1959).

Another classification identified five components : cost of living, productivity, the prevailing wages, ability to pay, attraction and retention of employees

(Lanham, 1963). By adding a few more items viz., comparable wages, cost of living, living wage (a wage level related to a pre-determined, or specified level of living standard for a family), ability to pay, productivity, labour supply and purchasing power, Belcher (1962) made it more comprehensive.

It is possible to identify, subject to terminological variations, some criteria common to these different classifications. Thus, wage-comparison, the cost of living, ability to pay and productivity are common to all of them. "Living Wage", as understood by Belcher, although not the same as the workers' budget mentioned by Backman, are closely conected concepts. In India, the term living wage has been used in a specific way to refer to the wage that would be payable to a worker to meet his and his family's subsistence need, together with a reasonable degree of comfort to maintain and improve his efficiency subject to his environment and culture (Fair Wage Committee, 1948). However, as the prevailing economic conditions may not always enable a company to pay its workers the living wage due to the limitations of its ability to pay, the concept of fair wage has been advocated by the Fair Wage Committee as a reasonable approximation between the minimum subsistence wages of the workers and the living wage. Thus, in the Indian context the 'living wage' criterion may be substituted by 'fair wage' as a reasonably realistic criterion for wage fixation.

In this context it is also useful to make a reference to the concept of "need based minimum wages" as enunciated in the 15th Indian Labour Conference. The "needbased minimum wages" sought to quantify the minimum wage which an average working class family consisting of three consumption units (husband, wife and two childern) would require to have for their physical subsistence on the basis of the minimum nutritional needs of 2700 calories per capita and 18 yds. clothing per head per year, along with some minimum comforts (e.g., housing space, fuel, lighting etc.). Although the exact estimates of need-based minimum wages in different industries and regions have been a matter of debate between labour and management, this concept has also been used frequently as a criterion for wage-fixation in India. In the wage-literature in advanced countries, however, for obvious reasons, the minimum wage criterion was hardly used in collective argeements and it yielded place to the living wage criterion, which naturally meant higher amounts than required under the minimum wages norm.

Lanham's criterion of "attraction and retention of employees" and Belcher's criterion of "labour supply", in a similar way may be treated as allied concepts, since the supply conditions in the labour market, including the competitive pulls from other units using similar categories of labour, is an important factor in attracting and retaining specific categories of labour for a particular organisation. As problems of retention and attraction in this sense have to be corrected often through wage adjustments by a particular concern, or several concerns, this factor naturally deserves inclusion as a wage-criterion. Of course, to some extent, the economic environment includes the labour market and is, thus, related to the supply factor mentioned above. But for the purpose of clarity we may treat them as separate criteria. While discussing economic environment Backman considered mainly factors connected with business cycle changes, local or regional economic conditions and the state of the industry and their impact on wages (Backman, 1959). In a broader way, we may refer to the 'economic environment' as consisting of all the contextual factors and influences operating at the national, regional, or the local level on the wages of a particular concern or industry excluding the lobour market influences operating through the labour supply. The latter may be then treated as a separate wage-criterion in itself.

Among the factors mentioned, the ability to pay and the productivity of labour are also related in the sense that the latter is an important factor affecting the ability to pay of an organisation. However, in view of the great significance attched to productivity as a determinant of the wages in theory as well as in practice (in the past and also at present), it may be treated as a separate wage-criterion by itself. This means that the capacity to pay or the ability to pay should be taken as being determined by other factors affecting it, e.g., the product price, cost and other

factors affecting profit, return on capital and the needs of reinvestment etc. In India, difierent tribunals and wage-boards have deliberated at length on the above factors in their determination of the capacity to pay (Subramanian, 1975).

On the basis of the above considerations we may, thus, identify the enterprise-level wage-criteria as the following: capacity to pay of the organisation, comparable wages in the industry or the region, average productivity of labour, cost of living changes, fair wage, labour market influences affecting the supply of labour, and the economic environment in which the organisation operates. In addition to these wage-criteria, the wage-rates and the level are also affected by the political, social and cultural environment, but they operate more as factors influencing the criteria mentioned above, rather than as separate yardsticks or criteria in themselves.

Among these political, social and cultural factors, the consideration of social justice works as an important influence in wage-fixation, both in the case of wage-adjudication by tribunals as well as in collective bargaining and wage-legislation. The fact that the Indian Constitution has mentioned Social Justice as a major objective of Indian polity has naturally influened judicial and quasi-judical processes affecting wage determination in India. This is also cited as a factor to support their arguments by the parties involved in collective bargaining. Thus, in such a context, social justice may work as a wage-criterion in itself instead of as an influence operating on other criteria.

In addition to the above mentioned criteria, which are used in almost all cases in India, some other wage-criteria have been used in some recent wage agreements, these will be referred to in the course of this paper.

Waegs Criteria and Collective Bargaining

Wages-criteria are used in collective bargaining by both the participants viz., employers as well as the union. They use one or more of the wage-criteria mentioned above, but the weights assigned to them vary according to the perception of the parties concerned. For example, during the public sector employees' strike in Bangalore in 1980-81, the trade unions attached lot of weightage to the wage-comparison argument and claimed that all public enterprises under the Central Government operating from Bangalore should have pay-scales similar to those introduced at the Bangalore plant of Bharat Heavy Electricals Ltd. This was contested by the Central Government as well as the managements of the public sector undertakings in Bangalore, who pointed to the higher profit and labour productivity at BHEL. But on other occasions the Central Government and the public enterprises under their control have, themselves, used the wage-comparison criterion. In fact, in 1982-83, the Bureau of Public Enterprises, (Govt. of India) expressed its displeasure over some concessions granted by a number of leading public enterprises with regard to the dearness allowance formula in their collective agreements, which exceeded the BPE norm of Rs. 1.30 per point rise in the cost of living index.

In reality, in the course of collective bargaining, trade unions and managements use whatever wage-criteria best serve their immediate objectives and interests. They do not deny any wage-criterion, but try to increase or reduce its weightage according to their own purpose. Sometimes they contest the other side's interpretation or presentation of the same criterion. Thus, while the management emphasising the capacity to pay criterion, may draw attention to the profits shown in the profit and loss account, the union may contest the authenticity of profit calculations and the accounting procedures used by the management.

While the use of the wage-criteria becomes quite conspicuous and visible in collective bargaining, the criteria used in reaching the agreed decisions are not always clearly stated in the collective agreement signed consequently. However, some of the criteria used can be inferred from the terms of the settlement itself. Thus, from the terms stating the exact neutralisation norms, one can easily infer that the cost-of-living criterion has been used in that connection. Similarly in the productivity agreements or those pertaining to incentive wages schemes, the use of productivity as the criterion becomes quite apparent. But in relation to

some other criteria like changes in economic environment or labour supply problems, while the agreed wage rates may really result from the use of such criteria, in reality these may not be formally stated or even hinted at in the collective agreement drawn up.

Wages-criteria used in some important Collective Agreements in India

The wage-criteria mentioned above have been used in a number of collective agreements signed in India, in the past as well as in the present. The agreements signed in the early years after the Second World War and Indian Independence mainly used the rise in the cost of living and the consequent fall in the real earnings of workers as the main wage criterion. The bonus disputes during this period as well as those following the Bonus Act (1965) often represented attempts to link directly the size of the bonus to the profits earned. Apart from profit, the trade unions also tried to link the magnitude of bonus to the social justice criterion by claiming that since most Indian enterprises could not afford to pay the living wage, or fair wage, the bonus should partly compensate the workers for the gap between the living wage and the actual wages paid. The social justice criterion also served as the basis on which the lumpsum ad hoc increases in wages were granted to low income workers. The wage-comparison criterion was also used in many cases of collective bargaining.

Among the earlier collective agreements signed in the fifties, a few successfully used productivity as a major wage criterion. Their number was not large, but having been signed in some leading industrial organisations, their significance was considerable. It was pointed out in the Labour Bureau's enquiry in 1956-57 that out of 57 units which provided details of their incentive schemes, 16 units had formulated incentive schemes on the basis of collective agreements. The leading instances of these collective agreements include those signed in Tata Iron & Steel Co., the Indian Aluminium Co., Belur, the Tata Engineering and Locomotive Co., etc. Productivity was used as a wage criterion in all these agreements.

The TISCO agreement signed in January 1956 is one of the early examples of the productivity bargaining-based collective agreements and covered measures for improvements in productivity, revision of wages and gratuity, job evaluation and wage structure, job security and also closer association of employees with management. The collective agreement signed in 1951 at the Indian Aluminium Co. introduced an incentive scheme based on output with a monthly and annual production bonus. The same organisation in another agreement signed in 1956 clearly mentioned that bonus payments made on the basis of profit were not satisfactory, and it categorically preferred linking bonus to productivity. Productivity as a leading wage criterion, was thus, successfully incorporated. However, inspite of the significance of these agreements and the attention they commanded, the use of productivity as a criterion for the determination of wages in Indian organisations has been used less frequently than other criteria based on cost of living (mainly governing agreements on fixation and revision of dearness allowance) and social justice.

Profit as a Criterion

The collective agreement in Mysore Iron and Steel Works, Bhadravati, (1956) linked the payment of bonus to profit on a sliding scale. No bonus was payable below a 5% profit-level, but between 5-9% profit, bonus was payable at the rate of 1/12 to 1/6 of total earnings excluding DA and other allowances. Above 9% profit level, the bonus would amount to 1/4th of earnings. It was also stipulated that no adult male worker covered by this agreement would receive less than Re. 1 per day as his wage, while the minimum daily wage of a woman-worker was fixed at 10 annas (0.62 paise). Thus, in addition to the profit criterion, a minimum wage was worked out obviously on the basis of the social justice criterion. The use of the social justice criterion was also indicated in the management's consent to raise the wage scales of all workers earning Rs. 300/- per month while for determining the number of increments for fitment purpose the length of service was used as the yardstick. The collective agreement signed between the Indian Tea Association and the Tea Garden Labour Association in Assam related the quantum of bonus payable to profit and mentioned that no bonus would be paid in gardens claiming no profit.

However, apart from the few agreements using productivity as mentioned above and the agreements on bonus using the profit criterion, the earlier agreements, signed in the fifties and sixties, appear to have been, generally, influenced by the criteria relating to the cost of living, social justice and improvement in the living standards of workers. The use of the cost of living criterion was prompted by the workers' interest in maintaining their real earnings in the face of mounting inflationary pressures—a demand which the employers could not deny, but could counteract with their emphasis on their capacity to pay. The social justice criterion, which is not conspicuously used in the collective agreements in the USA, and some western countries as a wage criterion, has been often cited in tripartite bargains and also in bipartite collective bargaining leading to wage revision in many collective agreements in India. The Report of the Fair Wage Committee (1949) and the recommendation made in the Report of the First Five Year Plan for wage increases granted for removing anamolies, and for raising wages when they were too low (Planning Commission, 1951) also worked as contributory factors,

In the collective agreement signed at the Tata Iron and Steel Co. Ltd., in 1959, cost of living rise had been recognised as the basis for the increase in dearness allowance. The same agreement followed the earlier agreement of 1956 and, this time, the extent of the wage rise amounted to 15 percent on average. Although no specific reason was mentioned in the body of the agreement this was obviously in response to the Union demand for higher wages in order to raise the level of living of workers. A flat increase of basic wages at the rate of 25 paise per day per worker was granted in the collective agreement signed in Hind Mercantile Corporation's manganese mines at Chicknayallana Hatti in Tumkur district in 1968. A similar flat increase in wages at the rate of 30 paise per day was also granted in the collective agreement (1968) in High Tension Insulator Factory, Ranchi. This agreement also provided for the fixation of the minimum basic wage of daily rated workers at Rs. 3 per day in response to the Fair Wage Committee Report and the consensus reached at the 15th Indian Labour Conference on need-based minimum wages. In the collective agreement signed in 1959 in Caltex (India) Ltd. the wage scales were revised upwards and, in addition, a special adjustment equal to two increments in the existing scale was permitted to each worker. The adjusting increments were subject to a minimum of Rs. 3. Apart from the apparent use of the standard improvement criterion mentioned above, this collective agreement also made use of the performance criterion, as the quantum of increment in this settlement was linked to the ability, work and merit of an individual employee.

The minimum basic wage fixation setting the floor of the wage level reflecting the social justice criterion was also incorporated in the region-wise collective agreement in the textile industry in Coimbatore (1956) between the textile mills and their workers. Here the minimum basic wage for the unskilled workers was fixed at Rs. 30.6 per month.

The collective agreements signed in India during the seventies and eighties have coutinued to use the criteria discussed above. In addition, the wage comparison criterion has been sought to be used with a greater force in certain cases of bargaining causing disputes between the labour and management.

In the seventies, collective agreements resulted in basic pay scales being revised upward, in several public and private sector organisations. In one case, viz., the collective agreement signed in the Indian Aluminium Co. Ltd., Hirakud Unit (1978) the objective of the pay-scale revision was clearly stated as payment of a fair wage to workers, reflecting the use of the social justice criterion as well as the criterion of improvement in the standard of living of workers. In other agreements, although not so explicitly stated, the same criteria appear to have influenced the union decision-making in choosing the items of demand and the managements' acceptance of the same. Apart from these, the relative bargaining forces of the two sides naturally also played a role in the agreement on this particular issue. Notable among the collective agreements providing for pay revision were those at the Indian Petrochemical Corpn. Ltd., Baroda (1979). Gujarat State Fertiliser Factory (1979), Indian Telephone Industries Ltd., Bangalore (1978), Second Coal Wage Agreement

(1978) and the National Steel Industry Agreements (1970, 1979) signed in the Seventies in the public sector. In the private sector, similar agreements on pay scale revision were signed in the Tata Engineering and Locomotive Co. Ltd., Pune (1979), Calcutta Electric Supply Corpn. Ltd., (1979), Hindusthan Lever Ltd., (1979), Indian Oxygen Co. Ltd. (1979), to name a few. Most of these organisations renewed these collective agreements in the eighties with an upward revision of wages and additional increments and fitment benefits. In addition, some of them provided for ad hoc lumpsum payments to workers under the terms of the collective agreements. For example, in the National Steel Agreement (1983), in addition to two annual increment being granted to each worker, a lumpsum fitment benefit of Rs. 91 was paid to every worker. The same benefit was paid in the National Coal Wage Agreement (1983) and in the next year the port workers insisted and obtained the same benefit based on the comparison criterion, steel and port workers having been employees of the public sector in both cases.

In the private sector, workers of Indian Oxygen Ltd., in their 1980 collective agreement obtained one additional increment each over the three steps increase in basic pay in the scales agreement to in the 1979 agreement. The same agreement provided for a lumpsum benefit of Rs. 350 in January 1980 and another Rs. 350 in November 1980 to each worker. The collective agreement in Indian Aluminium Co. Ltd., Hirakud (1978) granted 1.5 additional increments subject to a minimum rise of Rs. 15 to every permanent worker with 10 years' service or more. In fact, to pay additional increments and lumpsum benefits in addition to the fitment benefits has been quite a common feature in the collective agreements signed in the eighties. Apart from the progressive increase in the living standards of workers, the liberal revision of pay scales and substantial lumpsum benefits granted in some cases (e.g. Indian Oxygen Ltd. agreement in 1980) appear to have been also based on the capacity to pay criterion, with the impact of inflation on profits being taken note of. The insistence of the oil companies in the public sector, on exceeding the BPE guideline of a maximum 10 percent rise in the wage bill in the early eighties may be cited as a case in point.

The cost of living criterion continued to be used in many agreements signed in the '70s and '80s. Mention may be made of the collective agreement signed in ITC. Ltd., Bangalore (1980) providing for a variable DA linked to changes in the cost of living index at the rate of Rs. 1.30 per point rise in the All India working class consumer price index of 325 (Base : 1960 = 100). Similar agreements in the private sector (with lower or higher rates of neutralisation in some cases) were signed in many other enterprises e.g., Indian Oxygen Ltd. (1979), Indian Aluminium Co. Ltd., Hirakud (1978), Wage Agreement in Engineering Industry of West Bengal (1979) etc.

In some cases, instead of an escalated linkage of the variable DA with the consumer price index, dearness allowance had been increased by a flat rate. e.g., in Hindusthan Lever Ltd. (1979), TELCO (1979), etc. However, in the eighties the tendency has been more towards escalated cost of living linked DA at higher rates rather than a flat rate of increase in dearness allowance. In the public sector, this tendency was so strong that the Bureau of Public Enterprises tried to put a ceiling on the rate of neutralisation at Rs. 1.30 per point rise in the consumer price index in the early eighties, but this was resented by several public sector organisations and ultimately, many public enterprises have been permitted to sign collective agreements at the rate of Rs. 1.65 per point rise in the consumer price index.

In the private sector also a similar tendency is visible. The industry-wide settlement in the engineering industy (1983) and the industry-wide settlement in the jute industry (1984) raised the rate of neutralisation from Rs. 1.30 per point to Rs. 1.50 and again in the revisions of these two collective agreements in 1987 the neutralisation rates have been further raised to Rs. 1.65 per point.

Conflicting Interests

In this connection it is interesting to note that although, the capacity to pay argument was used by both sides, employers (as in the jute industry) trying to emphasise inability to pay and the unions (as in the oil sector) pointing to the higher level of revenue—the

result was the same viz., increase in the quantum of benefits granted to the workers. Partly this has been due to the growing bargaining strength of the unions concerned and partly due to the influence of political factors as reflected in the Government's role in tripartite bargains in such cases.

In collectivc bargaining in recent years wage comparisons have been used as the major criterion. It was sometimes reflected in the collective agreements signed, but on a few occasions failed to influence the final outcome. Illustrations of cases where the comparsion criterion affected the terms of collective agreements are, the minimum fitment benefits (Rs. 91) in public sector agreements signed around 1983 and 1984, in the aftermath of the National Agreement in Steel Industry (1983) (e.g. National Coal Wage agreement, 1983, All India agreement in Ports, 1984), or the same rate of neutralisation in dearness allowance at Rs. 1.30 per point rise in CPI in the agreements signed around 1979 and 1980. In collective agreements signed in 1983, 1984 and 1985, this rate went up to Rs. 1.50. On the other hand, the attempt of the trade unions of Bangalore-based public enterprises (December 1980—March 1981) to have the same pay scales and benefits as granted to BHEL, although forcefully placed as a bargaining argument, could not be sustained when the striking unions agreed to withdraw the strike on the basis of a lump sum benefit and a little additional emolument per worker (Chatterjee, 1983).

The attempt to use the productivity criterion have similarly been a mixed successs in several cases of collective bargaining in recent years. Although some recent collective agreements have provisions for wage-rises (or an incentive component of it) linked to rises in productivity or some other measure of employee efficiency, in most cases it finds no mention in the agreement although during the bargaining stage, at least, employers tried to argue for its use as a wage-fixing criterion.

The leading instance of the latter is found in the unsuccessful attempts by the jute mill owneres to make the rise in productivity a major basis for any wage improvement in 1984 as well as in 1987. Each time, the jute workers' unions rejected this criterion. In the ultimate collective settlements signed during both the times increases in monthly wages and consumer price-linked dearness allowance at higher rates were granted with-out any linkage of wages to productivity.

However, in some other cases of collective agreements, rise in workers' productivity (individual or overall performance) has been directly used as the criterion for the incentive component of earnings. Notable among them are the collective agreements signed at Hindustan Antibiotics Ltd. (1980), Hindustan Photo-films Ltd. (1980) and Indian Telephone Industries Ltd., Bangalore (Ghosh, 1986). A list of some important public sector companies which, through collective agreements, introduced or modified their incentive wage, on the basis of productivity or performance criterion in recent years is given Table I.

Conclusions

The use of wage criteria in collective bargaining and the agreements which resulted therefrom have not been uniform, consistent or even rationally worked out by the participants on the basis of long term interests or objectives. The differences in the use of and the weightages given to different criteria by the parties concerned viz., trade unions, employers or the Government, have been dictated more by short-run consderaitions, in particular the impressions regarding bargining advantages by each party. This shows why even in sick industries like jute or cotton textiles, the productivity criterion had not been given due importance; even though in recent years the competitive position of these industries in the international market has been found to be precarious and the survival of the many units is at state.

Apart from the perception of the parties concerned of their relative bargaing advantages, their reading of the national economic envienment also naturally affected the use of wage criteria, although such readings often lacked depth and were guided mainly by the relevance of the contextual factors to the short-run interests of the party concerned. The wide use of the cost of living criterion during inflationary times is one such example. If the economic environment has not been used more occasionally, it is due to the reluctance of

TABLE 1 Some Productivity Linked Wage Schemes in the Public Sector

Sl. No.	*Organisation*	*Type and Nature of the Scheme*	*How Introduced and When*	*Impact*
1.	Petrofils Cooperative Ltd. Baroda	Multi-factor Overall Performance Based Incentive Scheme	First unilaterally by management, later finalised through bipartite bargaining	Successful in improving capacity utilisation, reduction of waste, labour index (attendance), quality improvement
2.	Bharat Electronics Ltd. Gaziabad	Overall Performance Based Productivity Incentive Scheme	Not clear (1980)	Successful (details not available)
3.	M.A.M.C., Durgapur	Individual Incentive Schem	N.A. (appears to be through collective agreement)	N.A.
4.	Hindusthan Antibiotics Ltd., Pimpri	Overall Performance based scheme; multifactor	Collective agreement through conciliation (June '80)	N.A.
5.	Bengal Chemical & Pharmaceuticals Ltd.	Overall performance (department-wise) scheme	N.A.	N.A.
6.	Smith Stanistrict Pharmaceuticals Ltd.	Overall performance (department-wise) scheme	Bipartite negotiation (1977)	N.A.
7.	Kerala Soaps & Oils Ltd., Calicut	Overall performance (department-wise) scheme	Bipartite negotiation (1983)	Successful. Productlon increased
8.	Gun Carriage Factory, Jabalpur	(a) Individual incentives	(a) Unilaterally in production side (1941)	Not known
		(b) Productivity linked bonus	(b) Through Jt. consultation (1979)	Not known
9.	Filing Factory, Chanda, Maharashtra	(a) Individual Incentives	(a) By Govt. unilaterally (1941)	Not known
		(b) Productivity linked bonus	(b) Negotiation	Not known
10.	Electronics Corpn. of India Ltd.	Overall performance based (Corporate Division target fulfilment)	Through collective agreement (1975)	No improvement
11.	Hindusthan Insecticides Ltd.	Multi-factor overall performance based scheme	Bipartite collective agreement (1967-68; revised in 1981)	Successful; increase in production and sales revenue
12.	Hindusthan Photofilms Ltd.	Mrlti-factor overall performance based scheme	Collective agreement (1979)	Successful. Output and productivity improved
13.	Neyveli Lignite Corporation Ltd.	Overall performance based	First initiated in 1977 unilaterally by management. Reintroduced in 1981-82 by a collective agreement. Productivity bonus scheme introduced in 1981-82.	Successful. Production increased. Started earning profit from 1977 continuously

(Contd.)

Table 1 *Contd.*

Sl. No.	*Organisation*	*Type and Nature of the Scheme*	*How Introduced and When*	*Impact*
14.	Rourkela Steel Plant, SAIL	Overall performance based production incentive scheme and productivity bonus scheme. Basis of performance; meeting of capacity utilisation targets	First initiated by management (1961). Later on through collective agreement	Successful. Equipment productivity rose from less than 50% to 95% or around that; output increased
15.	Alloy Steel Plant, SAIL	Individual incentive wage-scheme (1973)	Bipartite negotiation (1973)	Successful. Saleable output per man-year increased

Source : Materials and data collected for the Research Project on "Management of Labour Productivity in Manufacturing Industries in the Public Sector" conducted by the author in 1982-84 (*Ghosh*, 1984).

trade unionists to get involved in spohisticated intellectual arguments and also to their ability to find the context in terms of the cost of living criterion and, when the situation permitted, with reference to industrial profits.

Collective bargaining being as much a "political" process, as economic or psychological, the political context in which bargains took place naturally affected the decisions and the terms that were evolved. In spite of the managements' opposition in many cases, the persistent use of the social justice criterion and the needbased minimum wage and the criterion of the standard of living of the workers has been dictated by the political leverage of the trade unions, often supported or passively helped by the Government. In its statement of Labour Policy in the plans and through active intervention in tripartite bargains, the grovenment has tried to give a better deal to the workers often with the aim of gaining political support.

In public setor bargaining and collective agreements, however, the Government has consciously tried to use, or obstruct, certain criteria, on the plea of national interest. This is reflected in the tough stance it adopted during the Bangalore strike (1980-81) and also in the Bureau of Public Enterprises', to attempt to set maximum rates of increase in the wage bill and the neutralisation rate. Although not completely successful, this clearly reflected the government's concern to contain the inflation stemming from wage rises in the public sector.

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Policy Analysis for Solution of Complex Techno-Economic Problems

P.N. Rastogi

Techno-economic and developmental problems are usually complex, ill-defined, and unprogrammed. The paper outlines a cybernetic methodology for a systematic analysis to policies. Its application is illustrated with reference to two problems—a micro-level situation of rural poverty, and a macro-level situation of low productivity in thermal power plants. Explanation, problem-solving, and prognostic inference are seen to be interrelated facets of the analysis which also provides a logically simple paradigm for multi-criteria decision-making.

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The complexity of developmental problems stems from the multilateral interactions of diverse technical economic, ecological, social, political, administrative, and psychological factors. Their ill-defined nature stems from a poor understanding of their structure and dynamics. Their unprogrammed nature arises from the non-avaiability of algorithmic computational procedures for analysis and solution. In what follows, a cybernetic methodology, with reference to two problems—a micro-level situation of rural poverty, and a macro-level situation of low productivity in thermal power plants, is elucidated.

A detailed discussion of the methodology and its applications is to be found in Rastogi (1979, 1986 a, 1987, 1988 b). Similarly, a detailed discussion of the rural poverty situation is given in Rastogi (1986 b) and the thermal power plant situation in Dastoor (1988). Application of the methodology to productivity, innovation, management, and development is given in Rastogi (1988 a).

The Base of the Methodology

The base consists of a multi-feedback loop model of an investigated problem situation. The model consists of a set of empirically determinate variables and their multi-lateral relationships in the form of interacting negative and positive feedback cycles. The feedback cycles represent the dynamic mechanisms of stability and change. A negative feedback cycle is a

circular reactive structure of system variables oriented towards the objectives of goal-seeking, stabilization, and balance. A positive cycle is concerned with achieving growth or decline in a cumulative manner. Each feedback cycle is associated with an empirically determinate cycling period over which it completes one interaction. Differential interaction of these cycles across differing (initial) values of their variables, non-linear relationships, and delay periods amongst them, random impacts from the system's environment, and the varying periods of the interacting cycles, together generate diverse modes of variation of a phenomenon. These modes of variation are capable of replicating the past, present, and future course of the situation being considered.

A multi-loop model of poverty and government development programmes in a central U.P. village is shown in Figure 1. It consists of some 30 variables including three exogenous variables, organized together in seven positive and negative feedback cycles. The cycles here are malfunctioning i.e., they are failing to achieve their intended role of poverty removal. They depict the failure of the development programme through corruption, inefficiency, inadequacy, and the unresponsiveness of the development administration and the persisting and deepening poverty of the weaker sections, exploited as they are by usury and suppression. Exogenous variables i.e., population growth, arbitrary accounts by the money lenders, and Partisan Role of the Police, are seen to aggravate the rural malaise through their long and short-term impacts.

A generalized multi-loop representation of the thermal power plants' situation is given in Figure 2.

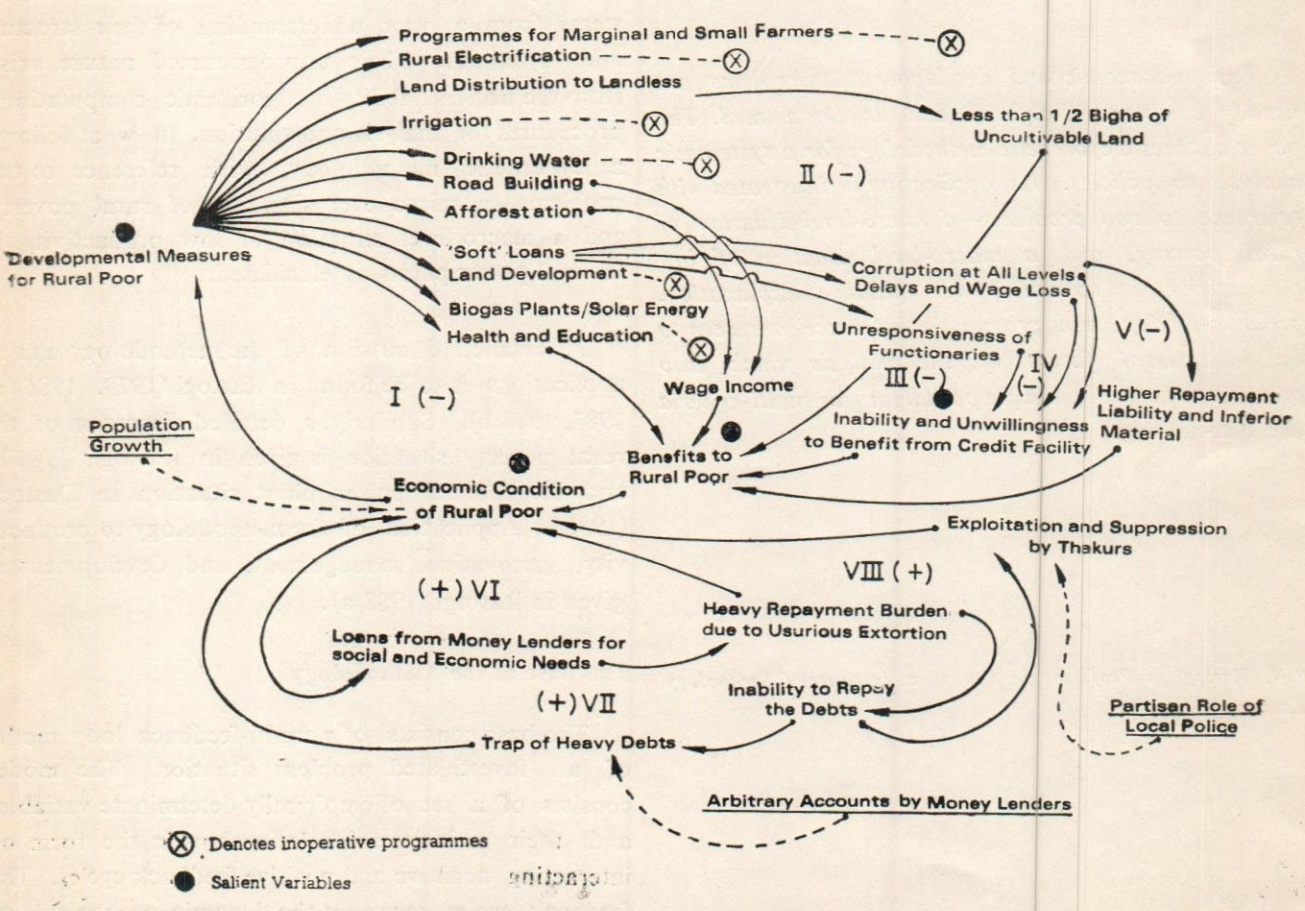

Fig. 1 Dynamics of Development at Duari and its Hamlets

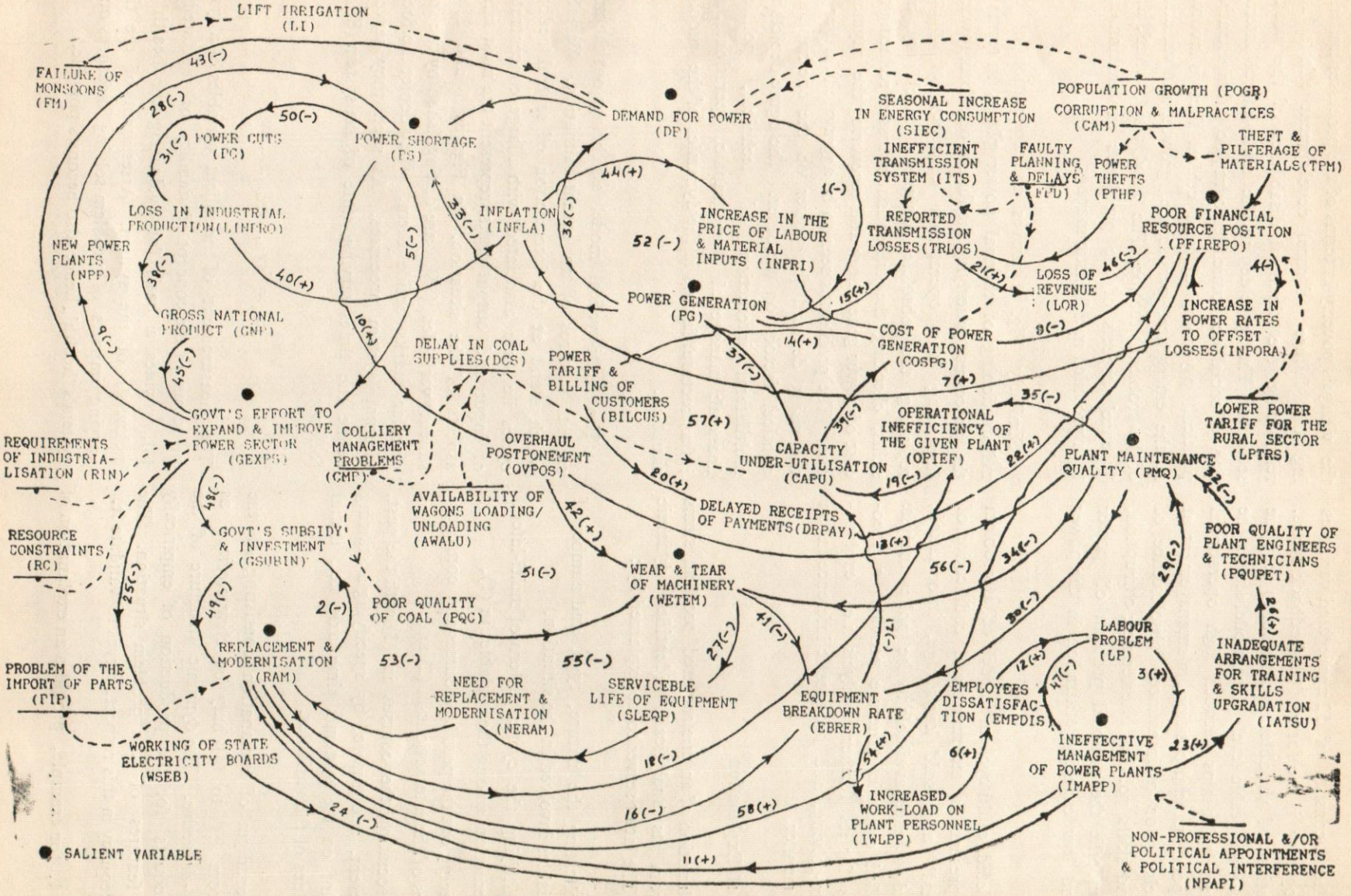

Fig. 2 Dynamics of Thermal Power System

The model here consists of 52 aggregated variables organized together in the form of 58 feedback cycles. The aggregation of variables is essential to keep the analysis at a manageable level. The model shows the complex interrelationships between high operational inefficiency, poor financial position, mismanagement at various levels, poor maintenance, obsolescence of machinery and skills, political interference; corruption, etc that underlie the national problem of power shortage and low capacity utilization in the power plants.

A completed multi-cyclical model of a problem situation represents an integration and codification of all the 'hard' and 'soft' knowledge, information, insights, and evidence, available to the policy analyst. Such a unified dynamic structure provides a theoretical basis for its further analysis i.e., explanation, problem-solving, and prognostic inference in an interrelated manner.

The Nature of Explanation

The explanation of an unstructured problem stems logically from its analytically identified dynamic structure. The latter serves to be explained by :

(1) Explicating the nature, type, and number of variables involved in the situation.

(2) Identifying the cyclic pattern of multi-lateral interaction among the variables in (1),

(3) Tracing out the possible courses and consequences of the interactions in (2) and

(4) Associating the courses in (3) with the past, present, and future, by specifying a starting point on the system's time axis i.e., initial values of the variables.

This paradigm of explanation consisting of the themes from (1) to (4) may be characterized as *hypothetico-deductive*. The dynamic structure of the model accounts for the production of empirically observed features of the problem situation. The model's adequacy in this respect, serves to validate it.

Figure 1, for example, provides an explanation of the village's poverty in terms of the processes underlying the failure of rural development efforts and reinforcing the financial disabilities of the weaker sections. The figure depicts the multi-lateral interaction of social, economic, demographic, administrative, political, psychological, and ethical factors involved in the emergence, persistence, growth, and variation of the problem situation. The 'how', why', 'what', and 'whence' aspects of the problem's explanation are then provided in a holistic manner.

Similarly Fig. 2 proves an explanation of the malfunctioning of thermal power plants in terms of the processes underlying the failure of efforts towards improving the operational efficiency of plants; replacing the obsolete equipment, machinery, and skills; checking the transmission losses; reducing the cost of power generation; and recovering the payments due. The problem is seen to be aggravated further by the rising demand for power on the one hand and political factors on the other. The figure depicts the multilateral interaction of technical, political, financial; managerial, demographic, operational, and infrastructural factors in the dynamics of the problem situation.

The multi-cyclical model also brings out the most salient features of an extant situation. Variables which stand at the intersection of several feedback cycles i.e., are associated with a large concentration of input and output links, represent the most salient aspects of the situation. In Figures 1 and 2, the salient variables (SV_s) are distinguished by the small circular marks beside them. They depict the foci of internal system processes. As such they serve to define the times-varying state of the system (SS_t) as follows:

$$SS_t = [SV_{1t}, SV_{2t}, \ldots\ldots, SV_{nt}]$$

The measurement of the salient variables of a system in terms of the concept of viability or regulatedness (λ), provides a basis for evaluating the 'health' (or sickness') of the system. Assessment of the time-varying impacts of problem-solving measures on the system's 'health', hence also becomes possible.

Viability (λ) Measurement of Salient Variables & System's 'Health'

The viability (λ) of a variable designates its 'regulatedness' (i.e., effectiveness from the standpoint of system regulator/problem solver) on a scale of 0 to 1. The concept represents a generalized evaluative measure mapped on to the performance values of the variables in their respective units. A viability measure of one ($\lambda=1$) corresponds to the maximum or uppermost limit of the performance value of a variable. A zero measure ($\lambda=0$) analogously denotes its lowest limit of performance. Midpoint of viability scale ($\lambda=0.5$) stands for the concept of an 'average, level of performance. The λ zones of 0.5 to 0.75, and 0.25 to 0.5, represent the spans of 'above average' and 'below average' performances respectively. Analogously, the zones of 0.75 to 1, and 0.25 to 0.0, represent the range of the 'most excellent' and 'chaotically worst' performance values respectively. Mapping the boundary value points of the four λ zones onto their corresponding performance values of the variables, yields a common base of measurement. The expression for system viability (Z_t) or 'health' during a given period t is then computable as below (Rostogi, 1979) :

$$Z_t = \sum_{i=1}^{N} /\lambda_i/ \; /N$$

where i is the viability measurement of the i*th* salient variable, and $i=1, 2, \ldots\ldots, N$ is the number of salient variables. Sidce λ ranges between 0 to 1, the value of Z also varies between 0 to 1.

The expression for system viability does not include any term indicating the relative importance of a system's salient variables. All the salient variables are equally important insofaras they represent the social system analogs of Ashby's concept of "essential variables", in biological systems (Ashby, 1956). Any essential variable by itself is capable of plunging the system in a state of acute disorder and eventual collapse if its value approaches and crosses its critical threshold (e.g., 107°F for human body temperature). Analogously; the entrance of any salient variable into the collapse zone of $0 \leqslant \lambda \leqslant 0.25$, would engender a state of serious disorder in a social system. The requirement of differential weights for the salient variables is therefore irrelevant.

In the light of the foregoing discussion, a number of inferences may be outlined as follows:

(i) For a 'healthy' system, $0.5 < Z_t \leqslant 1$, and $0.25 < SV_i\ (\lambda_i) \leqslant 1$.

(ii) The normative or goal state (GS_t) or problem-solution state of a system is definable by

(a) $0.75 \leqslant z_t \leqslant 1$, or equivalently,

(b) $GS_t = [SV_1\ (\lambda_1)_{iv}, SV_2\ (\lambda_2)_{iv}, \ldots\ldots, SV_n\ (\lambda_n)_{iv}]$

where SV_1 to SV_n are the n salient variables, and $(\lambda)_{iv}$ represents the IV zone of viability i.e., $0.75 \leqslant \lambda \leqslant 1.0$.

(iii) The sariousness or magnitude of a problem situation (SPS_t) is representable by

(a) $SPS_t = 1 - Z_t$, or equivalently,

(b) $SPS_t = d\,[(GS_t), (SS_t)]$

where d is the distance between the two sets of values.

(iv) Improvement in the status of a given problem situation (IPS_t) is representable by

$IPS_t = (Z_t - Z_{t-1})$,

where (IPS_t) is positive. Its negative value would analogously denote the situation's deterioration, while a null or near—null value would depict a state of stagnation or stability.

The problem situations depicted in Figures 1 and 2, show gradual decline or slow deterioration. The growth-inducing development mechanisms in the systems are weak and dominated by the growth-depressing socio-political processes. The viability values of the systems or their 'health' status (Z_t) are computed at $< 0.37\ \lambda$. They highlight the fact that the benefits of the development measures are not only low, but also are peripheral. The values of (IPS_t) in the situations are deemed to be slightly negative.

Time-varying values of (IPS_t), enable a policy analyst to evaluate the impact of policy measures over

a given period of time. But how and on what basis may one identify the nature and number of policy measures required for dealing with a complex problem situation?

Policy Analysis for Problem-Solving

The rationale of policy analysis for problem-solving emerges directly from the multi-cyclical model. The basic concept here is the *intended regulatory role* of a feedback cycle. A feedback cycle is a control mechanism whose intended regulatory role depends on the norms and values of the given social system. When the feeback cycles of a system fail to attain their recognized regulatory objectives, 'problem(s)' are generated within the system. The magnitude of the 'problem(s)' engendered by the cycles' failures, is assessable in terms of the observed discrepancies between the actual and the planned or desired values of the salient variables. The nature of malfunctioning cycles serves to bring out the causal and interactive factors behind a problem and its symptoms.

The necessary and sufficient conditions i.e., policy requirements for the solution of a problem thence also follow in a logically derivative manner. These requirements are empirically identified as the set of policy measures required for rectifying the malfunctioning cycles and thereby restoring their intended regulatory roles. The policy measures required for problem-solving may also be identified on the basis of the necessary and sufficient conditions for increasing the viability of the salient variables towards the IVth λ zone. If one or more of the identified conditions cannot be met in practice, the problem situation would continue to persist as incompletely resolved. This follows from Ashby's Law of Requisite Variety according to which the 'variety' of a problem situation/system to be regulated must, at least, be matched, if not exceeded, by the 'variety' of the responses available to the system regulator, (Ashby, 1956).

Multi-cycle models provide further useful insights toward policy analysis. For example, the variables with the highest values of $\Sigma\, 0_v/\Sigma\, I_v$ are most important from the control point of view. Most important constraints of the system are similarly represented by the variables with the highest values of $\Sigma\, I_v/\Sigma\, 0_v$. The variables for which the expression

$$BLV = [(\Sigma 0_v/\Sigma I_v)\,(\Sigma I_v + \Sigma 0_v)]\ \max$$

is maximum, represent the system's Basal Lever of change variables (BLV). Sustained improvement in the λ values of such variables produces cascading changes throughout the system leading to its enhanced viability. In a total society system model, BLVs were found to be Education in the sense of improving the productive skills of people, and Investible Resources i.e., the amount of productive investments in a national economy (Rastogi 1976, 1977, 1978). In the situation depicted in Figure 1, Developmental Measures for Rural Poor is the dominant BLV, while Economic Conditions of Rural Poor, and Benefits to Rural Poor are the most important system constraints. In Figure 2, the most important constraints are Poor Financial Resource Position and Transmission Losses, while the BLVs are absent. Their absence denotes a highly intricate situation.

A problem-situation is deemed to be 'solved', when the performance values of its salient variables reach the λ values of $\geqslant 0.75$. The policy goals of problem-solving are defined unambiguously by the normative or goal state (GS_t) of the system.

The multi-cycle model also specifies the lower *time-limit for the success of problem-solving efforts.* This time limit corresponds to the cycle time of the system. The cycle time of a multi-cycle system may often be approximated by that with the longest period of delays between that cycle's variables. This time limit attests to the fact that the impact of problem-solving measures cannot percolate through the system in a period less than the system's cycle time.

Importance of Policy Measures & Problem Dimensions

Identification of the problem dimension (D_i) and policy measures (P_j) required for their solution, follows from the analysis of the system's malfunctioning cycles, or its salient variables, as stated earlier. The rank orders and differential importance (or weights) of the policy measures may be determined

in the following manner. A binary matrix (PD) of policy measures *vs* problem dimensions is set up. The association coefficients C_{ij} between the problem dimensions D_i and D_j are calculated as follows :

$$C_{ij} = \frac{P_{ij}}{P_i + P_j - P_{ij}}$$

In the above expression, P_{ij} denotes the number of policy measures applicable to both D_i and D_j, and P_i and P_j denote the number of policies applicable individually to D_i and D_j respectively. The value of C_{ij} varies from zero to one. The relative importance (W_i) of a problem dimension D_i is then determinable as follows :

$$W_i (D_i) = \sum_{j=1}^{n} C_{ij},\ i \neq j$$

The weights of various problem dimensions involved in the situation of Figure 1, for example, emerge as follows :

(i) Indebtedness	= 0.16
(ii) Usury	= 0.16
(iii) Exploitation	= 0.15
(iv) Corruption	= 0.13
(v) Underemployment	= 0.12
(vi) Unawareness of Officially Available Benefits	= 0.12
(vii) Uncultivated Land	= 0.10
(viii) Lack of non-agricultural skills	= 0.06

A dimension D_i may be adjudged to co-occur with other dimensions D_i and D_k etc., if its association coefficients viz. C_{ij}, C_{ik} etc., exceed a specified threshold value (ϕ). The co-occurrence span (COS) of a dimension D_i may be expressed as

$$COS (D_i) = [D_i, D_j, D_k \ni D_{ij}, C_{ik} \geq \phi, \forall\ i \neq j \neq k]$$

Relative importance of a policy measure P_j is computable in terms of its plural applicability $A(P_j)$ to various problem dimensions (D_i). The applicability vector $A(P_j)$ is determined from the dimension weight vector $W(D_i)$ and the policy-dimension matrix PD. The matrix equation is,

$$A(P_j) = [(PD)\ \ (W\ (D_i))]$$

Computational results for applicability vector $A(P_j)$ for revealing the relative importance of policy measures in the situation of Figure 1 are :

(i) Legal Aid to the poor	= 0.25
(ii) Liberalization of 'Soft' Credit Scheme	= 0.24
(iii) Education Regarding Benefits and Legislation	= 0.14
(iv) Promotion of Animal Husbandry	= 0.125
(v) Anti-Corruption Measures	= 0.10
(vi) Land Reclamation and Distribution	= 0.08
(vii) Training in Trades & Crafts	= 0.065

Analogously the relative importance of the problem dimensions in Figure 2 are found to be as follows:

(i) Political Interference	= 0.11
(ii) Increasing Demand for Power	= 0.10
(iii) Slow Expansion of the Power Sector	= 0.10
(iv) Poor Quality of Coal	= 0.08
(v) Poorly Trained Plant Personnel	= 0.08
(vi) Delayed Receipt of Payment	= 0.07
(vii) Irregular Supply of Coal	= 0.07
(viii) Labour Problems	= 0.07
(ix) Worn out and/or Obsolete Plant & Machinery	= 0.07
(x) Over-staffing	= 0.07
(xi) Power Theft	= 0.06
(xii) Capacity Under-utilization	= 0.06
(xiii) Delayed/Irregular Servicing of Equipment	= 0.06

These thirteen values together constitute the column vector $W(D_i)$ for this problem.

Relative importance of policy measures in the context of this situation is seen as follows:

(i) Effective National Planning	= 0.26
(ii) Insulation of Political Influences	= 0.16
(iii) Improvement in Coal Quality	= 0.09
(iv) Regular Training of Plant Personnel	= 0.08
(v) Optimal Maintenance Schedule	= 0.08
(vi) Disciplined Climate of Work	= 0.08
(vii) Improved Working of Collieries	= 0.06
(viii) Timely Replacement of Obsolete Equipment	= 0.06
(ix) Improved Availability of Coal	= 0.05
(x) Vigorous Measures for Revenue Collection	= 0.05
(xi) Vigorous Anti-Corruption Measures	= 0.03

Most of the foregoing measures are managerial-cum-administrative in nature whilst the two most important ones are essentially socio-political. It may, thus, be seen that the deeper roots of the techno-economic problems of power plants lie in the socio-logical limits to growth.

The implementation of policy measures is however often bound up with the problem of resource constraints and their most effective use. Let Q_j (r_e), be an effectiveness function indicating the extent to which the objectives of a policy can be achieved by an expenditure of R resource units out of a total of N units available, and the value of r being R/N. If further, there exists a probability p for the relization of a system objective corresponding to a given level r of resource deployment, then the effectiveness function may be defined as

$$\theta_j (r_e) = 1-(1-p)^r,$$

where $0 \leqslant p \leqslant 1$, $0 \leqslant r \leqslant 1$, and r = R/N. This relationship indicates that both the effectiveness function and the probability p increase as r increases. The p may be deemed as a Bayesian estimate depending on a number of internal and external contraints, or experienced administrators may assign it a figure based on their experience and judgement.

The weighting factor (W) for a policy measure (P_j) is thence given by

$$W(P_j) = A\ (P_j) \times \theta_j (r_e)$$

or $$= A\ (P_j)\ [1-(1-p)^r]$$

Micro-Level Policy Analysis for Problem-Solving

The foregoing policy analysis for problem-solving however, yields solution measures at a relatively gross level. One may, often, be interesed in identifying more specific solution measures at the level of persons places, things, events, methods, procedures, time elements, interpersonal tensions, information channels, actors' definitions of the situation, and their perceptual and subjective factors. Such an identification of micro-level specific soluation measures is made possible by an analytic procedure of hierarchic disaggregation of the salient and/or problem symptom variables. This procedure is termed the 'morphological analysis'. It involves the micro-level dissection of the salient/symptom variables to uncover the fine level morphological structure of a problem situation or phenomenon (Rastogi, 1986 a, 1987).

The procedure of morphological analysis may be illustrated as below. It involves the disaggregation of a variable at successive levels of specificity and detail as follows :

(i) At the first level, the variable is decomposed into a set of distinct and non-overlapping 'Task & Activity' (T & A) elements. These elements represent the overtly observable empirical features of the variable. These elements are then assessed in terms of their relevant indicators as applicable. Those T & A elements which are non-normal or in 'disturbed' status; i.e., whose indicators are at variance with their normal expected values, are marked as such. They are then selected for further disaggregation. The unmarked or normal elements are not explored further.

(ii) At the second level, the social/organizational Role Types involved in the production of abnormal elements of level (I) are indentified. Their identification helps to trace the spread of the problem/phenomenon in the social or organizational structure(s). The non-normal Role Types are marked as before and explored further.

(iii) At the third level, the persons playing the non-normal roles are identified. If the number of persons coming under a role category is rather large (viz., landless labourers, marginal farmers, industrial workers etc.), their population may be appropriately sampled to limit their number for a manageable empirical investigation. The non-normal or disturbed elements i.e., the relevant persons are also marked here as before and examined further. The nature and number of individuals involved in the situation highlights the extent, complexity, and diversity of the problem's dimensions.

(iv) At the fourth and last level, the individuals identified in (III) are diagnosed in respect of their actions/behaviours, social linkages, world views, and definitions of the situation. The objective features of their situation space i.e., extant norms, policies, methods, facilities, resources, communication pattern, inter-personal linkages, and artifacts are indentified. They are juxtaposed together with the subjective factors of cognition and affect/motives, to bring out the incongruities, inconsistencies, and non-obvious aspects of the situation. The abnormal, disturbed, and dissonant elements are marked here also in the same manner as before.

The elements marked as disturbed/non-normal in the morphological analyses of all the salient variables are then conjoined together in terms of their empirical linkages. Such an assemblage of disturbed elements and their relational linkages is designated as the *morphological map* of the problem situation. The morphological map of the situation depicted in Figure 1 is given in Figure 3.

The micro-level specific policy measures for a problem are thence defined in terms of the requirements of eliminating all the abnormal elements and their pathological relationships i. e., disintegrating the map. A morphological map delineates the fine structure of a problem situation i.e., the micro-level specific non-normal factors engendering the situation and accounting for its persistence, deterioration, complexity, and difficulty. The map also provides a prognosis, or predictive inferences regarding the situation's course in the immediate future. It also enables one to trace and assess the differential impact of various policy solution measures which may have been tried in the past or may be tried at present.

The morphological map of a macro-level problem situation like the one in Figure 2 may not usually be possible in so far as its representation is generalized i.e., does not refer to specific power plants. Based on the micro-level commonalities of a number of specific situations, a generalized morphological map may however, be constructed. Macro-level generalized situations may however be further explored through policy experiments on their simulation models. The development of simulation models and identification of policy experiments are logically facilitated by the multi-cyclical representations and the identifications of salient variables respectively (Rastogi, 1979; Dastoor, 1988). A discussion of simulation models and policy experiments is outside the scope of this article.

Policy Levels for Problem Solution

Analyses of the morphological maps of several complex problems including that in Figure 3, show the different levels of policies for the solution of a complex problem. These levels are in an increasing order of difficulty and may be outlined as follows:

(I) At the first level of policies for problem solution, improvements in the problem follow from the optimization of time, facilities, and work schedules; removal of resource and blocking deficiencies; use of efficiency, productivity, and monitoring techniques; and so on. The quantitative techniques of operations research and simulation modelling

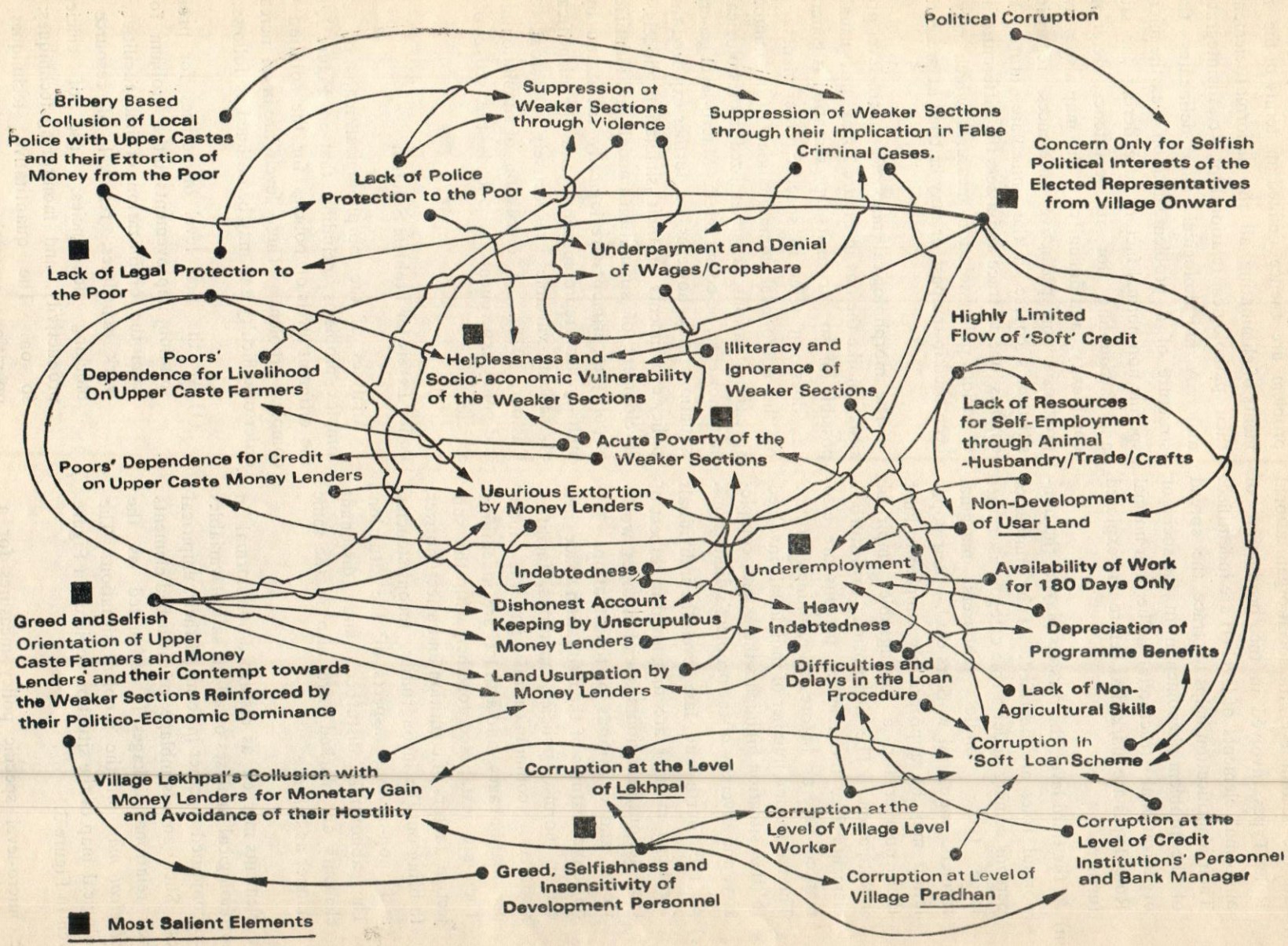

Fig. 3 Morphologieal Map of the Village's Poverty

have a very useful role to play in this context. The remedial policies adopted here may lead to a more efficient utilization of the available resources.

(2) At the next policy level, improvements in the problem usually require substantive changes in the existing policies and structures of the organization (s) associated with the problem situation. Such changes owing to their deeper and far-reaching nature, are not easy to implement. They may require considerable use of social, psychological, political, managerial, and leadership resources, besides economic/financial inputs. Poor availability of these non-economic resources may retard the progress towards problem-solution. The relevant analytical techniques involved here are strategic planning/analysis, organizational restructuring, system design, policy modelling and so on.

(3) The third and the most basic long term policy move involves planned changes in the subjective factors like motives, perceptions, attitudes, and outlooks of the actors involved in the problem. Subjective factors represent the most intractable aspects of complex problem situations. In the context of poor motivation for work and productivity, they refer to the 'X in-efficiency' of the workers/employees (Leibenstein, I976). They are however, seen to be essentially reducible to a limited set of disturbed emotions/motives/affect orientations (e^*/m^*). This set comprises egotism/pride/contempt, greed/selfishness/acquisitiveness, lust/hedonism, anger/revenge/wounded ego, and excessive parochialism/attachment.* This set can be nullified only through the four super-rational value operators (SRV) of man's unity in Divinity (*satya*), universal goodwill (*prema*) inner serenity (*shanti*), and righteous action consisting to duty and service (*dharma*) (Rastogi, 1984, 1985, 1986 (a)). Symbolically, $(<e_1^*/m_1^*, \ldots, e_6^*/m_6^*>.\rightarrow./<SRV_1, \ldots, SRV_4>)$

The four super-rational values i.e, truth, universal goodwill, inner serenity, and righteous action, according to Sri Satya Sai, represent the essence of man's life. *In so far as the third level of subjective factors is the most basic one for the solution of complex real world problems, it follows that human social systems cannot be improved in the absence of man's internalization of the transcendental spiritual values.* In the morphological map of Figure 3, the intractable subjective factors of disturbed emotions/motives are identifiable as greed, selfishness, contempt, insensitivity, and irresponsibility of the usurers, policemen, development personnel and political leaders. They are seen to lie at the root of the extant situation.

Analysis for Prognostic Inference

Prognostic inferences concerning a problem situation/phenomenon are made possible by the analysis in the following number of ways:

(i) Qualitative inferences of the form, 'IF X, THEN Y', where both X, and Y, may be plural, follow from the examination of a situation's multi-cyclical representation. They include inferences regarding the state and course of the system as a consequence of the exogenous impacts on specific system variables. They also include inferences as a result of specified changes in the system's endogenous controllable variables.

(ii) Control, constraint and basal lever (BLV) variables; specifications of $\lambda_i > 0.25$; and time varying values of Z_t; provide other useful predictive and diagnostic inferences.

(iii) Prognostic inferences regarding the state and course of the system in the near future are provided by the morphological map of the problem situation.

(iv) However, insoforas social systems are 'open'

* These disturbed affect orientations represent the 'six enemies of man', according to Indian scriptures. Unless and until, a man succeeds in overcoming them, he cannot realize the prime meaning and purpose of life.

systems i.e., subject to time-varying random exogenous impacts, meaningful and verifiable predictive inferences are possible only for limited time periods. The inferences would correspond to a specified set of environmental conditions which are expected to obtain over a relevant future period. Long range predictions are questionable as the nature and pattern of external events and situations may not be properly visualized over long spans of time.

(v) An important theoretical principle in deriving prognostic inferences is Wiener's principle of the Entrainment or Matching of Frequencies (Wiener, 1958, 1962). According to this principle, the constituent parts of a dynamic system tend to function together at a compatible and matching pace. It implies a reguirement of consistency in the values of the salient variables of a dynamic system. The state of a complex dynamic system during any given period tends to display an equilibrial behavioural profile. The salient variables of the system tend to be in phase with one another. The impacts from the system's evironment may however engender transient disequilibrium within the system. Such a disequilibrium may lead the system to a new state of internal consistency and equilibrium. The principle of matching or entrainment leads to a very powerful theoretical implication. Knowing the λ values of only one or more salient variables, one can infer the corresponding values of other salient variables on the basis of the requirement of consistency and balance amongst them.

The relationships involved here are:

$$\int_{t-1}^{t}\int_{0}^{1} SV_1(\lambda)\, d\lambda\, dt \equiv \int_{t-1}^{t}\int_{0}^{1} SV_2(\lambda)\, d\lambda\, dt \ldots, \equiv \int_{t-1}^{t}\int_{0}^{1} SV_n(\lambda)\, d\lambda\, dt$$

or more simply,

$$SV_1(\lambda) \equiv SV_2(\lambda) \equiv \ldots \equiv SV_n(\lambda)$$

The following additional implications for predictive inferences also follow from Wiener's Law:

(i) If the non-transient values of one or a few salient variables persist at extreme and critical levels, then values of the remaining salient variables would also tend to become critical in a matching manner.

(ii) Similarly, if the non-transient values of some salient variables persist at a high level of viability, then the values of the remaining salient variables would also tend to become correspondingly viable.

(iii) If the non-transient values of most of the salient variables are at a given level of viability, then the non-matching transient viability values (high or low) of the remaining few variables would also come (up or down) to the level of the majority of the salient variables.

The transient and non-matching values may come about as a result of the sudden and powerful impacts of random exogenous factors. The system reverts to its earlier state of equilibrium, when these exogenous impacts cease, or would attain a new level of equilibrium if they persist over a long period of time. Quantitative predictive inferences may be obtained through the simulation of the multi-cyclical model on a digital computer. The deficiencies of specification in the numerical values of parameters, variables, and non-linear functional relationships in the simulation model, however, tend to reduce the significance of predictive results to a qualitative level only.

Analysis for Decision-Making

The contribution of cybernetic analysis to the problem of decision-making may be seen along the following lines:

(i) The methodology of problem-solving clarifies the rationale and context of decision-making in complex situations. It also explicates the relative importance of problem dimensions and the policy measures required for their solution.

(ii) Morphological analysis serves to define the nature, objectives, and requirements of decision-making at a considerable level of specification and detail.

(iii) Cybernetic analysis also affords a perspective on monitoring and preventive or *anticipatory decision-making*. The perspective implies that the decision-maker should periodically monitor the salient variables of the system in order to forestall or check their descent toward their respective critical thresholds. The decision imperative in this context is that none of the salient variables should be allowed to reach its critical state lest it drive the system chaos.

(iv) The most distinctive perspective on decision-making here is, however, provided by the concept of the maximization of the system's viability (λ and Z values) in contrast to the concepts of money and utility. The decision-making paradigm here may be outlined as follows:

(a) Decision-maker (DM) identifies the salient aspects or core criteria of the situation over which he wishes to appraise his decision alternatives.

(b) In so far as, each of the selected criteria or aspects is salient i.e., compulsive, the issue of their respective weights becomes irrelevant.

(c) Each of the specified salient criteria is divided into four zones of performance values corresponding to the four zones of viability (λ). The resulting performance scales which may be non-linear i.e., only piecewise linear over the zones, are then mapped on a common linear λ-scale of 0 to 1.

(d) Any alternative involving a λ measure of $\leqslant 0.25$ for any core criterion, is thence ruled out from consideration. This premise may be viewed as a counterpart of the Elimination By Aspects (EBA) approach to decision-making.

(e) Among the remaining alternatives, the one with the highest value of Z (i. e., $\Sigma \lambda_i/N$), then emerges as the logical choice. The experssion for Z corresponds to the linear multi-attribute model for decision-making. The robustness of such a decision-making model has been noted by a number of writers (Edwards, 1985). The λ_i values are however, derived here from non-linear performance scales. Hence, they do not suffer from the infirmities of a linear utility scale, specially in respect of the concept of marginal utility. This model is also free from the arbitrary procedures and assumptions of the so-called 'lottery method' and computation of 'certainty equivalents'.

The viability measures are here derived from the performance scales whose terminal, average, and intermediate points, reflect the values, standards, and subjective world-view of a DM. The paradigm outlined here then conforms to the basic psychological premise of individuals' being rational within their subjective frames of reference.

Conclusion

The cybernetic methodology sketched here provides an integrated approach toward systematic policy analysis for explanation, problem-solving, prognostic inference, and decision-making in complex, real world problems. It abjures *adhoc* assumptions, and is extremely parsimonious in its conceptual frame. It provides full scope for the inclusion of 'soft' data, imprecise information, and qualitative insights based on experience and observation in the model formulation. It is applicable to a wide variety of problem domains, and is capable of being falsified through empirical verification.

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Biotechnology and Productivity in Agriculture

B.L. Dinakar

India, with its year-round sunshine, trained, scientific population, irrigation facilities and wide industrial base, is favourably placed to harness the benefits of biotechnology. The author lists the most recent trend in this field with particular reference to research carried out in various laboratories in India.

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The introduction of science based technology in agriculture in the sixties resulted in an increase in the production of foodgrains in what came to be known as the 'Green Revolution'. The elements of this revolution apart from improved plant varieties, were chemical fertilizers, irrigation and mechanisation—all fossil-fuel and capital intensive technologies.

The improved plant varieties were evolved mainly in rice, wheat and maize due to the discovery of dwarfing genes in third world countries like Taiwan. Most of these varieties responded well only when fertilizers and irrigation were applied. The indiscriminate use of fertilizers coupled with irrigation has brought the soil salinity level higher and increased water logging by bringing the water table close to the surface. Alongwith the new varieties, there was an outbreak of diseases and new pest varieties, which necessitated the use of plant protection chemicals. The pesticides not only left their residues in the food articles, thus reducing the quality, but also ousted the natural enemies of pests that existed in nature. In the absence of natural enemies which are beneficial to the crop growth, application of pesticides was a recurring phenomenon, thus, increasing the cost of cultivation.

Whatever may be the consequences of the 'Green Revolution' it did increase food production in our country and helped to attain self-sufficiency in food grains. But the population growth rate (2.4 percent) remained more than the food production growth rate (2.1 percent) during the last 25 years in India. Thus, the marginal increase in production was offset by the ever increasing population. Even though with the present level of agricultural technology, the world can feed the forecasted 10 billion population (Table 1) at

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TABLE 1 **Population Projections (in millions)**

Selected countries	1950 AD	2000 AD	2100 AD
China	603	1194	1462
India	362	994	1632
Nigeria	42	169	594
Developing countries	1670	4884	9463
Developed countries	834	1357	1407
Total World	2504	6147	10870

Source : World Bank, 1984.

2000 AD, in the developing countries of Africa and Asia the trends are very much disturbing.

In the case of India the population at 2000 AD will be 994 million and the food grain requirement will shoot upto 223-225 million tonnes leaving a gap of more than 75 million tonnes. Out of our 328 million hectares of land, 145 million hectares are subjected to severe erosion. As a result of growing deforestation, salination, desertification and increased land use for construction and industrial purposes, the possibility of increasing the crop land is remote. The per capita land available for cultivation will be reduced to 0.175 hectares in 2000 AD as against 0.292 hectares in 1971.

Thus, three important dimensions—population growth, ecological imbalance and the high cost of modern agriculture—demand that agricultural planners should reconsider the present strategy. "For planning purposes it is best to assume that virtually all growth in food output by the turn of the century will have to come from raising productivity" (United States Department of Agriculture, 1984). Thus, there exists a great challenge before scientists and development administrators in the identification and introduction of new methods by which the productivity in agriculture can be enhanced. One of the new methods is biotechnology. In India, we face the problem of having to improve production and consumption simultaneously. This will be possible under current economic conditions only if production costs are kept as low as possible so that the output price is reasonable to a majority of consumers. The alternative method is to subsidize the inputs or outputs which imposes a heavy burden on the financial resources. "This challenges those in charge of technology development to bring about continuous movement in the production of major farming systems per unit of land, water, time and energy without detriment to the long run production potential of the soil" (Swaminathan, 1982). Can biotechnology help in this ?

Biotechnology

Biotechnology encompasses many facets of the management and manipulation of the biological system. In 1981, the European Federation of Biotechnology defined this branch of science as "the integrated use of biochemistry, microbiology and chemical engineering in order to achieve the technological application of the capacities of microbes and culture cells." A recent offshoot of biotechnology is genetic engineering which involves gene splicing and recombinant DNA technology. For all practical purposes biotechnology can be defined as "Commercialization of biology."

Biotechnology includes the oldest technology of making leavened bread by the use of microorganisms (yeast) to the newest technique of making monolonal antibodies. There are as interesting experiments as incorporating animal gene in plant (mouse gene in oat), putting genes from different types of bacteria into one bacterium (superbug), crossing plants like potato and tomato (resulting pomato). This shows that today's revolution in the sophistication of biotechnologies and the science of genetics is slowly breaching biological barriers, raising the prospects that useful traits may soon be transferred between species that could never before be crossed by conventional breeders. But for a developing country like India the important technologies are tissue culture and biological nitrogen fixation in crop husbandry and super ovulation and embryo transfer in animal husbandry.

Plant Cell and Tissue Culture

Tissue culture, an innovation that is about two decades old, can be directly applied to increase food production in developing countries with dramatic results. This technology produces genetic duplicates of superior plants, each grown from bits of plant tissue that are taken from a single parent plant and placed in a test tube. "This represents the fastest method of cloning, upto a million times faster than traditional methods and scientists have perfected test tube environment for hundreds of plants" (Lewis, 1982) ranging from horticultural, agricultural to forestry plants.

The experiments conducted at the National Chemical Laboratory, Pune, documents that tissue culture-grown plants of Eucalyptus species showed greater height, diameter and biomass value (Table 2). But in these experiments a very high early increase in growth was noticed, the increase gradually decreasing with time. The unit cost per plantlet based on the capital and recurring expenses was estimated to be two rupees whereas on the recurring cost alone the price was half this amount. Authors opined that "although gains at the end of 60 months shows a fall in the increase in biomass but there is still a small gain. This suggests that tissue culture could have immediate commercial application. Since a gain however small in an applied forest tree improvement programme can be of enormous economic benefit when distributed over thousands of hectares of plantations established annually" (Mascarenhas, et. al., 1988). As a technique it is promising, and the same can be standardized in other crops of importance. However the cost factor can be still reduced.

Another potential area of tissue culture application in India is the upgradation of vegetable oil-bearing trees like coconut and oilpalm. Edible oils, which drains our exchequer to the tune of Rs. 1000 crores every year, has been a perpetual problem for Indian administrators and planners. In the absence of a breakthrough in field crops which give edible oil, an increase in the availability from tree sources has become the need of the hour. But most of the coconut holdings in India have uneconomic palms and the prevalence of diseases has aggravated the situation further leading to a steady decline in production and productivity in recent years. The average yield of coconut in the country is about 30 nuts/year/tree. In order to upgrade the population genetically, and thus increase in yields, an ambitious project has been launched in Kerala to plant high yielding coconut varieties/hybrids after removing uneconomic plants. To complete the project in about 40 years, it is estimated that the requirement of high yielding varieties/hybrids will be about 3 million seedlings per year. One of the major constraints is the non-availability of high yielding cultivars and hybrids in adequate quantities. However, the process can be accelerated by the application of tissue culture technology. A number of plants have been identified which are not only high yielders (500 nuts/tree/year) but presumably also resistant to diseases (Bhaskaran, 1985), such as root wilt and stem bleeding. One more advantage of tissue culture is that when tissue from the top of plant part such as leaf (meristem culture) is taken and plants are regenerated in the laboratory the resulting seedlings are found to be free of diseases. Apart from this many seedlings identical to the high yielding parent plant can be raised within a very short time, cutting down the generation cycles.

Developing countries can use tissue culture technology in several ways. Breeders can clone the best adapted superior plant varieties to produce duplicates for large scale production. If breeders begin with clean material, they can increase the productivity of a variety from 30 to 300 percent. By placing plant embroys in tissue culture, plant breeders can rescue rare-hybrids-offspring that combine the desirable traits of two varieties. In connection with the innumerable applications Bollinger (1980) has called tissue culture "the botanical equivalent of laser in that there are more potential applications than originally conceived."

Despite tissue culture's advantages in quickly selecting useful plant varieties, some of the most important cultivated plants cannot yet be consistently regenerated in a laboratory. Standard technologies are to be developed for wheat, maize, soyabeans etc.

TABLE 2 Growth Evaluation Data—Eucalyptus tereticornis

Age (Months)	Height (M)		Diameter		Biomass (Kg/Plant)	
	TC*	Control	TC	Control	TC	Control
34	8.45 ± 0.04	7.08 ± 0.06	6,60 ± 0.02	5.55 ± 0.02	4.80 ± 0.02	3.02 ± 0.02
42	9.47 ± 1.66	7.50 ± 2,62	7.80 ± 1.27	6.45 ± 2.39	14.30 ± 2.7	11.20 ± 2.9
52	9.75 ± 1.27	8.17 ± 2.62	8.75 ± 1.75	7.46 ± 2.39	18.50 ± 3.0	15.95 ± 3.1
60	10.25 ± 1.52	8.45 ± 2.42	9.35 ± 2.66	8.25 ± 2.55	20.15 ± 2.8	19.10 ± 3.5

Result of pilot scale trial after 60 months
Plant date : July, 1983
Spacing : 2 M X 2 M
Plot Size : 100 Sq. M
No. of plants : 36
*TC : Tissue Cultured Plants
Source : Mascarenhas *et. al.*, 1988

Biological Nitrogen Fixation

Nitrogen is frequently the limiting nutrient in agricultural productivity. Although 78 percent of the earth's atmosphere is composed of nitrogen gas (N_2), plants are unable to use it in that form. The nitrogen must be fixed, that is combined with other elements such as hydrogen, carbon or oxygen before it can be assimilated by higher plants. This is an energy-intensive process where heavy government subsidy is involved. For example, during the year 1984-85, the fertilizer subsidy in India reached an all-time high of $ 1009.00 million (Table 3). Apart from this the total value of fertilizers imported from abroad to meet domestic demand was Rs. 9252.2 million. (1984-85); urea alone accounted for Rs. 5399.2 million. Thus man-made nitrogeneous fertilizers are prohibitively expensive especially for developing countries and crops capable of fixing their own nitrogen have acquired urgent importance.

Some varieties of leguminous plants have the ability to fix atmospheric nitrogen. This ability is due to the enzyme present in the microbes of the roots of such plants. Superior strains of *Rhizobium* (which fixes N_2) are being evolved, by exploring their performance in different plant varieties and under different conditions of acidity, temperature and soil nutrient level. Some procedures developed at the International Crop Research Institute for Semi-Arid Tropics (ICRISAT), Hyderabad have, increased the rate of nitrogen fixation in legumes by 300-500 percent.

TABLE 3 Total amount of fertilizer subsidy* in some selected countries (US $ million)

Country	1981-82	1982-83	1983-84	1984-85†
India	307.99	571.67	873.11	1009.00
Greece	216.57	209.36	147.35	124.03
Indonesia	414.24	430.28	296.86	—
Iran	306.67	299.00	348.07	—

* Subsidy on indigenous fertilizers
† 1 $ Rs. 11.893.
Source : FAO, Fertilizer Year Book, 1985.
Note : In India subsidy programme started in 1977 for indigeneous nitrogen fertilizers and in 1979 for indigeneous phosphatic fertilizers.

A very promising system of nitrogen fixation in connection with rice cultivation is 'blue-green algae'. When rice is grown in submerged conditions the co-existing algae *Anabaena* alongwith a fern plant *Azolla* can sustain the crop without additional N_2 application. The potential of Azolla as a nitrogen-fixing, green manure crop suitable to rice culture has been recently recognised by many researchers, agricultural administrators and farmers. Some species of Azolla

can fix nitrogen at the maximum rate of about 3 kg/ha (*A pinnata*) to 10 kg/ha (*A foliculoides*), daily according to the experiments conducted at International Rice Research Institute (IRRI), Manila (Roger and Kulasooriya, 1980).

By using the bio-fertilizers mentioned above we are not only abandoning the use of man-made fertilizers which is a very costly input, but also reducing the pollution created by fertilizer factories and also the soil and water pollution created by the application of these fertilizers. These technologies are easy to follow, cost-effective and ecologically sound. Scientists are now trying to transfer the nitrogen-fixing genes from micro-organisms to leguminous plants as well as to non-leguminous plants like cereal.

One of the limitations of the biological nitrogen fixation technique especially in the context of *Rhizobia* is the indigeneous soil. A number of other micro organisms can make the added *Rhizobia* ineffective. A crop-specific and area-specific development of Bio-fertilizer is the only answer for this.

Animal Productivity

India's population of cows and buffaloes is 260 million, which is 1/6th of the world's population of cattle and $\frac{1}{2}$ of the world's buffaloes. Surprisingly, annual milk production is only 7 percent of the estimated world's production (NDDB estimates, 1984). The reason for this disparity is that 80 percent of the animals are non-reproductive (Young, 1987). Embryo transfer can be a useful tool for rapid multiplication and proliferation of genetically superior cows by utilising less reproductive cows as recipients.

A hormone called Bovine Follicle Stimulating Hormone (BFSH), a genetically engineered product plays a vital role in producing many embryos in a superior cow instead of, only one embryo. These are then fertilized with the sperm from a genetically valuable bull and placed into surrogate mothers which are less valuable cows who carry the embryo through to birth. This technique which is called 'superovulation' can produce 50-60 superior calves in a single year (Young, 1987). In addition, embryo transfer accelerates the introduction of new genetic material into indigeneous cattle; with a herd of recipient cows, it requires one generation. The conventional method of artificial insemination requires three generations before the off-spring are seven-eight the genetic make-up of the new breed.

Some of the experiments conducted (Toley, et. al., 1988) in the National Institute of Immunology, New Delhi have given encouraging results in this direction (Table 4). A total of 47 Holstein and crosses of Holstein × Sahiwal cows were superovulated with different doses of follicle stimulation hormone injection. Donors were then inseminated with semen and after a week embryos were collected and transferred to the non-descript cows. The researchers were able to recover 9 calves of which one was 100 percent Holstein. From the data obtained, they concluded thot non-descript, low genetic quality cows which are available in large numbers in the country can be better utilized for the production of genetically superior high milk producing cows by embryo transfer technology.

TABLE 4 **Production of multiple embryos from prized cows**

Dose of FSH (mg)	No. of cows Super-ovulated	Cows responded to treatment	Mean no. of embryo per donor	Mean no. of transferable embryos per donor
50	15	8	4.5	1.5
40	6	4	3.75	2.5
28	16	14	4.7	3.1

Source : Totey *et. al.*, 1988.

In the west many commercial houses are in the early stages of engineering a growth hormone for poultry. These proteins can reduce maturation from eight weeks to six, thus, reducing cost to farmers by 25 percent. Another growth hormone called Bovine Somatostatin (BST) can increase milk-yields 20 percent when injected into cows regularly. The dairy farmer can now produce the same amount of milk with fewer cows and less feed and equipment.

India's Favourable Position

Biotechnology works best where there is year round

warmth, sun, and controlled water i.e., irrigation (Malgavkar, 1988). India lies in the tropical climate zone, being placed just above the Equator. During the ripening period of the important cereal crops like rice the incident solar energy received are around 300 and 500 calories per square centimeters (cm^2) in the wet and dry seasons respectively. India irrigates 22.02 percent of the total agricultural area of 180 million hectares which is far above that in more developed countries like the USA (Table 5). Our manpower resource is abundant as we have the third largest stock of scientists and engineers after USA and USSR in the whole world. In 1977, India had 2.3282 mlllion qualified personnel with degrees in science and technology and way back in 1974-75, India trained 15,000 engineers and technologists and 5000 graduates in agriculture (Alam, 1987). Many institutions have started research in biotechnology (Table 6) and many have come out with usefu! contributions which can increase the productivity in agriculture as discussed earlier.

TABLE 5 **Land Use and Irrigation**

(000 hectares)

Country	Total Area	Total Agricultural Area	Irrigated Area	Irrigated area to the total agril. area (%)
USA	937,261	431,382	19,831	4.60
China	959,696	386,582	45,420	11.75
India	328,759	180,250	39,700	22.02
Egypt	100,145	2,474	2,474	100.00
North and Central America	2242,75	633941	27,414	4.32
Asia	2757,496	1100532	136,962	12.45
Europe	487081	225,510	15,616	6.92

Source : FAO, Production Year Book, Vol. 39, FAO, Rome, 1985.

TABLE 6 **Agencies Involved in Biotechnology in India and their Priorities**

* National Biotechnology Board (NBTB, 1982).

Hormones, Gene Therapy, Antibiotics and Antibodies

* International Centre for Genetic Engineering UNIDO sponsored : Agriculture, Animal health

* Institutions

1. Indian Agricultural Research Institute (IARI) :
   Micro-organism and plant interaction
2. CSIR's centre for Biochemicals :
   Enzyme Manufacturing
3. National Chemicals Laboratory, Pune :
   Plant tissue culture, virus free sugarcane
4. TIFR and BARC, Bombay : Genetic Engineering
5. Indian Institute of Science (IISc) Bangalore :
   Rice embryo culture, Biological N_2 Fixation
6. Indian Institute of Technology, New Delhi :
   Conversion of cellulose to Alcohol

* Industries

1. Hindustan Lever Ltd.
   Coconut propagation through tissue culture, N_2 fixation through genetic engineering
2. Beardsell—Madras (with State Ltd. UK)
   Single cell protein from wastes
3. Tatas' Plantic (with Native Plants International US)
   New strains of tea and oil palm through tissue culture
4. Tata Oil (TOMCO)—Fats from molasses
5. Hindustan Insecticides Ltd.—Microbial insecticides

Thus with its already well developed science and technology infrastructure, availability of trained manpower, diversified industrial base, rich genetic heritage and the low cost India is uniquely placed to harness the potentials of biotechnology for increasing its agricultural productivity.

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□

Rabies is fatal but you can prevent it

HOW IT IS CAUSED ?

— Rabies is caused by the bite of a rabid animal, mostly dogs.

— Once you get rabies, it leads to death as there is no treatment available to cure rabies.

PREVENTION

— But Rabies can be prevented. Get all the pet dogs vaccinated against rabies.

— Help authorities in catching and eliminating stray dogs as stray dogs get rabid and infect the pet dogs.

— In case a dog bites you, wash the wound with soap and water and go to the nearest hospital clinic immediately.

ANTI RABIC VACCINATION

— Take anti-rabic vaccination on the advice of the doctor

Central Health Education Bureau,
D.G.H.S., Kotla Road, New Delhi.

davp 88/782

Inventory Behaviour in Cotton Textile Industries

V. Selvaraju

Inventories are necessary to keep the production process continuous and also to manage the fluctuations in sales. Taking the cotton textile industries as an example, this study attempts to establish the nature of the relationship between sales and inventories and discover whether there are any differences in inventory behaviour among states with different endowments. The results estimated both at cross-sectional and time-series levels by using a linear regression model reveal that the level of sales and inventories are positively related.

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Inventory means a stock of some kind of physical commodity having economic value. Thus, the term includes items like stocks and stores of raw-materials, components, work-in-progress and finished goods. The size of the inventory is governed by many considerations—psychological, commercial and speculative. Inventories are generally held to keep the production process continuous and to manage the fluctuations in sales. They also support the time required for the economic transformation to be performed. At the same time holding of inventories involves costs of storage, insurance and financing as well as the risk of obsolescence. (Chadda, 1971). Therefore, the management of inventories is a process of balancing from holding additional stocks against their marginal cost. (Stanback, 1968).

Inventory behaviour has long been the concern of business cycle theorists. Among them, the relationship that exists between the level of inventories and sales was first established by JM Clark (1917). Since inventories and sales are related, the management always attempts to vary the level of inventories with, though not necessarily in proportion to, the level of activity of the firm. Usually, firms aim to maintain a fixed relationship between inventory and sales. (Hirsch and Lovell, 1969). Assuming JM Clark's proposition this study attempts to find out:

(1) the nature of relationship that exists between the level of inventories and sales, and

(2) whether there is any difference in inventory behaviour among the states with different endowments.

For the purpose of analysis, the cotton textile industries in three major cotton states, namely Gujarat, Maharashtra and Tamil Nadu have been considered in this study. The cotton textile industry has been selected for this study because of the crucial role played by inventories in the industry when compared to others. One of the major inputs for this industry is cotton which is seasonally grown. This seasonal supply is also not always guaranteed because of the heavy dependence of Indian agriculture on the monsoons.

The significance of this sector to the Indian economy is seen from the fact that nearly 10 percent of the total industrial labour force of the country have been employed in this industry. It contributes nearly Rs. 6,000 million to the national exchequer by way of taxes and earns Rs 5,000—6,000 million in foreign exchange per year through exports. (Kothari's Industrial Directory of India, 1988-89). The number of cotton mills also have grown significantly from 378 in 1951 to 984 in 1984-85. (Indian Cotton Annual, 1985-86).

Features of the States Selected

Out of the 984 mills in India in 1984-85, nearly 70 percent were located in three states, namely Tamil Nadu (427 mills), Gujarat (116 mills) and Maharashtra (115 mills). These three states account for nearly 60 percent of the total area under cotton crop in India (Tables 1—4). Maharashtra and Gujarat rank first and second in India in respect of area under cotton crop whereas Gujarat ranks first in respect of cotton production. Though the area under cotton and total cotton production is less in Tamil Nadu, the maximum number of mills and a maximum yield per hectare can be seen in this state.

Data

The secondary data published by Kothari's Economic and Industrial Guide of India have been used for this analysis. The data on the volume of sales and inventories have been collected for a period of one decade i.e., from 1976 to 1986. Both sales and inventories have been measured in monetary units i.e., in rupees; they have been defined in the guide as follows :

Inventories Inventories include stocks of raw-material, components, finished goods, loose tools, goods-in-transit, stores, goods-in-progress and such other items as are generally listed under inventories.

Sales It includes sales of finished goods, processing charges, service charges and such other items as are identified as income.

The Model

A linear regression model has been used in this study which is of the form :

$$I = a + b\,(S) + u$$

where

I = Inventories

S = Sales

a and b = Parameters and

u = Random term

The equation given above does not strictly hold good in the practical situation because of the randomness of the observed phenomenon. The linear approximation is basically used to explain the movement of the dependent variable within the region over which the linear approximation is assumed to be valid, but not outside the region. (Intriligator, 1978).

Using the above equation, both cross-sectional and time series models have been tried for the three states separately. The cross-section analysis for each year from 1976 to 1986 for each state have been tried by using the data of various cotton mills. The number of observations vary from year to year because of non-availability of data for the same number of cotton mills in the subsequent years. This may be one of the limitations of the present study.

Time series analysis for the period 1976 to 1986 has also been done for each state separately. For this

TABLE 1 **Cotton Data for Gujarat**

	Area Under Cotton (in 000 Hect.)	Cotton Production (in bls of 170 kgs. in 000s)	Yield per Hect. (in kgs.)	Cotton Consumed for Khadi Production (in bls of 180 kgs.)	Cotton Produced by CCI (in bales)	Cotton Consumed for Khadi/ Total Production (%)	Purchase by CCI/ Total Production (%)	Contribution to CCI (%)	Area under Cotton/ Area under Cotton in India (%)	Share of Cotton Production in India (%)
1975-76	1778	1677	160	—	44650	—	2.66	29.87	24.19	28.02
1976-77	1726	1630	161	4953	121471	0.32	7.45	22.71	25.07	27.92
1977-78	1829	1942	181	4367	111862	0.24	5.76	16.77	23.25	26.81
1978-79	1759	2102	203	5095	267374	0.26	12.72	25.80	21.67	26.41
1979-80	1717	1785	177	5928	164699	0.35	9.23	14.78	21.13	23.34
1980-81	1572	1714	185	7881	215471	0.49	12.57	18.27	20.09	24.45
1981-82	1531	2095	233	8832	242150	0.45	11.56	22.94	19.00	26.57
1982-83	1496	1548	176	9712	211051	0.66	13.63	21.74	19.01	20.54
1983-84	1399	1445	176	8219	94541	0.60	6.54	18.01	18.12	22.62
1984-85	1383	2069	254	7502	124730	0.38	6.03	18.65	18.73	24.32
1985-86	1404	1987	241	8622	496571	0.46	24.99	31.56	18.52	23.07

Source : Indian Cotton Annual, Various Issues.

TABLE 2 **Cotton Data for Maharashtra**

	Area under Cotton (in 000 Hect.)	Cotton Production (in bls of 170 kgs. in 000s)	Yield per Hect. (in kgs.)	Cotton Consumed for Khadi Production (in bls of 180 kgs)	Cotton Produced by CCI (in bales)	Cotton Consumed for Khadi/ total Production (%)	Purchase by CCI/ total Production (%)	Contribution to CCI (%)	Area under Cotton/ area under Cotton in India (%)	Share of Cotton Production in India (%)
1975-76	2310	772	57	—	—	—	—	—	31.43	12.97
1976-77	2120	833	67	723	—	0.09	—	—	30.79	14.27
1977-78	2314	1263	93	646	134687	0.05	10.66	20.19	29.42	17.44
1978-79	2509	1317	90	844	59639	0.07	4.53	5.79	30.90	16.55
1979-80	2588	1695	111	739	—	0.05	—	—	31,84	22.16
1980-81	2667	1269	81	931	—	0,08	—	—	34.09	18.10
1981-82	2710	1465	92	1206	—	0.09	—	—	33.64	18.58
1982-83	2648	1609	103	1318	—	0.09	—	—	33.64	21.36
1983-84	2685	814	52	1036	—	0.13	—	—	34.78	12.74
1984-85	2685	1467	93	1284	—	0.09	—	—	36.37	17.24
1985-86	2753	1894	117	1304	—	0.07	—	—	36.31	21.99

Source : Indian Cotton Annual, Various Issues.

TABLE 3 Cotton Data for Tamil Nadu

	Area Under Cotton (in 000 Hect.)	Cotton Production (in bls of 170 kgs. in 000s)	Yield per Hect. (in kgs.)	Cotton Consumed for Khadi Production (in bls of 180 kgs.)	Cotton Produced by CCI (in bales)	Cotton Consumed for Khadi/ total Production (%)	Purchase by CCI/ total Production (%)	Contribution to CCI (%)	Area under Cotton/ area under Cotton in India (%)	Share of Cotton Production in India (%)
1975-76	208	253	207	—	23229	—	9.18	15.54	2.83	4.25
1976-77	240	348	246	14678	28881	4.47	8.30	5.40	3.49	5.96
1977-78	325	538	282	16174	35780	3.18	6.65	5.36	4.13	7.43
1978-79	347	569	278	12461	81951	2.32	14.40	7.91	4.27	7.15
1979-80	280	387	234	13594	41560	3.72	10.74	3.73	3.45	5.06
1980-81	223	265	202	13199	84971	5.27	32.06	7.20	2.85	3.78
1981-82	240	278	197	14354	72302	5.47	26.01	6.85	2.98	3.53
1982-83	191	248	221	15328	38154	6.54	15.38	3.93	2.43	3.29
1983-84	178	262	250	16995	24291	6.87	9.27	4.63	2.31	4.10
1984-85	253	585	393	18155	31044	3.29	5.31	4.64	3.43	6.88
1985-86	261	549	358	17513	25992	3.38	4.73	1.65	3.44	6.37

Source : Indian Cotton Annual, Various Issues.

TABLE 4 Cotton Data : All India

	Area Under Cotton (in 000 Hect.)	Cotton Production (in bls of 170 kgs. in 000s)	Yield per Hect. (in kgs.)	Cotton Consumed for Khadi Production (in bls of 180 kgs.)	Cotton Produced by CCI (in bales)	Cotton Consumed for Khadi/ total Production (%)	Purchase by CCI/ total Production (%)	Exports (170 kgs) in 000 bales)	Exports/ Total Production (%)
1975-76	7350	5950	139	—	149503	—	2.51	405	6.81
1976-77	6885	5839	144	51249	534863	0.93	9.16	10	0.17
1977-78	7866	7243	157	52984	667189	0.77	9.21	15	0.21
1978-79	8119	7958	166	55061	1036403	0.73	13.02	270	3.39
1979-80	8127	7648	160	63406	1114117	0.88	14.57	531	6.64
1980-81	7823	7010	152	73594	1179425	1.11	16.82	697	9.94
1981-82	8057	7884	166	78324	1055746	1.05	13.39	400	5.07
1982-83	7871	7534	163	87166	970760	1.23	12.89	665	8.83
1983-84	7721	6387	141	86954	524864	1.44	8.22	357	5.59
1984-85	7382	8507	196	87983	668694	1.10	7.86	179	2.10
1985-86	7581	8612	193	85328	1573632	1.05	18.27	453	5.26

Source : Indian Cotton Annual, Various Issues.

purpose average sales and average inventory have been calculated for each year. This has been calculated by dividing the total sales and inventories by the number of cotton mills. The use of total sales and total inventories will be misleading because the number of mills are not same for each year. Hence to avoid the distortions, average sales and average inventories have been used.

Results of Cross-Section Analysis

The estimated cross-section results have been given in Tables 5—7. The regression coefficient b which explains the level of changes in the inventories for a unit change in the sales assumed a positive sign in all the three states and satisfied the theoretical expectation. The magnitude of the value of b varied much in Gujarat i.e., between 0.17 and 0.32, when compared to Maharashtra and Tamil Nadu. This implies that the cotton mills in Gujarat could easily adjust their level of inventories according to sales. The larger production of cotton in this state might have facilitated greater flexibility in the procurement of raw materials by mills.

Theoretically, firms are expected to keep a minimum level of inventory even if there are no sales, under the assumption that lack of demand for a product is a short term phenomenon. The intercept term a in the model gives the level of inventories to be maintained in a situation where there are no sales. The estimated value of this coefficient for Gujarat assumed positive sign for all the years except for the period 1979 to 1981 during which period it turned out to be negative. But in the economic sense, a negative inventory is meaningless. In the case of Tamil Nadu

TABLE 5 Cross Section Estimates—Gujarat

	N	a	b	R^2	F
1976	19	54.28 (1.88)	0.20 (10.61)	0.87	112.68
1977	20	32.75 (1.20)**	0.19 (13.14)	0.91	172.73
1978	17	81.46 (1.79)*	0.17 (7.62)	0.79	58.00
1979	25	—35.33 (—1.68)*	0.24 (4.25)	0.98	162.08
1980	17	—88.51 (—2.45)	0.26 (12.50)	0.96	111.40
1981	13	—110.99 (—1.62)*	0.32 (7.97)	0.83	53.79
1982	20	100.52 (1.20)**	0.19 (12.53)	0.90	156 89
1983	18	252.76 (2.60)	0.18 (9.68)	0.85	93.78
1984	21	285.84 (1.84)	0.17 (5.44)	0.61	29.61
1985	15	285.16 (1.62)*	0.21 (6.35)	0.76	40.36
1986	15	319.71 (2.01)	0.17 (5.31)	0.70	28.14

Figures in Parentheses are t values.
* indicates significant at 10% level.
** indicates significant at 15% level.
Other t and F values are significant at 5% level.

TABLE 6 Cross-Section Estimates—Maharashtra

	N	a	b	R^2	F
1976	20	134.32 (2.22)	0.22 (11.84)	0.89	140.25
1977	20	158.79 (3.09)	0.21 (15.91)	0.93	253.15
1978	20	171.53 (3.20)	0.19 (16.12)	0.94	260.00
1979	15	93.57 (1.41)*	0.21 (13.75)	0.94	189.08
1980	11	21.14 (0.45)**	0.23 (11.59)	0.94	134.38
1981	18	90.05 (1.57)*	0.16 (6.32)	0.71	39.94
1982	26	141.84 (1.62)*	0.20 (11.67)	0.85	136.26
1983	20	216.50 (1.65)*	0.25 (8.54)	0.80	72.92
1984	20	230.97 (2.26)	0.20 (8.85)	0.80	78.37
1985	20	267.89 (2.72)	0.15 (16.64)	0.94	276.99
1986	15	231.94 (2.23)	0.18 (7.31)	0.84	53.39

Figures in Parentheses are t values.
* indicates significant at 10% level.
** indicates significant at 15% level.
Other t and F values are significant at 5% level.

TABLE 7 Cross-Section Estimates—Tamil Nadu

	N	a	b	R^2	F
1976	37	−15.63 (−1.77)*	0.26 (18.14)	0.90	310.79
1977	30	−10.90 (−0.78)***	0.23 (8.24)	0.71	67.91
1978	30	−5.44 (−0.46)***	0.22 (10.34)	0.79	106.83
1979	20	28.39 (1.42)*	0.19 (6.80)	0.72	46.28
1980	21	13.51 (1.11)**	0.18 (10.33)	0.85	106.63
1981	25	23.87 (1.19)**	0.19 (10.68)	0.83	114.09
1982	14	85.68 (1.12)**	0 18 (4.96)	0.67	24.61
1983	13	30.98 (0.44)***	0.22 (7.20)	0.82	51.79
1984	12	93.19 (2.01)	0.27 (7.81)	0.86	61.06
1985	11	30.71 (0.63)***	0.20 (10.42)	0.92	108.51
1986	9	63.23 (1.25)**	0.18 (9.05)	0.92	81.89

Figures in Parentheses are t values.
* indicates significant at 10% level.
** indicates significant at 15% level.
*** indicates not significant.
Other t and F values are significant at 5% level.

also, the coefficient assumed a negative sign during 1976-1978. These coefficients are positive in all the years for Maharashtra.

The coefficient of determination i.e., R^2, which is a measure of the extent of movement in the dependent variable that is explained by the independent variables, is quite high i.e., above 61 percent for Gujarat, above 71 per cent for Maharashtra and for Tamil Nadu it is above 67 percent. The estimated values of a and b, and also R^2 have been proved statistically significant by 't' and 'F' tests respectively.

The cross-section analysis in general reveals that Maharashtra, maintained positive inventories throughout the period and hence the addition to the inventories for a unit increase in the sales was less. In Gujarat and Tamil Nadu the stock of inventories fluctuated much and hence additions to inventories for a unit increase in salesw as more. The influenee of sales on inventories was very high when the stock of inventories declined to zero.

It can be concluded from the above analysis that the minimum required level of inventories will be less where the quantity of sales is less and vice-versa. The influence of sales on the level of inventories will be more or less same at any particular point of time irrespective of the level of sales, production of raw materials, or the number of firms. The influence of sales on inventories will be slightly more when the stock of inventories approaches zero and vice-versa.

Results of Time Series Analysis

The estimates of the time series analysis (Table 8) reveal that the influence of sales on inventories is more in Gujarat (0.26) and in Tamil Nadu (0.24) when compared to Maharashtra (0.18). The minimum required level of inventories on an average was negative in the former states. The explanatory power of the models estimated is quite high i.e., above 84 percent. The model as well as the parameters have emerged statistically significant and they have been confirmed by 'F' and 't' tests respectively.

The estimates of the time series analysis substantiate some of the observations drawn from the cross section analysis. Further, they reveal that the states, like Gujarat and Tamil Nadu, with more of raw-material production and or with a larger number of firms could achieve economies of cost over a period of time by keeping lower levels of stocks of inventories. But states like Maharashtra had to keep higher levels of inventories in order to run the industries which involves additional cost for the industries. This leads to the cost difference among the industries in different states which in turn leads to the concentration of industries in states like Tamil Nadu where there is an economic gain. If this process continues the industries in other states may slowly disappear. Further, concentration of an industry in a particular state, may, after a certain level, leads to diseconomies of scale.

In order to reduce the concentration and the regional disparities, the Cotton Corporation of India

TABLE 8 Results of Time Series Analysis

	N	a	b	R^2	F
Gujarat	11	−64.80 (−1.65)*	0.26 (20.42)	0.98	416.96
Maharashtra	11	230.31 (2.38)	0.18 (6.91)	0.84	47,76
Tamil Nadu	11	−11.48 (−11.48)	0.24 (26.44)	0.98	699.09

Figures in Parentheses are 't' values.
* indicates significant at 10% level.
Other t and F values are significant at 5% level.

(CCI) has to undertake the task of buying the entire production directly from the farmers through regulated markets. The CCI should also channelise the distribution of cotton to all the states. The distribution should be made in proportion to the number of cotton textile industries in each state in order to avoid discrimination. This will go towards reducing the cost of idle inventory.

But the present situation is not encouraging. For example, more than 80 percent of the cotton produced in the country has been purchased by the private traders and the CCI has purchased less than 20 percent during 1976-86 (Table 4). So any attempt by the government in the field of cotton textiles should be through CCI and the latter has to be made more active.

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Structural Transformation Towards Stagnation : An Overview Kerala Economy

Jose Sebastian

This paper is addressed to the unique development experience of Kerala. Over the last two decades Kerala economy has been undergoing a process of structural transformation. There has taken place a marked shift in the sectoral composition of workforce and state domestic product from primary sector to the secondary and tertiary sectors. But the structural change, instead of leading to economic development, resulted in the stagnation of primary and secondary sectors. The paper seeks to inquire into the nature and causes of the present crisis.

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It is generally held that economic development is accompanied by structural transformation. The term denotes the shifts in the contribution of different sectors to total output and also in the proportion of employment in agriculture in favour of secondary and tertiary sectors (Kuznets, 1972; Clark, 1960). Though the term is used in the context of countries, the generalizations may be applicable to regional economies within a country as well. Attempts have been made to put forward a 'Kerala model of development' and to suggest it as a replicable model for other less developed countries. At the same time, the trends in production and productivity in various sectors suggest that the economy of the state is moving towards stagnation. In the present paper an attempt is made to examine the salient features of Kerala's development pattern and to inquire into the nature and causes of the present crisis.

The most noteworthy feature of Kerala's development pattern is the achievements in various social and infrastructural fields. These achievements are far ahead of most Indian States and in some instances even comparable to that of developed countries. In Table 1 some of the selected development indicators of Kerala and India are presented. In most of the indicators, Kerala is far ahead of India. The demographic and infrastructural indicators present the picture of a fairly developed econmy; but a closer look at the structure of Kerala economy provides an entirely different picture—a picture of stagnant productive sectors which co-exist with a growing tertiary sector.

TABLE 1 Development Indicators—Kerala and India

Sl. No.	Indicator	Unit	Kerala	India	Reference period
1.	Per capita SDP/NDP	Rs.	1951	2180	1983-84
2.	Per capita consumer expenditure	Rs.	1837.65	1537.50	1982-83
3.	Per capita consumption of nonfood items	Rs.	713.58	552.85	1982-83
4.	Birth rate	per 1000 people	22.9	32.7	1985
5.	Death rate	per 1000 people	64	76	1985
6.	Infant morality rate	per 1000 birth	32	102	1986
7.	Life expectancy	years	66	54	1981
8.	Growth rate of population	percent/annum	1.9	2.5	1980-81
9.	Population below poverty line	percent	26.8	37.4	1983-84
10.	Literacy rate	percent	70.4	36.2	1981
11.	Road length	per 000 square km	2744	470	1981-82
12.	Vehicles registered per lakh of population	No	966	981	1984-85
13.	Per capita bank deposits	Rs.	1559	1396	1987
14.	Total rural assets per family	Rs.	80,000	35,000	1981-82
15.	Physical quality of life Index	No	50	29	1961
16.	Index of infrastructure Development	No	140	100	1985-86
17.	Villages electrified	percent	100	73	1988 January
18.	Per capita domestic power consumption	KWH	32.2	25.3	1986-87
19.	Non agricultural workers as a percent of total work force	percent	59	33	1981 Census

Source: Central Statistical Organization, Statistical Abstract of India, various issues

Table 2 shows that production in the primary sector has registered an absolute decline in 1983-84 over 1970-71. The performance of the secondary sector is better; but only when compared to the primary sector. The tertiary sector, on the other hand, is having a higher growth rate than primary and secondary sectors. The State domestic product has registered a growth rate of only 2.05% per annum. But for the decline in population, the percapita income would have registered an absolute decline.

For a deeper understanding, we may consider the sectoral distribution of work force and State domestic product. For purposes of comparison the corresponding All India magnitudes are also presented in Tables 3 and 4.

TABLE 2 **The Indices of domestic product and their growth rates for important sectors**

Sector	Index of domestic product 1983-84 (1970-71=100)	Annual growth rate
Agriculture	96.46	−0.14
Forestry	40.38	−5.03
Fishing	100.35	−2.22
Primary sector	95.73	−0.28
Industry	135.96	2.41
Construction	184.21	4.09
Electricity and irrigation	301.78	10.23
Secondary sector	154.16	3.41
Transport and communication	232.51	6.36
Trade, Hotels and restaurants	129.34	1.47
Banking	315.10	7.93
Public Administration	343.27	9.22
Tertiary sector	180.25	4.14
State domestic product	131.81	2.05
Percapita income	104.38	0.30

Source : T.N. Krishnan (undated).

Table 3 shows that during the period 1961-81, the percentage of main workers to total population registered a decrease for both India and Kerala though the former always stood above the latter. This means that not only the work participation rate of Kerala is below that of India but over the period it has been steadily falling. Coming to the sectoral distribution of workers, we find that the percentage of cultivators to total main workers is much higher for India than for Kerala. At the same time the percentage of agricultural labourers in the total main workers is somewhat higher for Kerala than for India. On the other hand, the percentage of workers in the nonagricultural secotrs is substantially above India in all the three censuses.

We may, now, relate the distribution of work force to the sectoral composition of State domestic product.

Some Structural Features

Though the percentage of work force employed in the primary sector is much higher for India than for Kerala, the percentage share in domestic product is more or less similar. The disproportionate share of the primary sector of Kerala in domestic product may be explained by the predominance of cash crops whose value of output is much higher than that of food crops. On the other hand, the secondary and tertiary sectors in which more than 50% of the total work force is employed contribute around 30 to 35% of State domestic product only. The corresponding figures

TABLE 3 **The Distribution of Workforce for Kerala and India 1961-81**

Percentage of	Kerala			India		
	1961	1971	1981	1961	1971	1981
Main workers to total population	33.3	29.12	26.68	42.98	33.06	33.45
Cultivators to total main workers	20.92	17.80	13.07	52.49	43.07	41.58
Agricultural labourers to total main workers	17.38	30.69	28.23	17.05	26.71	24.94
Household industry workers to total main workers	8.68	4.28	3.69	6.40	3.57	3.47
Other workers to total main workers	53.02	47.23	55.01	24.06	26.65	30.01

Source : Census of India, Various issues.

marketed surplus of these crops have increased the market participation by rural households.

Net Imports

But the industrial sector of Kerala failed to exploit the tremendous potentialities of the consumption boom. Only a small proportion of the total demand for manufactured consumer goods is met by the industrial sector of Kerala. As a result, a major part of the manufactured consumer goods has been imported from other states. According to a study conducted by the State Planning Board (1980) on the trade balance of Kerala, the State experienced an adverse balance of trade in 1975-76. Aggregate imports exceeded aggregate exports by about Rs. 165.55 crores. A 1983 study on interstate movement of goods by road for the year 1980-81 by the Directorate of Economics and Statistics showed that the value of incoming goods was Rs. 1990 crores while the value of outgoing goods was only Rs. 1381 crores. According to the study, the incoming goods were mainly finished consumer items the outgoing goods were agricultural products, raw materials and petroleum products. The adverse trade points towards the fact that the State has become a market for manufactured products from elsewhere. The comparatively higher growth rate of transport and communication and banking has to be viewed in this background.

As for the achievements in various social and infrastructural fields, the explanation has to be sought from the socio-political and cultural roots of Kerala. The high level of male as well as female literacy combined with widespread public health facilities explains the better demographic indicators of the State. The activities of the various social and political movements compelled the popular governments to initiate and carry out a number of infrastructural facilties. Thus, it appears that the achievements in various fields are largely influenced by factors unrelated to the level of economic development in the State.

But can Kerala sustain her achievements for long with the slender production base? Recent developments suggest that this will be a remote possibility unless some fundamental changes take place in the structure of the economy. A good number of migrants working in the Gulf countries have returned and more and more people are expected to return within a short period. The flow of remittances is fast drying up. Already educated unemployment is a pressing problem for the State. According to the National Sample Survey (N.S.S) 38th Round (1983) Survey, Kerala has the highest rate of unemployment in the country. The estimates of the Department of Employment shows that in 1984 there were 23-35 lakhs applicants on the live registers of employment exchanges. The Gulf returnees will aggravate the already precarious employment situation in the state.

Some Lessons

The solution to the present malady lies in the exploitation of the employment and income potential in the primary sector. The development of agriculture will rejuvenate the existing agro-based industries like coir, cashew and coconut. The income, thus, generated will widen the already existing market for consumer goods and may further accelerate the pace of industrialisation in the State. Though the strategy appears to be simple, there are a number of obstacles to be overcome in its actual implementation.

The lesson that may be drawn from the development experience of Kerala is very obvious—economic development in the ultimate analysis is dependent on the activization of the productive sectors. And the overall socio-economic progress which is not rooted in the productive sectors is not sustainable in the long run.

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The Electricity (Supply) Act, 1948 provided for the creation of state electricity boards (SEB), charged with the responsibility of generation, transmission and distribution of electricity in the state. This Act also envisaged the creation of a central body, the Central Electricity Authority (CEA), with the responsibility

NPC PERIODICALS

of evolving a national power policy as well as co-ordinating the activites of the power sector in the country. The CEA has also been given the responsibility of providing technical advice to the electricity boards regarding the formulation of projects for power development.

In addition to the SEBs, the Central Government plays a direct role in the power programme through: (a) Damoder Valley Corporation: (b) Neyveli Lignite Corporation: and (c) Nuclear Power Projects. By an amendment to the Act in 1976, the National Thermal Power Corporation (NTPC), the National Hydro-electric Power Corporation (NHPC) and North-Eastern Electric Power Corporation (NEEPCO) were set up to construct power stations, exploit economies of scale and cater to the needs of several states.

Transmission and distribution of power is the responsibility of the state electricity boards. Due to diversity in consumption patterns between states as well as variations in generation mix, transfer of power between the states takes place during different times of the day as and when the need arises. The need to promote regional integration of power systems to ensure optimum utilization of scarce national resources was strongly felt. Keeping this in view, the country was divided into five regions and Regional Electricity Boards were set up in Delhi, Bombay, Bangalore, Calcutta and Shillong to act as nodal agencies to monitor inter-state exchanges of power. The ultimate objective is, of course, to integrate the activities of these boards to form a national grid.

Growth of Electricity Supply and Demand

Installed capacity The installed capacity has doubled between 1970-71 and 1980-81 and again between 1980-81 and 1987-88. The installed capacity in the country as at the end of March 1988 was 54195 MW (hydro-17215 MW; thermal-35650 MW; nuclear-1330 MW). Details pertaining to growth in installed capacities over the years is given in Table 1. A State-wise breakup is given in Annexure 1.

It is quite obvious that most of the states are dependant predominantly on either hydro or thermal sources. The share of hydro in the total installed capacity for all-India has fallen from 43 percent in 1970-71 to 32 percent in 1987-88. This is the situation inspite of the emphasis by the Rajadhyaksha Committee (Government of India, 1980) on adding more hydro capacity, mainly as a backup for shortfalls in thermal generation, as also to meet peaking demand. The Rajadhyaksha Committee also cautioned against placing extra emphasis by some states on hydel power (e.g. Karnataka, Orissa), as a failure of monsoons can and did have disastrous consequences.

Gross energy generation Gross energy generation has grown at an average rate of 10 percent during the period 1960-61 to 1987-88 (Table 1). The share of thermal generation has also increased over the years, from 53.7 percent in 1960-61 to 74 percent in 1987-88. Thermal generation accounts for 91 percent of the total generation in the western region; the figures for the other regions are: eastern region, 87 percent; northern region, 62 percent; southern region 59 percent and north-eastern region, 56 percent.

TABLE 1 **Installed capacity and energy generation (1960-61 to 1987-88)**

Year	Installed capacity		Energy generation	
	MW	% thermal	GWh	% thermal
1960-61	4653	58.8	16937	53.7
1965-66	9027	54.3	32990	53.8
1970-71	14709	53.7	55827	50.4
1975-76	20117	54.7	79230	54.7
1980-81	30214	58.1	110844	55.3
1985-86	46769	64.1	170350	67.1
1986-87	49265	64.4	187799	68.7
1987-88	54195	65.8	201753	74.0

Source : TERI, (1988).

Energy consumption Over the last three decades, electricity consumption has grown at a faster rate as compared to the growth of oil and coal. While electricity consumption grew at 8 percent compound during the period 1970-71 to 1986-87, the growth

rates for oil and coal were 5.5 percent ant 5.0 percent respectively. There has been a structural change in the consumption pattern across various categories over the years (Table 2) :

(a) There has been a marked increase in the share of electricity consumed by the agricultural sector (from 5.0 percent in 1960-61 to 21.0 percent in 1986-87).
(b) The share of industries has declined from 74.5 percent in 1960-61 to 61.8 percent in 1980-81. The share went down further, to 52.8 percent in 1986-87.
(c) The share of residential and commercial sectors has increased from 14 percent in (1960-61) to 20 percent in 1986-87.

TABLE 2 **Breakup of energy consumption across different consumer categories**

(GWh)

Year	Agriculture	Industry	Domestic & Commercial	Others
1960-61	833	12455	2340	1083
	(5.0)	(74.4)	(14.0)	(6.5)
1970-71	4470	34291	6412	3262
	(9.2)	(70.8)	(13.2)	(6.8)
1980-81	14489	55363	13928	5881
	(16.1)	(61.8)	(15.5)	(6.6)
1984-85	21194	73455	22001	7946
	(17.0)	(58.9)	(17.7)	(6.4)
1986-87	28218	71496	27235	9132
	(20.7)	(52.8)	(19.9)	(6.6)

Source : Central Electricity Authority (1987).
Figures in brackets indicate percentages.

Recognizing tne important role played by electricity in development, the SEBs have embarked on a massive electrification programme in the rural areas. States such as Punjab and Haryana have already achieved 100 percent village electrification. Gujarat, Andhra Pradesh and Karnataka have planned for 100 percent village electrification by 1989-90. States in the north-eastern region, Utter Pradesh, Orissa and Bihar would still have substantial scope for electrification. The large scale rural electrification programme has its impact on the performance of the boards and this will be discussed in the subsequent sections.

Reliability of Power Supply

The power supply position in the country has moved from a power surplus state in the early sixties to a deficit one from late seventies onwards. The peak demand in the country registered a growth rate of 8.4 percent during the period 1960-61 to 1985-86. It must be stated, here, that of peak demand only indicates the availability rather than the unrestricted peak demand mainly because peak demands in almost all the state electricity boards have been suppressed due to power shortages.

Cuts are imposed both on energy consumed as well as on maximum demand (for details of power cuts imposed, see Annexure 2). The sectors which are affected the most are the industries and agriculture. The agriculture sector resorted to rostering of loads to manage power demand. As against this, the industries sector installed captive diesel generating, sets in order to avoid cut-backs in production. It is not uncommon to find industries meeting almost 100 percent of their demand through captive sources.

The SEBs undertook large scale rural electrification programmes only to find that there was no power for supply to rural areas. The actual load growth in the rural areas was far higher than the projected figures. As a result, rural consumers have had to go without electricity for the major part of the day. By rostering, electricity is supplied for 6-8 hours during the day. Again, the better off farmers have standby diesel generating sets for use in the farms when power is not available. This is an option which is very expensive for the economy.

One of the major reasons for shortfalls in supply has been the substantial slippages in the addition of capacity (see Table 3). Targets are set, only to be revised downwards; even this revised target is often not met. Simultaneously, the expenditure in each Plan period has exceeded the outlay for the sector. Both cost and time over-runs have become a common

TABLE 3 Plan-wise slippage in additions to installed capacity

Plan	Target (MW)	Achievement (MW)	Slippage (%)
First Plan (1951-56)	1300	1100	15.4
Second Plan (1961-61)	3500	2250	35.7
Third Plan (1961-66)	7040	4520	35.8
Annual Plan (1966-69)	5430	4120	24.1
Fourth Plan (1969-74)	9264	4579	50.5
Fifth Plan (1974-79)	12499	10202	18.4
Annual Plan (1979-80)	2945	1799	38.9
Sixth Plan (1980-85)	19666	14226	27.7
Seventh Plan (1985-87)	7856	6848	12.8

Source : TERI, (1988).

feature. The gestation period for thermal stations range from 60 to 84 months, while that for hydel stations from 80 to 145 months. The record for nuclear power stations is again of the order of 150 to 180 months.

Delays in materials procurement and in boiler/ turbine deliveries, the practice of tendering and re-tendering for major equipment, getting environment, clearance, and the responsbility to resettle displaced population etc. have all contributed to the delays in commissioning. There have been changes in designs of sub-systems, plant layout and civil construction and these have added to shortfalls in capacity additions. The Bureau of Indian Standards has recently initiated steps, in collaboration with CEA, NTPC, BHEL etc. for standardizing plant layouts, civil construction etc. in order to minimize construction period for thermal power stations. This is one of the major thrust areas that the SEBs would have to address for reducing the power shortages in the state.

Transmission and Distribution

The growth of the transmission and distribution network (T & D) in the Indian power sector has not kept pace with generation facilities. There have been several intances when generation had to be backed down due to poor reliability of the T & D network. This has only added to the already existing power deficit situation in the country. The Rajadhyaksha Committee (1980) had recommeneded that 50 percent of the total outlay for the power sector should be for T & D facilities. As against this the actual outlay for T&D during the Sixth and Seventh Five Year Plans has been about 38 percent only.

Losses in the T & D network continue to be a matter of serious cocern. T & D losses have actually increased over the years, from 17.5 percent in 1970-71 to 21.5 percent in 1986-87 (for state-wise details, see Annexure 3). Inadequate provision for the T & D network is one of the major resasons for this situation. Also, distribution lines have been laid without due planning, a result of haphazard growth of load centres, thus leading to overloading of the network and contributing to higher losses.

There is a problem in estimating losses in the T & D network. Consumption for all consumer categories, except agriculture is taken from energy billed. For agriculture, this is not possible since consumption is not metered in most of the states. Hence, consumption is estimated based on assumed hours of operation and, thus, the balancing figure of losses is arrived at. Hence, losses could always be offset against agricultural consumption, to a limited extent, thus, distorting the picture.

Performance of Thermal Power Stations

Plant load factor As mentioned earlier, the share of thermal energy in gross energy generation has gradually increased from 55 percent in 1980-81 to 74 percent in 1987-88. There has also been a gradual improvement in the plant load factor of thermal power stations over the years (see Table 4).

Measures to improve plant load factor mainly by way of better maintenance management has yielded results. From a low of 44.2 percent in 1980-81, PLF of thermal power stations has gradually but steadily increased to 56.5 percent in 1987-88. The modernization and renovation programme undertaken by the

TABLE 4 All-India plant load factor in thermal power stations, 1975-76 to 1987-88

Year	P.L.F. (%)
1975-76	52.16
1976-77	55.47
1977-78	50.98
1978-79	47.99
1979-80	44.30
1980-81	44.21
1981-82	46.42
1982-83	49.43
1983-84	47.94
1984-85	50.15
1985-86	52.46
1986-87	53.27
1987-88	56.58

Source : Central Electricity Authority, (1988).

SEBs are also largely responsible for the improvement in PLF of some of the older power plants. Also, there has been a significant change in the unit size of thermal power stations and this has enormously assisted the SEBs in increasing the PLF. The improvement in PLF has come mainly from unit sizes of 200 MW and above. Most of the power plants in this category have achieved PLF of over 70 percent (Vijayawada, 92.4 percent; Singarauli, 79.7 percent; Trombay, 79 percent; Tuticorin, 77.3 percent). Also, the average for units in the range of 500 MW has also been substantially high. As against 79.5 percent in 1986-87, the PLF of this category of units have increased to 87 percent in 1987-88 (for details, see Table 5).

Coal and oil consumption The SEBs have had serious problems relating to poor quality of coal and this has resulted in higher coal and oil consumption in the thermal power stations. Data on coal and oil consumption for some SEBs is given in Table 6. It

TABLE 5 Performance of thermal generating units (20 MW and above) during 1987-88 vis-a-vis programme and during 1986-87

Capacity group	No.	Capacity (MW)	P.L.F. (%)		
			Actual 1986-87	Prog. 1987-88	Actual 1987-88
500 MW	6	3000.0	75.9	51.1	87.0
200/210 MW	77	16050.0	59.6	57.5	63.7
140/150 MW	9	1270.0	51.1	53.3	57.3
120 MW	20	2400.0	40.7	46.3	37.1
110 MW	36	3960.0	44.8	47.9	48.4
100 MW	11	1100.0	51.4	48.8	48.4
70/80 MW	7	540.0	36.7	43.5	38.5
62.5/63.5 MW	19	1191.5	57.4	55.7	55.5
60 MW	25	1500.0	50.4	54.6	47.1
50/55 MW	31	1565.0	50.5	49.4	53.3
20-40 MW	33	956.0	45.0	52.2	38.0
Total	274	33532.5	53.2	53.5	56.5
Units less than 20 MW & G.T.		1730.5	—	—	—
Total		35263.0	53.2	53.5	56.5

Source : Central Electricity Authority (1988).

TABLE 6 Coal and oil consumption in some SEBs

Board	1984-85	1985-86	1986-87
Coal (kg/kWh)			
MPEB	0.767	0.79	0.88
APSEB	NA	0.72	0.76
TNEB	0.62	0.67	0.70
HSEB	0.63	0.90	0.86
UPSEB	0.83	0.83	0.81
ASEB	0.62	0.61	0.60
Oil (ml/kWh)			
MPEB	20.26	13.18	10.97
APSEB	NA	3.39	3.24
TNEB	39.07	9.06	5.44
HSEB	24.00	28.00	32.00
UPSEB	17.58	16.01	13.79
ASEB	119.45	145.24	71.72

Source : Compiled from annual reports of State Electricity Boards.

NA—Not available.

must be noted that these figures represent averages for the state and for a detailed analysis, one would have to collect data at the power station level. However, these figures are indicative of the situation in the SEBs and are intended to give a range of consumption across power stations in the boards. While the coal consumption varies from 0.604 to 0.896 kg/kwh, oil consumption varies from a low of 5.44 ml/kwh in Tamil Nadu, to a high of 119.45 ml/kwh in Assam. These figures must be seen in the light of the quality of coal being used by different power stations in the states. While there is no data available on quality of coal being supplied, it is a well-known fact that there is a lot of exteraneous matter being supplied alongwith coal like shale, stones, overburdens etc. Oil consumption is high particularly during the rainy season, when the moisture content of coal is high and also due to frequent start-ups because of high occurrance of tube failures and forced outages. There is however considerable scope to reduce the consumption of coal to 0.65 kg/kwh and oil to 10 ml/kwh (NCPU, 1987). This would enable the boards to reduce their costs cosiderably.

Staff strength in SEBs The SEBs have generally been considered to be an outlet for employment and the senior officials of the boards often receive requests to accomodate persons even where there is no post sanctioned. Overstaffing is in the boards and the boards have expressed their inability to control this phenomenon. Table 7 gives details of employees per million units sold and per thousand consumers for

TABLE 7 Employee ratios for select utilities in India and Abroad

Board	1984-85	1985-86	1986-87
Employees per MU sold			
MPEB	7.47	6.77	6.27
APSEB	NA	5.33	4.84
TNEB	8.49	8.63	7.71
HSEB	9.00	8.50	8.08
UPSEB	8.76	8.11	7.16
ASEB	19.52	17.84	17.66
KEB	6.22	6.56	NA
MSEB	5.22	4.59	NA
SCE	0.26	0.27	0.26
KEPCO	0.38	0.37	0.34
Employees per 1000 consumers			
MPEB	22.72	21.47	19.71
APSEB	NA	14.00	13.00
TNEB	15.71	15.23	15.06
HSEB	20.80	21.09	20.10
UPSEB	38.00	35.00	33.00
ASEB	70.69	65.73	61.00
KEB	13.28	12.68	NA
MSEB	19.18	17.53	NA
SCE	4.92	4.89	4.60
KEPCO	2.75	2.84	2.88

Source : Compiled from annual reports of State Electricity Boards.

SCE—Southern California Edison Company
KEPCO—Korea Electric Power Company
NA—Not available.

some boards and also for the Southern California Edison Company (SCE-capacity 22,000 MW, energy sold 65.5 Gwh, number of consumers 3.7 million in 1987) and for the Korea Electric Power Company (KEPCO-capacity 19,000 MW, energy sold 66 Gwh, number of consumers 7.7 million, in 1987). The two foreign utilities have been included only to give an indication of the levels at which these utilities operate. Even if one agrees that the conditions in which these utilities operate are different from those prevailing in India, there is still substantial scope for improvement. Even across SEBs in India, the range for employees per million units sold is from 4.84 to 8.08 (if one excludes a figure of 17.66 for Assam), and that for employees per 1000 consumers is from 13 to 33 (a factor of 2.53), again not including Assam. This is an important area of cost control that the SEBs would have to seriously consider, for this would greatly assist them in improving their productivity.

Finances of State Electricity Boards

The Electricity (Supply) Act, 1948, specifies that the electricity board should operate as a commercial undertaking and not incur losses in its operations as far as possible. To enable the board to do this, it could adjust its tariffs accordingly from time to time. Inspite of the autonomy given, the poor financial performance of state electricity boards continues to be a matter of concern for the central as well as state governments. Various committees have been set up in the past to review the functioning of the electricity boards and have recommended measures, from time to time, to improve their performance. One of the main reasons for this state of affairs is the high quantum of subsidy for some consumer categories. The agriculture sector continues to get the largest subsidy as far as electricity consumption is concerned. In most states, electricity supply to the agricultural sector is charged at a flat rate, which is far below the cost and in some cases it is almost free. A flat rate also encourages misuse of electricity by way of running small industries under this category.

A working group set up by the Planning Commission in 1963 had recommended that boards should earn a return of 12 percent (including electricity duty) on capital, after providing for operating expenses and depreciation. The Venkataraman Committee in 1964 recommended that the boards should earn a return of 11 percent on the capital employed, if not immediately, at least within the next ten years. This return was to be taken after providing for operating cost and depreciation, but including receipts from electricity duty, which were estimited to be 1.5 percent of the capital. In negotiations for assistance to power projects from external agencies like the World Bank, a return of 11 percent including 1.5 percent from electricity duty, on the average capital base was agreed to. This, however, was never implemented, mainly because the shortfall in achieving this rate of return was often made up by a subsidy from the state government. This enabled the boards to fulfil the obligations to the World Bank. Presently, the boards are expected to achieve a statutory 3 percent rate of return after providing for operating expenses, interest liability and depreciation. This 3 percent is to be calculated on the total capital as at the beginning of the financial year. Most of the SEBs are not even able to earn enough to meet the average cost of energy sold to their consumers.

Tariffs in SEBs

One of the major reasons for the continued poor financial health of the boards is the unremunerative tariffs for some consumer categories and the inability of the tariffs to keep up with the cost of supply. The Planning Commission has estimated that about 80 percent of the losses incurred by the boards is due to low tariffs for the agriculture sector (NCPU, 1987). While there may be reasons for giving this sector a rate below cost, there is no economic justification for the present very low tariffs that encourage misuse and inefficient use of electricity. Agriculture consumers have a flat rate per hp of connected load in almost all the SEBs and the small farmer gets electricity free (a small farmer is defined as one who owns either 2.5 acres of wet land or 5 acres of dry land and depends solely on agriculture for his livelihood). There is no metering of consumption and there are several instances of farmers running small industries with this connection. A summary of the average rates in force in the SEBs is given in Annexure 4. The other categories

who recieve electricity below cost are the domestic, LT industries and in some states the power intensive consumers also.

Several government committees have commented on the need for a rational tariffs structure which would encourage efficient use of electricity. Tariffs based on time-of-day would help in reducing consumption at peak and encourage counsumption during off-peak hours (more on this in subsequent sections). The SEBs could, to begin with, introduce inverted block rates for domestic and commercial consumers, which charges higher blocks of consumption at progressively higher rates. This would serve the double purpose of providing cheap electricity to the poorer consumers and at the same time encouraging demand management.

Future Issues Facing the Power Sector

As mentioned in the earlier paragraphs, an attempt has been made briefly to draw a profile of the power sector. We have looked at the growth in installed capacity, energy generation, structure of energy consumption across different consumer categories, as well as the technical and financial performance of the power sector. Over the last five years, there has been a gradual improvement in the performance of the state electricity boards on technical account. On the financial side, the situation is not very good. Losses have been mounting and the SEBs have found it difficult to find finances for adding to capacity. The SEBs, which form core of the power sector in India, will have to address themselves to several new issues apart from just adding to capacity and generating and transmitting the energy.

Demand Management The concept of demand management is yet to catch on. Presently demand management is restricted to staggering of holidays, enforcing energy and demand cuts mainly on HT consumers and rostering of loads in the agriculture sector. The SEBs will have to look beyond physical means of managing demand. An important area in this regard is the role of tariffs. Several developed countries have shown that price can be used to influence demand and have used tariffs effectively not only to generate resources, bot also to flatten their load curves.

Electricite de France (EdF) the leader in the area of time-of-use tariffs. In 1956, France introduced, for the first time in the world, a marginal cost based tariffs, which has progressively been modified and expanded to what is probably the most sophisticated tariff structure. The rates are based on seasons (summer and winter) and also on time-of-day. The highest rate is during the three evening peak hours in winter; this was followed by day-time "full-use" hours; and the lowest rate was levied during off-peak hours in summer. EdF has reported that the national load curve flattened by 5 percent, after a year under this pricing system. The total resultant saving, including investment in generation, T & D was estimated at more than 50 billion Franc, for the seven years following the new tariff (Meek, 1973).

Another example often quoted in literature is the case of Korea. Introducing peak load control tariffs has decreased the peak load ratio (defined as the ratio of peak load to average load during a day) from 127.3 to 119.7. As against this, the off-peak ratio increased from 79.7 to 85.7. Based on this, the Korean Electric Power Company estimated a possible saving of US$ 250 million in future investments. A number of utilities in the USA are moving towoards using peak load control tariffs to influence demand. Proposals relating to spot pricing which means that consumers are informed of prices 24-48 hours in advance are also being talked about in order to influence the demand. (for details see Ramesh and Natarajan, 1987).

Utilities in the USA have been late entrants in the area of time-of-use pricing. Nevertheless, they are increasingly becoming aware of the usefulness of TOU pricing for demand management. Several utilities have introduced TOU rates and customer awareness has reached such levels that consumers who are presently not covered under TOU rates are demanding that they be included. An interesting case is of the Pacific Gas and Electric Company, who in 1987 were ordered by the California Public Utilities Commission to install 20, 000 TOD meters across all customer

classes (California Public Utility Commission, 1988-87). The Commission deferred installation of these meters for residential consumers until 1988 when the cost of meters is expected to fall below US$ 200. Similar orders are expected to be issued to San Diego Gas & Electric Co. and Edison Light and Power in future proceedings.

In India, tariffs for different consumer categories are restricted to a simple energy rate for LT consumers and a demand and energy rate for HT consumers. A beginning has been made by Gujarat where time differentiated tariffs were introduced. However, there is no information to determine the effectiveness of these tariffs. Tamil Nadu has introduced special concessional rates for night consumption. Preliminary indications are that consumers are taking note of this incentive and are gearing up their production systems in order to avail of this benefit. Before introducing these rates, it is improtant that studies are carried out to determine consumer response for effective implementation.

Energy Conservation The utilities in India have not considered conservation as an option for adding to generation. Utilities in developed countries have benefitted by not only participating in, but also initiating energy conservation programmes in their area. The utilities have realized that by investing in energy conservation, they can avoid or postpone investments in future capacity. It is well known that the success of the concept of storage heating among residential consumers was largely due to the active support from the utilities. The utilities found that they could better utilize their capacity at higher load factors of consumers used off-peak energy to heat their homes and also released some of the demand from the daytime. Several utilities in the USA have invested in Installation of energy-efficient lighting systems, particulary in the area of street lighting. The SEBs in India should consider invesments in these areas as an option for adding to capacity.

Utilities in developed countries, especially, USA, Germany, Japan etc. have specialized officers (called "account executives" in some utilities) to initiate and follow-up on energy conservation activities in their area. This is done more for large cosumers and these executives constantly advise the consumers on ways and means to reduce their energy either through conservation or by taking advantage of off-peak concessions. This special team of executives has been responsible for the success of the energy conservation programmes in these countries.

In India, attempts at conservation, if any, have been initiated by the industries themselves, due to increased awareness of the energy shortage and also as a means to reduce there cost of operations. In a situation where industries face demand and/or energy cuts, the consumers who undertake conservation measures are the ones who are at a disadvantage. SEBs often decide on quotas based on demand and energy records of the last 12 months. This is a big disincentive for consumers who have taken steps towards conservation. On the contrary these consumers should be encouraged and one of the ways to do this would be to either restore their quotas or to determine the quota based not on the last 12 months' consumption pattern, but on the basis of a 12 month period starting 24/36 months back.

On the domestic fronts, there is an enormous potential for energy conservation by way of improving the efficiency of domestic appliances. It is a well known fact that most of the domestic appliances like water heaters, room heaters, air-coolers, fans etc. are manufactured with little or no control on quality. Even though the Bureau of Indian Standards has issued several standards relating to these appliances there is nothing done to enforce them. Another problem relates to cosumer awareness of efficient energy use. Consumers prefer to buy appliances which have lower intial costs and tend to ignore the higher energy bills that they would have to pay rather than going in for energy efficient equipment, which would cost more initially, but save on energy bills. This awareness is yet to come. Flat rates and charges on minimum consumption are levied by a few of the SEBs. This is a disincentive for the energy conservation efforts by the household consumer.

Cogeneration is another option that would assist SEBs in reducing the power shortage. SEBs should

actively encourage industries that have requirements of both steam and energy to go in for cogeneration. The sugar industries and some chemical industries have already taken the lead to generate power and steam simultaneously and some of these industries also feed the surplus energy into the grid. Again, drawing on experiences in the USA, cogeneration has forced the utilities to market their energy in a more aggressive manner, for several large consumers have been resorting to self-generation to meet their power and steam requirements. The SEBs in India now see their role as only power supplying agents and have not looked at other alternatives which would enable them to achieve their objectives. This view would necessarily have to change because it is the boards that would benefit by taking these measures.

Consumer Awareness The question relating to consumer service has to get increased attention. Utilities in developed countries have realised that any programme launched by the electric utility has a greater chance of success if the consumer is kept in the picture right from the beginning. If the consumer is informed of the costs and the likely benefits, both to him and to the utility, and the possible role that he has to play and the co-operation that he must give, utilities have found that this helps their programme enormously. To mention the Korean experience once again, peak control tariffs were not introduced overnight through an administrative order. KEPCO had a 18 month preparatory period wherein consumers were taken into confidence ragarding the new tariff structure and the benefits likely to accrue to them were highlighted and their full cooperation sought in this exercise. Experts from KEPCO spent a substantial amount of time with each HT consumer and explained to him ways by which the consumer could benefit by way of reduced costs. The utility, of course, benefits by way of optimum utilization of existing capacity.

The present Indian environment would have to change. There have been several instances where the government has had to go back on rates already increased due to pressure from consumer groups. There is a lot to be done in improving the relationships with the consumer as well as improving the image of the electric utility in the eyes of the consumer. During discussions with HT industrial consumers on peak load tariffs, the consumers expressed their lack of confidence in the board, sofaras keeping promises was concerned. They pointed out that even though they were prepared to pay a higher rate at peak time, they were not sure that the board would give them assured supply. Confidence building is a major exercise that the SEBs have to undertake during the next 2-3 years.

Energy From Renewable Technologies Energy from renewable energy technologies is an important area in the government's energy plan. The Department of Non-conventional Energy Sources which is the nodal agency for planning and implementing the renewable technology programme, in consultation with the state nodal agencies, has been making efforts to promote these technologies. The electricity boards presently perceive their responsibilities mainly as agencies for adding power stations This thinking will have to be re-evaluated. Electric utilities in India will have to take a fresh look at policies ralating to investments in renewables, as a part-substitute for adding power stations, especially in remote areas where substantial losses are to be incurred in transmission and distribution. Electric utilities in developed countries have considered investments in renewable energy sources as options for power generation especially taking into account the fact that costs of power supply are on the increase and the cost of the renewable is falling. One or two electricity boards have gone in for ventures in the area of wind farms and have done reasonably well. The SEBs stand to benefit from more such ventures.

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ANNEXURE 1 **Statewise Power Generating Capacity (1960-61 and 1986-87)**

	Installed capacity (MW)				Growth rate %
	1960-61	1986-87			
	Total	Hydro	Thermal	Total	
Dominantly Hydro					
Kerala	137	1,476	—	1,476	9.6
Himachal Pradesh	—	306	—	306	—
Meghalaya, Tripura, Manipur & Assam	19	295	495	790	—
Sikkim	—	12	—	12	—
Jammu & Kashmir	13	176	23	199	11.1
Karnataka	191	2,082	420	2,502	10.4
Orissa	136	730	470	1,200	8.7
Andhra Pradesh	270	2,442	1,825	4,267	11.2
Bhakra Beas Management Board	—	2,705	—	2,705	—
Daminantly Thermal					
Delhi	76	—	1,196	1.196	11.2
West Bengal	754	41	2,927	2,968	5.4
Haryana	11	16	635	651	17.0
Madhya Pradesh	268	115	3,452	3,567	10.5
Gujarat	333	300	3,193	3,493	9.5
Bihar	351	150	1,425	1,575	5.9
Uttar Pradesh	397	1,422	4,663	6,085	11.1
Maharashtra	760	1,556	5,875	7,421	9.2
Punjab	336	334	860	1,194	5.0
Tamil Nadu	517	1,389	2,850	4,239	8.4
D.V.C.	—	104	1,655	1,759	
Dominantly Nuclear					
Rajasthan	71	321	660	981	10.6
All-India (utilities)	—	15,962	32,624	48,586	—

Source : CMIE (1987).

Note : 1. Thermal includes nuclear capacity also.
2. The capacity for each state includes only the power plants located in the state boundaries and excludes the multi-state projects.

ANNEXURE 2 **Power Cuts/Restrictions: February 1987**

A. No Notified Power Cuts/Restrictions

States/Union Territories/Systems			
1. Madhya Pradesh	5. Bihar (a)	8. Manipur	11. Assam (c)
2. Goa	6. Damodar Valley Corporation (DVC) (b)	9. Mizoram	12. Nagaland
3. Andhra Pradesh	7. Arunachal Pradesh	10. Meghalaya	13. Tripura
4. Kerala			

(a) Though there are no notified power cuts/restrictions in Bihar, load shedding is being taken recourse to on a day-to-day basis depending upon availability of power.

(b) Power cuts/restrictions were imposed by DVC on a day-to-day basis as per their order of priority depending upon availability of power vis-a-vis the requirement.

(c) Although there are no notified power cuts in Assam, load shedding is being taken recourse to on a day-to-day basis depending upon availability of power.

B. Power Cuts/Restrictions in Force during February 1987

	Demand cut	Energy cut
Delhi	Peak period restrictions on industries	10%
Haryana	1-2 off days/week with 6 1/2—8 1/2 hrs /day supply to industries	60%
	Agricultural consumers were supplied power for 6—8 hrs/day	—
Chandigarh	Staggered weekly off days and peak period restrictions on industrial consumers	—
Jammu & Kashmir	4—19 hrs /day supply to industrial, commercial, domestic and agricultural consumers	—
Himachal Pradesh	Peak period restrictions on industries	—
Punjab	50%. Peak period restrictions on general industries	—
	Agricultural consumers were supplied power for 11½ hrs. to 24 hrs/day depending upon day-to-day availability	—
Rajasthan	Peak period restrictions on industries	80%
	Agricultural consumers were supplied power for 6—8 hrs/day	—
Uttar Pradesh	Restricted supply for certain categories of industries 1 day/week closure for general industrial consumers with peak period restrictions	35%
	Agricultural consumers were supplied power for 8 hrs./day	
Gujarat	15%—30%	—
	Rural feeders were supplied pewer for 8—22 1/4 hrs./day	

(*Contd.*)

ANNEXURE 2 (*Contd.*)

	Demand cut	Energy cut
Maharashtra	10%—15% 24 hrs. power supply to rural areas	
Karnataka	10%—20%	20—70%
Tamil Nadu	15%—40% Agricultural consumers were supplied power as per the grouping of rural feeders	15—40%
Pondicherry	15%—40% Agricultural consumers were supplied power as per the grouping of rural feeders	15—40%
West Bengal	Restricted supply to certain categories of industries and also peak period restrictions on industries	—
Orissa	75% pewer cut on heavy and power intensive industries. Large industries except State Government Undertakings were subjected to 50% power cut. However, these were permitted to draw power purchased from outside sources by OSEB (being available at present) to meet their requirement and peak period restrictions on industries.	—

Source: Central Electricity Authority, 1987.

ANNEXURE 3 **Transmission and distribution losses in SEBs**

SEB/Department	T & D Losses (%)	
	1985-86	1986-87
Haryana	19.8	20.6
Himachal Pradesh	20.2	21.0
Jammu & Kashmir	35.6	33.5
Punjab	18.8	17.0
Rajasthan	26.5	23.9
Uttar Pradesh	20.5	20.0
Chandigarh	18.9	NA
Delhi	18.0	NA
Gujarat	25.5	24.0
Madhya Pradesh	18.9	20.8
Andhra Pradesh	19.2	18.5
Karnataka	22.5	22.2
Kerala	24.6	27.5
Tamil Nadu	18.7	18.7
Bihar	22.5	22.1
Orissa	23.0	22.0
West Bengal	23.1	23.2
Assam	20.0	21.0
Manipur	45.0	37.0
Mizoram	43.6	48.1

Source: TERI (1988).

ANNEXURE 4 **Average Electricity Rates as on 31 January 1987**

(Paise/kwh)

	Domestic (30 kWh/ month)	Commercial (200 kWh/ month)	Agricultural 5HP 10Z load factor (LF) (272 kWh/ month)	Small industries 5 HP 10Z LF (272 kWh/ month)	Medium industries 50kW 30Z LF (10950 kWh/month)	Large industries 1000 kW 50Z LF (3,65,000 kWh/month)
Andhra Pradesh	51.67	96.50	9.50	56.84	55.05	69.61
Assam	65.00	105.00	50.00	49.00	94.00	102.19
Bihar	62.33	83.50	96.00	112.00	110.00	97.28
Gujarat (May to Oct.)	65.00	90.07	36.51	86,42	93.63	95.49
(Nov. to April)	65.00	90.07	36.51	86.42	98.36	99.85
Haryana	45.00	106.75	32.35	65.00	86.00	91.60
Himachal Pradesh	45.67	82.00	21.94	44.00	59.00	57.00
Jammu & Kashmir	33.08	58.90	11.50	22.70	22.70	20.40
Karnataka	55.00	156.25	11.49	96.03	88.67	81.28
Kerala	47.66	60.50	15.22	30.77	22.72	34.20
Madhya Pradesh : Urban	48.00	103.50	16.00	68.00	77.61	95.03
Rural	46.00	103.50	16.00	68.00	77.61	95.03
Maharashtra : Bombay, Pune	38.50	109.80	15.31	60.00	80.54	111.33
Other areas	37.50	104.80	15.31	60.00	80.54	98.10
Meghalaya	50.00	81.00	21.60	70.00	66.85	48.60
Orissa	56.00	95.00	22.71	57.00	65.56	87.28
Punjab	60.33	116.00	13.50	64.00	73.35	71.89
Rajasthan	58.00	96.00	29.60	69.00	83.00	85.00
Tamil Nadu : Madras	55.00	120.00	11.49	100.00	100.00	93.12
Other areas	55.00	115.00	11.49	95.00	95 00	88.12
Uttar Pradesh	74.00	104.00	55.15	92.66	87.33	103.46
West Bengal	57.00	85.00	35.00	63.50		95.45
Arunachal Pradesh	50.00	50.00		27.00	27.00	42.00
Manipur	45.00	—		25.00	25.00	
Mizoram	48.00	60.00		25.00	24.46	
Nagaland	64.00	74.00	56.00	62.00	62.00	62.00
Sikkim	46.67	64.00	64.00	64.00	64.00	38 88
Tripura	60.00	77.00	35.00	40.00	40.00	
Andaman and Nicobar Island	58.00	51.75		43.00		
Chandigarh	36.65	88.00	17.76	32.20	42.37	44.44
Dadra & Nagar Haveli	60.00	92.75	54.19	103.75	98.89	98.61
Delhi : DESU	29.00	91.00	21.00	78.00	78.00	113.73
NDMC	29.00	92.00		78.00	78.00	
Goa	40.00	82.75	25.00	50.00	63 00	68.80
Daman & Diu	60.00	83.50	45.00	55.00	63.00	72.67
Lakshadweep	60.00	60.00		40.00	32.74	
Pondicherry	55.00	135.00	16.85	72.00	72.00	70.50

Productivity Norms for Agro-Paper Mills

NPC Research Section

In India, today, there are about 66 agro-paper mills accounting for about 0.55 million tonnes of paper production out of a total capacity in the country of about 2.8 million tonnes. In this study, the NPC Research Team has attempted to measure and analyse the major productivity ratios of the sector. The study also recommends productivity guide norms. This is a part of a major study just concluded at the National Productivity Council.

Prepared by a team of specialists consisting of S.A. Khadev, Regional Director, NPC, Madras; N.K. Nair, Director (Research) and A.K. Burman, Dy. Director (Research) NPC, New Delhi and K. Venkataraman, Assistant Director, NPC, Madras.

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Importance of Agro-Paper Mills

Pulp and Paper constitutes one of the most important segments of India's industrial economy and is treated as a basic sector. Its performance is crucial to the economy to the extent that the growth of its services sector, has been crucially dependant on the supplies of printing and writing papers and newsprint in order to meet the requirements in sectors like education, communication, trade and commerce, banking and insurance, public administration etc. The industrial sector also requires paper both for packaging and for its service sector components. The prominent role of paper continued untill recently when the revolutions in micro-electronics and petrochemicals posed a challenge to this industry.

Near famine conditions prevailed in the Indian paper market during the late sixties and through the seventies alongwith the increasingly uncertain supplies of wood from the Indian forests to the integrated paper mills due to economic, enviromental and ecological reasons, led to the setting up of a large number of short gestation period, less capital intensive and less energy consuming agro-residue based paper mills throughout India. Today, there are about 66 such mills having an installed capacity of over 0.55 million tonnes out of a total industry capacity of about 2.8 million tonnes. Most of them are small in size, with less than 30 tpd, while a few of them are having a capacity of 50 tpd or more. Based on the norm of 20 persons per tonne of capacity, the agro-paper sector employs about 110 lakh mandays in both direct and indirect activities including rawmaterial handling, i.e. about 41,000 persons. Based on an average price of

Rs. 9,000 per tonne including duties and levies the gross values of production at 100% capacity utilisation works out to be about Rs. 500 crores. At an assumed capacity utilisation ratio of about 70 percent, the sector produces an output, the gross value of which will be in the range of about Rs. 350 crores in recent years. Based on a gross value added to value of output ratio of 25 percent, the sector would be contributing about Rs. 88 crores as value added per year.

Scope and Objectives of the Present Study

The total paper industry in India seemed to undergo a difficult phase, particularly after the mid Eighties. Capacity utilisation ratio of the industry continued to fall reaching an all time low of 61 percent in 1987. There were fears among the industry managements that the rate of growth in demand for output was much lower than the rate of growth in capacity. Amidst the declining profitability in the industry, a few agro-paper mills closed down their operations and a few others were declared sick. While soaring input prices added momentum to the slide down by these mills, the absence of recovery units led to their suspected viability. The tightening of anti-pollution measures by the respective State Pollution Control Boards added to the woes of this sector. It became apparent that, unless there is a remarkable improvement in the productivity of various factor inputs deployed by the sector, this group of mills would not be able to survive in the market in competition with paper substituting technologies like those from micro-electronics and petrochemicals on the one hand, and the large size integrated paper mills with economies of size and recovery systems on the other. Further there are a large number of imported waste paper based small plants which enjoy advantages over the others under the existing market conditions and fiscal framework, although not intrinsically.

Under the above circumstances, the National Productivity Council in collaboration with the Indian Agro-Paper Mills Association decided to undertake a comprehensive study of the techno-economic status and productivity performance of the agro-paper mills sector in India. The study was divided into two parts. While the first part concentrated on the micro level aspects directly relating to the management of the mills, based on the shop-floor conditions available in India, the second part dealt with some of the crucial issues connected with the planning and management of the sector at a macro level. The detailed set of objectives are as follows:—

Part I

(i) To evolve an integrated Productivity indicator structure for typical agro based paper mills;

(ii) To work out industry level guide norms for vital productivity indicators on the basis of the historical performance of a sample of units representing a cross-section of the industry;

(iii) To prepare an analytical report on the productivity performance of the industry to unearth weaker areas and suggest remedial measures.

Part II

(i) To find out the numbers, installed capacities and production of agro-based paper mills in India with particular reference to the raw-materials used by this industry and their availability;

(ii) To analyse the reasons for sickness, if any, in the agro-based paper industry and to suggest remedial measures including available concessions and incentives:

(iii) To analyse the energy and water pollution implications of the industry;

(iv) Any other aspect of the agro-based paper mills which will be within the framework of the study but not included as the objectives.

The present paper covers some salient features of part 1 of the study.

Methodology

Pilot visits were undertaken by the NPC Study team to all the major areas of agro-paper mills concentration in U.P., A.P., Maharshtra, Punjab, Tamil

Nadu and Gujarat to understand the techno-economic aspects of thelr operations, the data monitoring structure etc. Subsequently, a Steering Committee was constituted to guide the Study Team. The constitution of the Steering Committee is given at Annexure I. The questionnaire for collection of data was formulated in consultation with the Steering Committee.

The measurement centres were arrived at broadly based on the general process sequence and measurability of the inputs and outputs. The various factors within each measurement centre were decided based on their importance in the cost of production. Annexure II gives the details of the various measurement centres and the respective factors considered for the development of norms.

In the process of evolving suitable measurement centres, the utility functions like Boiler House, Pump House etc. were not considered because of the fact that the level of operation of the utility functions is governed by the requirements of the process.

The questionnaires were then sent to about 60 agro-paper units spread all over India. Subsequently, field visits were undertaken by the NPC team to a large number of agro-paper mills for collection of required data.

The observed range of different indicators for various groups of agro-paper mills was worked out and presented to the Steering Committee. The guide norms were then finalised taking into consideration the steering committee's comments and suggestions.

Limitations

Being the first ever attempt to consolidate a data base on the agro-paper mills sector, the present study has several limitations. From the absence of an operationally valid concept of agro-paper mills to the data on cost of operations, the team faced empirical and analytical constraints throughout the study. Although the structured questionnaire was sent to as many as 60 mills and attempts were made to follow up with these mills through personal visits, responses were obtained only from 24 mills of which only 18 could be utilised for purposes of analysis. Remaining six were either incomplete or received very late. A list of respondant units is given in Annexure III.

The data obtained directly from these mills also could not be treated as error free. The data infrastructure in these mills was found to be extremely inadequate to arrive at consumption of any major material or fuel inputs particularly in various sections like the pulp mills, paper machine units etc. The data used here, therefore, may sometimes, be based on back calculations and, thus, suffer from inaccuracies. However, care has been taken to cross-check with experienced experts wherever found necessary.

Norms Development

The measurement of centrewies productivity ratios were worked out for the 18 units. The unitwise productivity ratios of each measurement centre were then classified into different groups based on type of raw material used, HP installed, product type and GSM range produced. These were presented to the Steering Committee with a view to arrive at a consensus on the groupings resorted to for the purpose, the need, significance and relevence of the indicators from the point of view of monitoring. The observed range of the various indicators were then worked out for different measurement centres ignoring the exceptional values on either side viz., maximum and minimum. Thus the guide norms recommended gives both the maximum and minimum values to take into account the possible variations that may arise due to different unaccounted factors, viz. the final input and output furnish composition, the GSM variations, level of technology etc.

Tables 1 to 4 give measurements centrewise observed range and the recommended ratios for different indicators. Though the guide norms give both maixmum and minimum values, it is recommended that the units should strive towards achieving the minimum values recommended.

Labour Productivity

One of the easier and vital measures of efficiency in a paper mill is the productivity of labour. This could

TABLE 1 **Productivity Ratios**

Group	Raw Material Handling etc.						Short Fibre Digesting					
	Kwh/T of RML cut		Mandays/T of RML received in the Yard		Mandays/T of RML cut (feeding)		Caustic/T of Pulp		Steam/T of Pulp		Kwh/T of Pulp	
	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.
Observed												
UNBLEACHED	—	—	—	—	—	—	—	—	—	—	—	—
Bagasse	6.4	23.3	0.2	0.4	0.6	1.2	0.15	0.20	2.1	4.0	20	35
Straw	—	—	1.2	—	2.5	2.7	0.14	0.15	2.0	4.3	17	25
Mixed	19.4	27.5	—	—	0.8	—	0.17	0.19	3.2	3.9	28	35
BLEACHED	—	—	—	—	—	—	—	—	—	—	—	—
Bagasse	—	—	—	—	—	—	—	—	—	—	—	—
Straw	3.5	47.3	3.1	3.7	2.5	—	0.15	0.21	2.5	3.6	38	42
Mixed	3.5	27.6	0.3	—	0.6	—	0.20	—	3.4	4.3	—	—
Recommended												
All Types	—	—	—	—	—	—	—	—	2.0	4.0	17.0	40.0
Unbleached	—	—	—	—	—	—	—	—	—	—	—	—
Bleached	—	—	—	—	—	—	—	—	—	—	—	—

Note : 1. The norms recommended are for those using more than 75% of own (Agro) Pulp.

TABLE 2 **Productivity Ratios**

Group	Stock Preparation						Paper			
	Sizing Che. in Rosin equv (Kg)/ T of pulp refined		Alum. (Kg)/T of pulp refined		Kwh/T of Pulp refined		Steam per T of Machine Production		Water per T of Machine Production	
	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max,
Observed										
All Types	—	—	—	—	—	—	2.7	5.6	37	190
Unbleached	3.0	28 0	29.0	97.0	93.0	300	—	—	—	—
Bleached	8.0	33.0	57.0	87.0	42	166	—	—	—	—
Reels	—	—	—	—	—	—	—	—	—	—
Sheetings	—	—	—	—	—	—	—	—	—	—
Recommended										
All Types	—	—	—	—	—	—	2.5	5.0	30	60*
Reels	—	—	—	—	—	—	—	—	—	—
Sheetings	—	—	—	—	—	—	—	—	—	—

Note : * However the water consumption may go upto 120m³/T wherever there are no fibre recovery systems. Thus concerted efforts should be made to have recovery system in order to enable recycling of water.

† The Loss from head box to shipment would be in the range of 5—11%.

in Pulp Making

Long Fibre Digesting						Washing & Screening		Bleaching				Pulping (Including Stock Prep.)			
Caustic/T of Pulp		Steam/T of Pulp		Kwh/T of Pulp		Water/T of washed Pulp (AD)		Chlorine/T of Pulp bleached		Lime/T of Pulp bleached		Kwh/T of Pulp refined		Steam/T of Pulp refined	
Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.
0.06	0.12	—	—	31.0	60.0	—	—	—	—	—	—	400	675	2.0	5.0
—	—	—	—	—	—	37.0	97.0	—	—	—	—	—	—	—	—
—	—	—	—	—	—	35.0	110.0	—	—	—	—	—	—	—	—
—	—	—	—	—	—	43.0	48.0	—	—	—	—	—	—	—	—
0.06	0.08	—	—	22.0	60.0	—	—	0.08	0.24	0.09	0.21	680	760	2.0	5.0
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	94.0	98.0	—	—	—	—	—	—	—	—
—	—	—	—	—	—	76.0	120.0	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
0.06	0.12	2.0	3.0	17.0	40.0	—	—	—	—	—	—	—	—	—	—
0.06	0.08	2.0	3.0	17.0	40.0	—	—	0.08	0.20	0.09	0.22	—	—	—	—

2. The maximum is recommended to account for the furnish variations.

in Paper Making

Machine											
										Finishinug House	
Kwh/T of Machine Prodn.		Condensate Return per of steam		Fibre loss (%)		Moisture (%)		Pulp to Paper ratio		Finishing loss (%)	
Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.
400	890	0.4	0.85	2	5	5	7	0.88	1.05	—	—
—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—
400	750	0.4	0.85	1.5	3	5	8	0.88	1.05	—	—
—	—	—	—	—	—	—	—	—	—	2†	5†
—	—	—	—	—	—	—	—	—	—	6†	10‡

1. The norms recommended are only for those using more than 75% own (Agro) Pulp.
2. The maximum is recommended to account for the furnish variations.

TABLE 3 Ratios in Effluent Treatment

Group	Waste Water Per T of Finished Paper		Effluent characteristics before treatment								Effluent characteristics after Treatment
			PH		TSS		BOD		COD		
	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	
Observed											
Unbleached	100	190	7	9	400	1100	400	1150	1000	2500	—
Bleached	170	250	7	9	650	1500	650	1100	1500	3250	—
Recommended											
Unbleached	70	180	6	8	—	—	400	800	1000	3200	As per Minas
Bleached	135	225	7	9	—	—	600	1200	1500	4800	standard

Note : 1. Maximum is recommended to account for the furnish variations.

TABLE 4 Productivity Ratios for Overall Plant

Group	Mandays per T of finished paper		Electricity per T of finished paper		Thermal Energy (steam equv) per T of finished paper		Water per T of finished paper		Caustics per T of finished paper		Sizing chemicals in terms of Rosin (kg) per T of finished paper		Alum. (Kg) per T of finished paper		Chlorine per T of finished paper		Lime (kg)/ T of finished paper	
	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
Observed																		
Unbleached	20	35	800	1310	4	8	93	205	0.19	0.23	4.2	17.1	41.6	90.0	—	—	—	—
Bleached	20	35	1250	1800	7	10	180	320	—	—	7.9	19.2	72	140.0	0.13	0.25	75	170
Recommended																		
Unbleached	20		800*	1300*	4	6	75	200	0.17	0.22	4.0	12.0	40†	70†	—	—	—	—
Bleached	20		1000*	1500*	7	9	150	250	0.30	0.35	7.0	12.0	40†	70†	0.13	—	—	—

* Varies depending upon the furnish (output & input).

† Depends on PH of water and recycling of water.

Note : The maximum are recommended to account for the furnish variations.

be measured, in this context, as a ratio of total man-days to the total finished output at the company level. When the respondents were grouped based on the type of paper produced viz. bleached and unbleached, the ratios were in the range of 25 to 35. The reasonable value which these mills could achieve would be about 20.

A major part of the manpower was found to be deployed in raw material handling at the yard and in feeding in the case of almost all the mills. The observed value of mandays deployed at the yard and at the feeding stage per tonne of raw material received and raw material cut respectively is found to be in the range of 0.20 to 3.70 and 0.60 to 2.70 respectively. This extent of manual operation further gives rise to a high degree of raw material losses in handing which lies in the range of 3% to 9%. It is felt that partial mechanisation could be carried out at the raw material handling, feeding and cleaning stages to conserve the material resources. It is also felt that corresponding manpower fixation at the workforce level (direct and indirect and the staff level) be carried out to arrive at the requirements in tune with the level of operations in vague. It is also recommended that the units may evolve/adopt standard plant lay out practices so that multistage handling of materials is avoided on the one hand, and reclaiming methods could be adopted on the other, through which the net raw material losses may be reduced to about 3—4%.

Cooking Chemical Productivity

The most important chemical used towards production of pulp in chemical pulping is the caustic soda. The quantity of caustic consumption is governed by the type of end product and the extent of agricultural residue used. The caustic consumption per tonne of paper produced for these groups of mills is found to vary from 0.19 tonnes to 0.23 tonnes. It is suggested that in the light of rapid escalation in caustic price, the mills in the long run may consider retrofitting their pulp mills with vapour phase cooking technology so as to further improve on the specific caustic consumption ratio. Further, this helps in reducing the quantum of black liquor produced, directly leading to improvements in the associated effluent characterestics.

It is also suggested that the units may consider the option of premixing the caustics with the rawmaterial prior to feeding them into the digesters so as to improve the specific consumption ratio.

Loading & Filling Chemicals productivity

The loading and filling chemicals requirement is governed by the end products and the raw material mix. However, the usage of loading and filling chemicals do not affect the economics unfavourably and hence is not examined in detail.

Bleaching Chemicals Productivity

The consumption of bleaching chemicals viz. chlorine and lime, is found to be in the range of 0.13 to 0.25 T/T and 75 to 170 kg/T of paper produced respectively. The bleaching chemicals consumption again is governed by the output furnish and usage of bleached pulp. This is not, therefore, examined in detail.

Energy Productivity

The most important indicator to be monitored and controlled in a paper plant is the energy productivity which could be measured in terms of thermal energy per tonne of production and electrical energy per tonne of production for analysis. In the present study, specific electrical energy consumption was calculated as Kwh per tonne of paper produced. The specific thermal energy was calculated as equivalent tonnes of steam per tonne of paper produced using an evaporation ratio norm of 4.8 T of steam per tonne of coal. This ratio for the group of respondents is found to vary in the range of 4 to 10 T of steam/T and 800 to 1800 KWH/T.

The energy consumption in a paper mill depends on factors like the process employed at different stages, output furnish, raw material furnish, potential ability to recover waste heat in the units etc. In order to make an analysis, plants were grouped on the basis of the type of output produced viz. bleached and unbleached. It was observed during the field visits that most of the units do not even recover the condensate from the paper machine dryers efficiently.

Thus, as a top priority, the units may adopt efficient techniques to recover the condensate from the paper machine. It is also suggested that concerted efforts need to be undertaken to adopt suitable waste heat recovery system and also to conduct detailed energy audits so as to further improve upon the specific thermal and electrical energy consumption.

Water Consumption

The most vital input in production of paper is water. The water consumption per T of paper produced was found in the range of 93 to 205 CUM in the mills predominantly producing unbleached paper and 180 to 320 CUM in the mills producing predominantly bleached varieties of paper. The water consumption for a typical agro-paper mill producing writing and printing paper in West Germany is reported to be in the range of 100 CUM per tonne. The large quantity of water intake not only costs money in terms of required pumping load to be handled but also in terms of the pollution load to be handled in the effluent treatment plant.

Most of the agro-paper mills of smaller capacity do not have fibre recovery systems, which restraints them from using the back water of the paper machine. It is suggested that proper fibre recovery system may be installed which not only helps in recovering the fibres but also in using the back water of the paper machine down the line. Also it is felt that the mills may initiate possible water conservation techniques through implementation of 'safe all' system for complete waste water circulation and other judicious attempts in reducing the present level of water consumption.

ANNEXURE I **Steering Committee Members**

1. Dr. M.C. Bansal
   Institute of Paper Technology
2. Dr. A. Panda
   Central Pulp and Paper Research Institute
3. Dr. A.N. Rao
   Directorate General of Technical Development
4. Dr. N.J. Rao
   Institute of Paper Technology
5. Shri Ashok Goel
   Indian Agro Paper Mills Association
6. Dr. S.L. Keshwani
   Chemo Projects Desgin & Engineering (P) Limited
7. Shri Pramod Jain
   Shiva Paper Mills Limited
8. Shri D. Subba Rao
   Coastal Paper Mills Limited
9. Shri N.L. Todi
   Supreme Paper Mills Limited
10. Shri Badal Mittal
    Aurangabad Paper Mills Limited
11. Dr. G.K. Suri
    National Productivity Council
12. Shri B.K. Ghosh
    National Productivity Council

ANNEXURE II **Recommended Measurement Centres and Productivity Ratios**

Measurement Centre	Productivity Ratio	Unit of Measurement
Raw Material Handling, Preparation etc.	(i) Electricity per T of Raw material cut	KWH/T
	(ii) Mandays per T of Raw-material received in the yard	Mandays/T
	(iii) Mandays (feeding) per T of Raw material cut	Mandays/T
Short Fibre Digesting	(i) Caustic per T of pulp produced	T/T
	(ii) Steam per T of pulp produced	T/T
	(iii) Power per T of pulp produced	KWH/T
Long Fibre Digesting	(i) Caustic per T of pulp produced	T/T
	(ii) Steam per T of pulp produced	T/T
	(iii) Power per T of pulp produced	KWH/T
Washing and Screening	(i) Water per T of washed pulp (in AD bans)	M^3/T
Bleaching	(i) Chlorine per T of pulp bleached	T/T
	(ii) Lime per T of pulp bleached	T/T
Pulping (Inc. of Stock Preparation)	(i) Eiectricity per T of pulp refined	KWH/T
	(ii) Steam per T of pulp refined	T/T
Stock Preparation	(i) Sizing chemicals in terms of Rosin (kg) per T of pulp refined	Kg/T
	(ii) Alum (kg) per 1000 T of pulp refined	Kg/T
Paper Machine	(i) Steam per T of paper	T/T
	(ii) Water per T of Paper	M^3/T
	(iii) Power per T of Paper	KWH/T
	(iv) Condensate return per T of Steam used	M^3/T
	(v) Fibre loss	%
	(vi) Moisture at reel	%
	(vii) Pulp to paper ratio	%
Finishing House	(i) Cutting losses	%
Effluent Treatment	(i) Waste water per T of finished paper	M^3/T
	(ii) Effluent characteristics before treatment	
	(a) PH	Mg/lit
	(b) TSS	Mg/lit
	(c) BOK	Mg/lit
	(d) COD	Mg/lit
Overall Plant	(i) Total mandays per T of finished paper	Mandays/T
	(ii) Caustic per T of finished paper	T/T
	(iii) Sizing chemicals in terms of Rosin (kg) per T of finished paper	Kg/T
	(iv) Alum (kg) per T of finished paper	Kg/T
	(v) Chlorine per T of finished paper	T/T
	(vi) Lime kg/T of finished paper	Kg/T
	(vii) Thermal energy in equivalent steam T per T	T/T
	(viii) Water per T of finished paper	M^3/T
	(ix) Electriciiy per T of finished paper	KWH/T

ANNEXURE III **List of Respoondents**

Sl. No.	Name of the units	Capacity (TPD)
1.	Rahuri Pulp and Paper Mills	25
2.	Nizam Paper and Boards Mills Ltd.	20
3.	Zenith Papers (A unit of Zenith Ltd.)	50
4.	Pennar Paper Limited	15
5.	Amrit Paper (Div. of Amrit Banaspati Co. Ltd.)	30
6.	Rohit Pulp and Paper Mills Ltd.	22
7.	Coastal Papers Limited	33
8.	Pravara Sahakari Sakhar Karkhana (Paper Mill Division)	20
9.	Vamshadhara Paper Mills Limited	18
10.	Shree Datta Shetkari Sahakari Sakhar Karkhana Ltd. (Paper complex)	20
11.	Delta Paper Mills Limited	60
12.	Shreyans Paper Mills Limited	30
13.	Shiva Paper Mills Limited	30
14.	Madhya Bharat Papers Limited	50
15.	Babri Paper Mills Limited	12
16.	Nath Pulp and Paper Mills Limited	36
17.	Shamli Paper Mills Limited	10
18.	Aurangabad Paper Mills Limited	48
19.	Shree Bhawani Paper Mills Limited	33
20.	The Kopergaon Shakari Sakhar Karkhana Limited (Paper Mills Div.)	25
21.	UP Straw Limited	30
22.	Circar Paper Mills Limited	30
23.	Cheema Paper Mills Limited	15
24.	Coastal Chemicals Limited (Paper Division)	50

Towards Realistic Approaches to Management Consulting and Organisation Development

Why do we continue to do things the way we do in our organisations even when we know that they do not work ? Just to have three wellknown situations:

1. Despite the huge amount of planning and theoretical knowledge that goes into strategic business planning, reality disturbs more as a rule than as an exception in most well polished plans. Where was the real vision during the conception stage? Was planning based on budget necessities only or on wishful thinking? Were those planned in connection with reality? Still, we continue to use the same techniques and instruments of market research, computerised planning and so on.

2. Meetings drag on for hours without significant results; at the best, some form of agreement is reached on the surface. It is the informal circuit of personal contacts between some key managers which will make the deals later on, in the process, leaving many who took part in the decision making in the dark. But the latter will have to execute the decisions in practice. We, then, wonder why there is a lack of motivation, even sabotage?

3. Work executed is rarely up to standard, whether it concerns the starting and functioning of a new plant, the quality of products manufactured, or even the quality of a sales call attended. This, despite the fact that, instructions were clear and technical capabilities sufficient. And all rules and make-sure procedures to eliminate these problems, often, only result in more inventive ways of bypassing them. Still, we continue, as if nothing happened, with our approaches as before.

There is certainly no lack of information available for resolving these questions. Even more complex business-planning systems, computer-aided strategic planning, motivation-stimulating assessments and remuneration systems and, not to be forgotten, refined project-management and network planning schedules have become available. However, they have all one thing in common; they work to the extent that (like any calculation model) reality behaves as has been predicted by the variables in the system. The truth is, reality seldom does.

Some Consequences

Some of the consequences of the above mentioned approaches to organisational and management problems can be the following:

1. *An increasing communication distance* between those in boardrooms, managing largely on the basis of abstract notions, figures and plans, and the people out in the field, or on the shopfloor, dealing with day to day reality; with middle management facing an increas-

ingly difficult task of interconnecting top and bottom. As reality becomes more and more out of sight for the decisionmakers, the number of mistakes and incorrect decisions will grow rapidly.

For all concerned, this can lead to:

2. *Increasing lack of trust in one's abilities and vision* through an overall dependence on the external so-called objectlve instruments and recipes that seem ever so genius but fail to produce the desired results when tested in real life situations. This is because of the obvious fact that no two situations in life are ever the same; there are different people involved with different experiences, knowledge and attitudes, the organisation cultures are never the same and so on. But this obvious fact is hardly ever recognised and thought through to its full extent; if it has been, there would be less need for ever more sophisticated instruments. The goal would be to become one's own instrument by developing personal skills and abilities. To compensate for this lack of trust, refuge is often sought in dominant, seemingly self-assured behavior that in turn reinforces the lack of self-confidence of subordinates and colleagues.

Corporate culture, as a result of this mechanism, will be characterised by a:

3. *Defensive attitude* since the value of the applied instrument or planning technique is thought as beyond doubt, any discrepancy between the true result and the projected result must be accounted for by somebody. A lot of effort is spent in organisations to ensure this. The negative effects that such an attitude will have on organisational performance are obvious.

Thus, unless one can make a sound judgement on what to do in every single situation that occurs, based on factual observation and analysis, standardised or programmed approaches will mentally fail to produce the desired results.

Analogous Approach

Analogous to this approach of looking for tools outside ourselves, as individuals too we have the habit to often programme ourselves. We do this by means of imposing experiences from the past on present situations; often this is done in such a way that it becomes dogmatic; we tend to dislike the idea of taking a real look at the situation because what we see may cause us to judge our prefabricated solution as being inadequate. The strange thing is that once we start off in our working life, after school or university, we seem to forget that our experiences are the results of conscious learning processes, and that our knowledge, abilities and attitudes are only able to grow thanks to the fact that they are in constant motion.

And all learning-processes are characterized by the fact that the existing thought-patterns are changing, or better, qualitatively developing. For these processes to take place, it is essential that an inner judgement is continuously made on whether the old thoughts and notions, experiences and approaches provide adequate solutions in view of the new situation that presents itself.

When, for instance, continuously, severe quality problems occur in the manufacture of products, there is always the obvious quick solution: change some of the people, invent new rules and procedures or work harder on the suppliers. But often all that has been tried before in, one form or the other, do not work. When, therefore, yet another problem-solving technique is used, the decision to do so is based on the assumption that the limits of the existing thinking and acting framework should not be surpassed; the solution or the approach has to be found within the present framework of corporate do's and dont's, all within the organisational reference framework. In other words, learning from a situation and developing one's own abilities beyond the framework of the thinking done so far, is assumed to be unnecessary. It is our experience that in the majority of corporate cultures there is little tendency to see the work place as a learning-place. Yet, here lies the core

of many problems that organisations face today—problems such as why all instructions, instruments for control, tests and procedures do not prevent people from letting the same things do wrong over and over again.

So now we have to come back to our original question: why do we continue to do things in our organisation the way we do, even when they do not work?

We think that part of the answer has to do with a general fear to step beyond the boundaries of the thinking and acting that have been done so far. In other words, the existing ideas related to a specific situation often stem from the past, from experiences in comparable situations.

So an important question to really new-age management could be: has the past developed you to such an extent that you no longer see your suitcase full of experiences, knowledge and solutions as your most valuable assets? But sense that your really most valuable tool is your *ability to create in any new situation the ideas which are unique and perfectly adequate for the situation itself*; and that you are conscious of the fact that in order to reach this stage of professionalism your past experiences were all necessary, but at the same time must be abadoned when a new problem occurs to enable you to look at it and observe it without the projection of your experiences; if not, these projections will colour your observations, and re-shape reality in such a way that your familiar approach fits in. Thus, it is not the contents of your experiences that is important but the process of creating your ideas in the situation itself. And if you look back to your experiences, can you discover how this process took place, what were the conditions that made your idea-creating process at that time a successful one, or an unsuccessful one? The discovery of the laws governing this idea-creating process and the ability to apply them will be your greatest step in becoming your own instrument.

In looking at and making use of your experiences in this way you will put yourself in the process of rapid personal development and growth. Your abilities will increase and past experiences, knowledge and standardized approaches will not hamper you anymore to make the proper diagnosis and take the correct action.

As Albert Einstein once said : "The world we have made as a result of the level of thinking we have done so far, creates problems we cannot solve at the same level."

Now let's pose another question : are all problems in organisations of the same nature? And if not, what distinctions can be made, and why?

Important Questions

At NPI, Institute for Organisational Development, we see three categories of questions that organisations or parts of it can be confronted with, each asking for different abilities and skills to be developed and applied:

Preventive questions when processes and activities are running well. This is seldom because all factors contributing to this success are acknowledged, conscious and under control. Therefore, attention has to be paid to these processes in order to ensure that they will keep on running smoothly.

Problem solving questions : If a "problem" is defined as the deviation from an agreed standard, measures can be taken to correct the situation, to restore it to the original condition. This can be done only in those cases where it is possible to restore the original situation. But when people, their co-operation and interaction are concerned, situations can never be restored to the original because new constellations of people and individuals are continuously developing. Therefore, problem-solving questions only relate to situations where the human factor is not of much weight e.g. in technical, highly automated production systems, in financial systems and the like.

Questions of innovations, i.e. questions where existing structures, cultures, abilities and experiences are obviously inadequate. And thus, the most effective approach is to treat these questions not as a problem so as to put a solution to it; but to start working on developing the skills of the

people involved, individually as well as in groups, with or without the management, and creating conditions for individual and group development. And when as a result of such a process, totally new questions arise, we consider these the best proof that the previous level of thinking and acting, the abilities and disabilities of the past have been overcome and have developed to a further stage; that overall consciousness has increased.

And when we try to give an answer to the question mentioned at the beginning of this paper, it might be that the reason lies in our way of looking at, judging and approaching situations: we treat questions of innovation as though they were problem-solving questions. No doubt, this has to do with the fact that the methodology of physical sciences with all the material successes and important discoveries they have brought us, has also entered the field of social relations where other laws govern. If the assumption is true that people are static, programmable beings with behaviour that can be controlled, who do not develop and are not unique in all aspects, then the physical sciences will also have answers to problems in social sciences. But this, fortunately or unfortunately, is not true.

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BOOK REVIEW

ALTERNATIVES IN INDUSTRIAL DEVELOPMENT: SUGARCANE PROCESSING IN INDIA, by H.H. de Haans, Sage Publications, New Delhi, 1988. pp. 177, Rs 165.

Many aspects of industrialisation in developing countries like India are coming in for searching enquiries, particularly in the light of the divergent experiences and conflicting theoretical positions. The question of alternative techniques adopted in industrial activities is one such area, providing a rich fare of theoretical issues, policy alternatives and empirical materials.

While posing the problem in the context of broader development goals and policy instruments, the emphasis is on alternatives in industrial technology, particularly owing to the simultaneous existence of a variety of methods of production which the author refers to as "co-existence of different modes of production" (p. 155)—an avoidable confusion since 'mode of production' is a term better known in a different sense.

The study is based on a detailed investigation, through primary and secondary data and field visits of the sugar industry in a limited geographical area. The study is presented against the backdrop of a crisp, issue-based survey of the theoretical and emperical work on the subject of choice among alternative technologies and the conflicts which arise in this process owing to multiple objectives. Using a social cost-benefit analysis and techniques of programming, the author examines the viability of Vaccum Pan Sulphitation process (VPS) used in large-sized modern sugar mills, the Open Pan Sulphitation process (OPS), an intermediate technology used in the medium-sized dispersed plants, Gur and non-sulphur Khandsari (GNSK) and the traditional gur-making technologies as alternative methods of processing sugarcane in Western Uttar Pradesh. The book provides a good descriptive account of these technologies and their organisational frameworks, a result of insights obtained from extensive field studies. The overall problems of the sugar industry and their relationship with the government also find, at places, a perceptive account. After describing the technologies and the socio-economic profile of the units making use of them, these technologies are evaluated on the basis of a social cost-benefit analysis.

Broadly, using Net Present Value (NPV) as the criteria for selection, both at the project and sectoral levels, the procedure followed is to make the estimates in terms of financial prices, economic prices and social prices. Apparently these tasks involve daunting methodological, data-availability, data handling and interpretation problems. One can easily find a number of snags, simplifications, adjustments, heroic assumptions and data gaps in any work of this kind. So long as one is cautious in interpreting the results, it would not be very fruitful to join issues with the author on such matters.

The results arrived at by the auther show that VPS is far superior to any other technology both at economic and social prices. The NPV of VPS at economic prices is so much larger than that of OPS, that, in terms of the Pareto-Hicks compensation rule, the losers from a re-allocation of sugarcane processing can be compensated "in principle". The author views the role of OPS (which is "likely to disappear" before long) as an instrument of rural development.

Given the high profitability of uncontrolled OPS, the author thinks that "an OPS plant might serve as an instrument for the upliftment of poverty-striken areas, suitable for cane-cultivation but not sufficiently iarge to supply a sugar mill" though, even this task is better served by a modern, large sugar mill. Even on account of equity, the author is unable to find support for his hypothesis that an intermediate technology like OPS would be a viable proposition. However, OPS is found superior to GNSK, though it cannot be preferred to gur-making, which is a subsidiary work for the small peasants and is eventually not a sweetening-agent but a food. The implications of recognising gur as a food and a wage-good are left unspecified.

These certainly are interesting and significant results. One may not be able to generalise them with respect to other industrial activities having a similar access to a wide spectrum of technologies. However, if these results are found credible enough, they have notable policy implications for the sugar policy and regional planning in Western U.P., both in the short and long-run. But a careful look at the theoretical foundations, methodologies, data-base, data interpretation, as well as the manner in which the problem is posed and analysed and the vorious adjustments and assumptions made tend to make one sceptical about both the validity and relevance of these results. Let us briefly state some of the problems one finds with the approach and conclusion of the present study.

The author has quite rightly adopted growth and equity (both relative and absolute) as objectives for guiding the choice of technology. He recognises that "growth of production alone is not sufficient to attain the employment targets". This view fails to recognise that growth of output may even be accompanied by a fall in output, particularly in the long-run. This is so when the growth of output is accompanied by greater concentration, non-growth of home market, change in product-mix in favour of capital-intensive products, increased use of imported inputs necessitating large external borrowing, ecological degradation and imbalances and increased damand for foreign consumption patterns and technologies. The experience of many Third World countries has made such apprehensions come dangerously true. Thus, what appears technically and allocatively efficient technologies may involve further underdevelopment and defeat the basic objective of industrialisation. Technical efficiency is geared to growth, while allocative efficiency is geared to existing market relations, distribution of income and pattern of demand. Technology choices and the satisfaction of these criteria may even mark a negative contribution to development as it is now generally understood. On the other hand, a technology which satisfies none of these conditions could still be an instrument of industrialisation geared to equity, use of available manpower, nautural resources and greater weight of merit goods. Morever, without satisfying these objectives attainment of sustainable and stable growth too may become problematic.

In general, the entire theoretical model in term of which various economic processes are worked out is that of private competitive market economy which is generally without imperfections except for some explicit mention of government controls and other imperfections. For example, it is maintained that new technology with lower unit costs will sell at a lower price; or higher profitability will generate a higher rate of investment which also will create more employment. These are indications of the inability to specify a model of the Indian econmy which is broadly operational in real life. In a work discussing various technologies, some of which pertain to certain segments of what is usually termed the unorganised or the informal sector, a model incorporating joint operation of the formal and the informal sectors is a basic pre-requisite for working out the project, sectoral and economy-wide implications of various technologies. Unfortunately neo-classical propositions are tacitly taken to be the reality on the ground, despite the empirical evidence collected by the author himself pointing in the other direction. This holds true even with respect to the VPS-using large mills, which overstate costs, delay payments to canegrowers and are enmeshed in the black economy no less than the OPS units

These difficulties reappear in the use of social cost-bensfit analysis (SCBA). For one thing, conversion of financial (i.e., market) prices into economic and

social prices apart from being highly imperfect and biased, does not go well with the basic character of SCBA. The SCBA identifies, quantifies, valuates and compares a much broader set of costs (in terms of forgone opportunites) and benefits (in terms of social objectives). Initial listing in terms of market cash flows builds in biases even with respect to non-externalities and quantifiables, let alone externalities, intangibles, qualitative and indirect factors. The macro and the regional parameters needed for SCBA in a particular region are absent from the persent exercise. The absence of such a framework leads to a neglect of crucial issues and vitiates the evaluation of alternative technologies.

Certain other factors also put a question mark on the results obtained by the author. The evaluation in terms of SCBA here refers to *exisiting* units and not the new or proposed projects. This fact has critical relevance as also the fact that non-VPS, non-OPS technologies are largely adopted by the canegrowers themselves, leading to vertical integration and *diversified* peasant/rural economy. On the question of employment, reliance on compensation *a la* walfare economics seems to be pedantic. Generally, it does not seem to be realised that ineffective employment for the poor masses has a human and social urgency and socio-economic costs, and any marginal improvement in productivity, capability and, thereby, access to means of livelihood has to be adopted, without making the best the enemy of better. In the absence of a theoretical frame which incorporates such concerns, which the author is aware, the adopted procedure does not appear to incorporate many factors relevant for the evaluation.

In sum, the problems of industrialisation are rather complex, particularly for late industrialisers with a lop-sided, industrial structure, and in a highly heterogeneous economy with a low degree of mutuality among its components. In such societies small-scale industries are not to be viewed basically as a means of producing goods at competitive costs in accordance with the existing market signals. *Giving higher productivity to workers over their already realised low level of productivity*, making use of skills and natural resources in an ecologically sensible manner, creating greater propagation effects, producing the means for an improved standard of living over the existing one and achieving spatial dispersal consistent with the factors mentioned above, are the tasks which industrialisation has to achieve. Such tasks widen the entrepreneurial base and put a brake on the incessant processes of concentration. The procedures for evaluation of technologies have to transform these kinds of factors which cannot be derived from an explicit or implicit competitive market model into quantifiable criteria for evaluating alternatives. The present book, despite its deft use of conventional analytical techniques, does not come close to the real challenges of industrialisation as an instrument of development.

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MINERAL RESOURCE ASSESSMENT FOR NATIONAL PLANNING AND POLICY FORMULATION—a Report published by Asian Productivity Organization (APO) and East-West Centre's Resource Systems Institute, Tokyo, 1988.

This is a report of the study meeting organised by APO & RSI in Bandung, Indonesia in July 1986, in which papers by experts from USA and Japan were presented before representatives from China, Indonesia. Malaysia, Papua New Guinea, Thailand and Vietnam. Among others, representatives from ESCAP and RMRDC also participated. The publication contains four leading papers on resource assessment programmes, mine/prospect evaluation and financial techniques for evaluation of mineral projects followed by seven case histories covering six countries.

The main aim of the publication is to encourage mineral resources assessment programmes in developing countries. It recommends comprehensive geological assessments followed by programmes where necessary, for collection of required data and their analysis to

arrive at an inventory of mineral resources. The procedures are time consuming and capital intensive and therefore require due planning. Besides the early development of mineral resources is a key factor in economic progress, with the returns proportional to the promptness with which they are exploited.

The report lays special stress on the estimation of resource potential and the methodologies used. Even though the techniques of assessment of resource potential are still developing, the report strongly recommends an early application of these methodologies for developing countries. It suggests that most countries have realised the need to assess their mineral reserves and potential resources. The interest of developed nations such as USA and Japan and others with endowment of less mineral wealth is understandable. Their strategy is two-fold; firstly encouragement to the assessment of resources in the Third World and secondly, continuing programmes of mineral resource assessments in their own countries. The need to conserve anticipated mineral resources as well as the environment in their own countries has impelled these countries to take interest in the mineral resources assessment of the Third World countries.

This report brings out the fact that China and Indonesia are very well endowed in mineral resources. The potential of China, which is very large indeed, is almost untapped as yet. In the Indian context, there is need to follow closely the results of the programmes undertaken for the assessment of our resource potential, particularly in their disaggregated forms, and relate them to an economic sub-model. Interaction is needed with the RSI, particularly in the context of an assesssment of the results pertaining to mineral resources where considerable work seems to have been done. For India where major future mineral discoveries are likely to be in virgin fields where mining activity is unknown as yet, the developments in these methodologies have to be not only carefully watched but a whole programme of productive mineral resource assessment methodologies has to be launched.

One of the examples of application of productive assessment is the Alaska Mineral Resource Assessment Programme (AMRAP) of the U.S. Geological Survey, which for the most part is based on standard field and laboratory methods. Its contribution however is significant in that it has systematically integrated geological, geo-chemical and geo-physical studies of the areas of complex geology with no mineral shows while at the same time making use of a successful productive technique. Similarly, the case histories of Indonesia, Papua-New Guinea and China illustrate the application of the technique of unit regional value, a new analytical technique for assessing mineral potential. Although the technique results in an aggregated estimate, it has served the purpose of the planners for exploration and development decisions. In Japan, a research and development project on deep sea manganese nodules was started in 1981; the case study illustrates the uncertainties of mining methods and recovery, pollution and economic viability in deep sea projects. It also brings out the fact that the nodule and metal recovery rates and efficiencies must be considered in addition to the overall resource potential. These are important conclusions for our country where a polymetallic nodules programme has been launched in the Indian Ocean. Japan's example has also highlighted the need to integrate mineral resources development with the Government's regional development plan. Interestingly the case history on assessment of mineral resources and development in Japan has highlighted the fact that superior hardware technologies to obtain precise geological data are an important part of a precise assessment of mineral resources, the assessment methodologies which are being progressively developed being considered as software technologies. Attention has also been drawn to the need for an effective national policy and funding for environmental impact studies and development of technology to prevent environmental pollution caused by operating and closed mines. These are essential to maintain a balance in the efficient and economical exploitation of resources and environmental protection.

There is a whole chapter devoted to the financial evaluation techniques and their application to mineral projects in which various methods such as the internal rate of return, payback period, net present value and others have been discussed and explained.

All in all, it is a very useful reference volume for

all those involved in the planning and development of mineral resource-exploration both in the Government and in the industry.

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MARKETING ENVIRONMENT AND PRACTICES IN NEPAL, by Y.S. Verma and M.P. Dhal, Sterling Publishers, New Delhi, 1988, 176p, Rs. 150.

The book presents the proceedings of a Seminar-cum-Workshop organised by the Institute of Management, Nepal. The proceedings have been edited by the authors dividing them into four Sections. Sections I & II contain articles written by various authors giving an overview of the Nepalese Economic & Marketing Environment; Cultural & Social Environment; Political & Legal Environment & Technological Environment. The information and data presented in the book such as regional distribution of population age-wise distribution of population, sexwise distribution of population, family life cycle, literacy of population, religious values and attitudes, economic growth in Nepal, employment income and expenditure, consumer price index, import export trend etc. will help exporters from India as well as manufacturers from Nepal to make decisions on new products and designs the right strategy for marketing.

Section III of the book makes an interesting reading. The case studies of the following organisations of Nepal have been presented in the book.

1. Royal Nepal Airlines Corporation
2. Janakpur Cigarette Factory
3. Veergam Sugar Factory Ltd.
4. Agricultural Tool Factory Ltd.

The authors of the papers have presented the philosophy and marketing strategy of the above companies which are not only informative but can also serve as models for designing the strategy for one's own organisation.

Section IV deals with the summary of the analysis of marketing practices in RNAC. JCF, PSF & ATF which is by and large duplication of the papers presented in Section III. Overall the book will be of some use to the exporters to Nepal and will be of more use to those who are engaged in marketing activities in Nepal

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AGRICULTURAL RESEARCH SYSTEMS AND MANAGEMENT IN THE 21ST CENTURY, Edited by K.V. Raman, M.M. Anwar and Gadoginath, National Academy of Agricultural Research, Hyderabad, 1988, 212p, Rs. 150.

The volume contains the proceedings of a Seminar on Agricultural Research Systems and Management in the 21st Century organised by NAARM Alumni Association, National Academy of Agricultural Research Management, Hyderabad, incorporating 17 papers. The papers are arranged according to four themes viz. (i) projecting the future demand of food and fibre for the 21st Century; (ii) developing technological innovations to meet the challanges of the 21st Century; (iii) Reviewing the current agricultural research and educational systems in the country and (iv) developing appropriates national agricultural research systems, to meet the needs of the 21st century.

The papers presented for projecting the future demands for food and fibre certainly make an interesting reading. One of the papers has indicated that at the prevailing consumption pattern and nutritional levels, it should be possible to feed 1,400 million people by producing 550 million tonnes of foodgrains by the year 2050 A.D. However, to reach this level of production with the level of arable land declining from the persent 140 million hectares to less than 125 million hectares, productivity per unit of land may have to be raised by a multiple of four or more. Development and application of science and technology ensuring income gains to farmers; mechanisation; strengthening

of credit and marketing; processing and warehousing and transport & communication infrastructure are mentioned as some of the main issues for research for the next century.

Another point that has been emphasised is that the productivity per unit of irrigated water will have to be raised because total water drawals including in agriculture, industry and civic needs would be 3030 million litres constituting 72% of the total estimated runoff, which does not seem to be within the realm of feasibility.

The supply of and demand for animal products like milk, eggs, wool and meat have been projected. For 2.001 A.D. the production of milk and eggs is likely to be more than the demand for them. However, while the projections for the supply of wool have been provided the demand for wool has not been projected. Similarly, the damand for meat has been projected but no projections are available for the supply of meat. It has been pointed out that, presently, only two-thirds of the fodder and one-fourth of the concentrates required for providing adequate nutrients to the livestock population is available. The problem of competing demands for food from an increasing population and fodder and concentrates for animals and birds has not found any place in the papers presented.

Despite the growing importance of synthetic fibres in the textile industry, cotton will continue to be the source of fibre for the masses and the cotton crop will be grown not only for its fibre but also for its vast edible oil and by-product potential. One of the papers indicates that a target of 132.5 lakh bales of catton for 2001 A.D. for a population of 1000 million and 282 lakhs bales for a population of 1600 million by 2050 A.D. is possible, without any increase in total area, but with slight increase in the irrigated croped area. Looking at the developments in the advanced countries, the scope for reaching the targeted production of cotton for the 21st century seems to be bright.

The collection of papers reviewing the current Agricultural Research and Educational Systems in the country covers the details of agricultural research systems in India. These papars review the present position regarding manpower and investments in agricultural research. The details about the Indian Council of Aricultural Research and various bodies working under it can also be found in the collection of papers. It has been mentioned in one of the papers that every third position in the ICAR and every fourth position in the state research systems continued to be vacant. The paper dealing with the Agricultural University system details of why and how Agricultural Universities came to be established. The specific features of organisation, planning and implementation of the tripartite roles assigned to these Universities namely, manpower training, research and extension education have also been discussed.

Towards the end, papers relating to the development of an appropriate National Agricultural Research System to meet the needs of the 21st Century have been put together. One of papers indicates that agricultural research in developing countries receives very limited resources (0.5% of the agricultural income in 1980), less than a third of its share in the developed countires. It further mentions that the overall level of spending on research will have to be increased and a strong National Agricultural Research System will have to be evolved. In these papers the whole of the Research System has been reviewed and future needs highlighted. A couple of papers presented by American experts have also been included. One expert has emphasised the need for private sector research in plant breeding for producing improved variety of seeds.

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BOOKS IN BRIEF

Behavioural Economics

By Peter E. Earl. England, Gower Press, Two volumes, 1988, 964p, £110.

'Behavioural Economics' is a relatively new School of economic thought and can encompass a number of strands, such as 'new-institutional/transaction cost' economics, economic psychology and psychological economics, consumer behaviour and decision theory. The papers presented here reveal something of the development, philosophy and range of applicability of 'behavioural economics.

Biotechnology Revolution and the Third World

By IRS. New Delhi, Research and Information System for the Non-Aligned and Other Developing Countries, 1988, 451p, Rs 250.

The biotechnology revolution presents an immense challenge for developing countries and international organisations to take appropriate policy measures to harness the development potential of new technologies and to ward off their adverce effects. The eighteen contributions in this volume by distinguished experts critically examine the nature of these challenges and suggest policy imperatives. Part one highlights to potential of bio-technologies for developing countries in different areas. Part two deals with various issues of concern to the Third World arising from the emerging trends in global biotechnology industry. Part three proposes the policy options and the strategies for the international community.

A Concise Introduction to Engineering Economics

Peter Cassimates. Mass, Unwin Hyman Inc. Co., 1988.

The empahasis is on problem solving, evaluation of projects, capital budgeting and resource allocation. The current theory of economics and finance is also discussed. The book proceeds through compounding, discounting and economic equivalence to cash-flow analysis and inflation. The author also deals with risk analysis, capital rationing methods and the evaluation of public projects. Economic decision models are presented, including profitability analysis and lease or buy decisions.

Corrosion Atlas

By E.D.D. During, Netherland, Krachtwerktuigen Association of Industries and Organisation for Energy and Environment, 1988, 2Vols, 242p, $342.

It comprises two loose-leaf volumes: Volume 1 contains the case histories concerning carbon steels; Volume 2 contains those concering stainless steels and non-ferrous materials. The case histories are classified by material and sub-divided according to the system from which the corroded part originates. A separate phenomenon index, a glossary of terms, and a comprehensive bibliography are included in order to keep the information as up-to-date as possible.

Developing Countries in the Gatt Legal System

By Robert E. Hudac. England, Gower Press, 1988, 280p, £ 12.95.

There is a growing conflict over the role that developing countries should play in the international trading system. Developed countries are calling on developing countries to assume fuller participation in legal disciplines of the General Agreement on Tariffs and

Trade (GATT). Developing countries are resisting these demands on the ground that their less favourable economic status entitles them to continue using GATT-prohibited measures in aid of development. The author's study traces the evolution of the GATT's current legal policy towards developing countries, detailing the succession of greater and greater departures from GATT obligations authorized since 1947 in order to satisfy demands for 'special and differential treatment'.

Dynamics of Co-operative Administration

By B.B. Goel. New Delhi, Deep & Deep Publications, 1988, 370p, Rs. 225.

Cooperatives are the vital instrument of social and economic transformation in the gigantic national efforts all over the world. These are still in a blossoming stage and have rarely found commanding the heights of economy. It calls for building cooperative discipline, strengthening primaries, democratisation and professionalisation of management, blending of schematic project approach and technology with cooperative principles and practices. This book, divided into 15 chapters, makes an extensive study of the entire gamut of cooperative administration based on painstaking empirical research. Some of the topics discussed are cooperative administration, board of management, personnel administration, cooperative legislation, rural development and cooperatives, and various aspects of management.

Economic Develpoment Since Independence

By R.K. Sinha, Editor. New Delhi, Deep & Deep Publications, 1988, 438p, Rs. 300.

The present collection of essays and papers is a welcome addition to the existing literature because of the keen analysis and depth with which various topics have been covered. As the contributors happen to be men who have held and are holding senior positions in the country it is hoped that their suggestions will be given serious thought and consideration which they deserve. The collection has been published at an appropriate time when a mid-term review of the current Seventh Plan has just been completed, very serious thought is being given about the priorities in the Eighth Plan and a number of new ideas are being debated about planning, plan formulation and plan administration in the country.

Energy and Environmental Terms : A Glossary

By Peter Brackley, England, Gower Press, 1988, 200p, £ 18.95.

This glossary provides a layman hundreds of words, acronyms, agreements, organisations, chemical names etc. that crop up daily in discussion and argument about energy and environmental topics. It tries to make them understandable to all those who lack the detailed knowledge of the scientific disciplines and industries involved. It provides simple explanations of some complicated ideas, and easy conversions of many confusing units of measurement.

Food Policy in India : A Survey

By R.N. Chopra. New Delhi, Agricole Publishing Academy, 1988, 414p, Rs. 275.

This book is a text on the evolution of food policy in India from pre-Independence years to the present day. Written by the former Chairman of the Food Corporation of India, it provides an 'inside view' of the various phases of food policy in India to give a balanced perspective of the growth of food and agriculture during the last forty years. Ably supported by statistical data throughout the text, the book contains a separate section on statistical tables which have been brought together for the first time.

Handbook of Applied Thermal Design

By Eric C. Guyer, Editor, NY, McGraw-Hill Book Co. 1988, $ 75.

This book tells how to specify appropriate materials, choose heating and cooling equipments and determine the best temperature measurement devices to monitor thermal effects. Other topics include heat transfer fluids, structural materials in thermal design, electric

powered heating, and thermophysical properties of selected material.

Indian Economy : Planning and Changing Dimensions

By Radha Raman Singh. New Delhi, Deep & Deep Publications, 1988, 387p, Rs. 275.

The present volume brings together the outstanding studies of the author on planning and development. Agriculture, industry, public distribution system, rural and urban development, rural credit and institutional credit agencies are discussed in depth. An attempt is made to investigate the impact of planned development efforts on the socio-economic conditions of the country. The author gives an appraisal of the Five Year Plans in the field of growth and development and a comprehensive and critical account of the public distribution system in Indla. The concluding chapter focusses on the respective approach and strategies which may prove effective in making the planning exercises more fruitful and equitable for the Indian economy.

Indian Social and Economic Development 1988 : An Index to Literature

By Cendit. New Delhi, Sage Publications, 1988, 206p, Rs. 175.

This is a valuable reference book. Being the second volume in a series, it contains over 500 entries divided into six areas—Ecology, Human Resources, Women/Children, Income Generation, Empowerment and Debates. Each item provides bibliographic details and a brief description of the contents. In the context of marked increase in developmental activity in India and the lack of access to literature from other countries, this book will be welcomed by all as a valuable reference tool.

Management of Working Capital in Public Enterprises

By A.K. Mukherjee. Allahabad, Vohra Publishers & Distributors, 1988, 339p, Rs. 275.

Public enterprises as a world-wide phenomenon have come to stay. The number of units in the public sector is constantly increasing since India achieved Independence. This is in keeping with the public policy in a socialistic pattern of society. This book makes an effort to assess various aspects of working capital mangement in selected public enterprises. It tries to determine the quantum of working capital and its adequacy both technical and operational. Besides working capital leverage, financing both internal and external, the impact of the size of business on working capital, the impact of change in working capital over profitability and the diversion of working fund towards capital fund are assessed. Thus, the book provides a new opportunity for researchers and professionals to look into the field of working capital management from a fresh angle.

Management Philosophy and Style in Indian Industries Volume I

By G.L. Tayal. New Delhi, Deep & Deep Publications, 1988, 382p, Rs. 500 (Set of two volumes).

Management Philosophy and Style in Indian Industries Volume II

By G.L. Tayal. New Delhi, Deep & Deep Publications, 1988, 774p, Rs. 550 (Set of two volumes).

Business leaders in India face many issues in their business policies and practices. To the increasing interference from the Government in business affairs are to be added specific challenges from the corporate social environment. For most managers, the challenges of comprehending and managing the environmental forces has been quite a difficult task. On the other hand, a number of researchers in the past few decades have been fascinated by the personality profile, philosophy and the style of managers. This study attempts to identify the management styles of top executives in large business enterprises. It also examines the relationship between management styles and the background of higher level managers. In accordance with its objectives, the study has been able to identify certain important elements concerning the philosophy and styles of top management in larger sized Indian Private and Public Sector Companies. The study has explored some relationships between manage-

ment philosophy and management style. Finally an attempt has also been made to interpret and explain the nature of findings.

Organisational Behaviour

By Pardeep Sahni & K.K. Sharma. New Delhi, Deep & Deep Publications, 1988, 351p, Rs. 225.

There are a number of scholarly works available which have touched upon several facets of organisational behaviour. Most of these books are by foreign authors on their respective countries. This book contains an empirical exploration of some of the important facets of organisational bevhaiour. After analysing the theoretical dimensions of each facet in detail, an attempt has been made to verify its applicability in various pubilc and private sectors in India. The meaning of organisation, organisational behaviour, job design and goal setting, transactional analysis, communication, leader and leadership and other topics are discussed in detail. Researchers and students of business and public administration and social workers will find this book a useful addition to their collection.

Performance of Integrated Milk Co-operatives: (A Study of Selected Cooperative Dairies in Gujarat and Maharashtra)

By C.G. Ranade, D.P. Mathur, B. Rangarajan and V.K. Gupta. New Delhi, Concept Publishing House, 1988, 143p, Rs. 100.

The study tries to explore the hypothesis that the cooperatives as they develop backward, forward and horizontal integration are to able increase the income of their farmer members through rationalization of costs and through undertaking value addition functions. The findings of the study reveal that cooperative in milk commodity have played an important role in improving the incomes of their members from the milk operation substantially and have also helped small landless to undertake milk production as a primary occupation.

Population and Economic Growth in India

By A.M. Goryacheva. New Delhi, Agricole Publishing Academy, 1988, Rs. 150.

This book deals with the question of economic and demographic processes in India after independence. On the one hand, the author examines the impact of changes in Indian economy on demographic behaviour particularly fertility and mortality rates, age composition of population and its occupational structure. On the other hand, influence of population growth on the rates, scales, character and efficiency of economic growth is studied. It is an important book for economists, planners, policy-makers and sociologists.

Process Design for Reliable Operations

By Norman F. Lieberman, Houstan, Gulf Publishing Co., 1988, 2nd edition, $ 35.

This edition explores a wide range of retrofit projects and explains why they went awry. It also examines ways to avoid poor process designs caused by over-reliance on computer design technology. It offers techniques to enhance the operating integrity, efficiency and flexibility of trayed and packed columns.

Regional Development Banks and Industrialisation

By L.K. Bansal. New Delhi, Deep & Deep Publications, 1988, 352p, Rs. 250.

The volume attempts to capture systematically and analytically the financial precedures, policies and operations of development banks in the field of large and medium industries, specially for the states of Punjab and Haryana. The efficiency and efficacy of these institutions have also been empirically tested. The study also highlights their inadequacies and shortcomings in performing their basic role. It presents a wide canvas to cover all important issues which may prove valuable to teachers, research scholars and policy-makers for the critical analysis of the development banks.

Rural Industry and Rural Industrialisation

By Ajit Kumar Sinha. Jaipur, Pointer Publishers, 1988, 144p, Rs. 140, $28.

The plan strategies for development have often been based on imported models. States like Bihar have remained non-industrialised backward regions.

The need for a native model for development in tune with socio-economic structure has often been stressed. This book is an attempt to work out a model development path for our economy on the basis of a balanced inter-relation between development, industrialisation and rural industries. A micro-level study based on field work, this work reveals that inspite of planned development efforts, rural industries continue to be an insignificant and inefficient activity in the rural areas. Industrialisation efforts of the country has had little or no influence on them. The study, tries to fill the gap of inadequacy of knowledge that exists on various aspects of rural industrialisation and its role in regional and national development. The author hopes that the study will provide new insights for future action for rapid development and thereby help in realising the dream of a developed India at the dawn of 21st century.

Scientists and Organisations: Managing People

By A.S. Menon. Trivandrum, CBH Publication, 1989, 214p, Rs. 160.

This book is the outcome of an indepth research study of work environments in a large Indian Research and Development Organisation and its impact on employee satisfaction and Organisational productivity. It deals with the Human Resource Management in an R&D Organisation. Unlike in other Organisations, Human Resources are the vital of all resources, which determine the productivity in an R&D Organisation. The chapter on Intrinsic work motivation forms a new aspect of contribution to motivation literature and should attract the theoreticians as well. The Chapter on Some guidelines and Practical suggestions, gives some indepth findings of the research.

Some Aspects of Resource Utilization in Agriculture

By Paul V. Solomakhin, New Delhi, Agricole Publishing Academy, 1989, 105p, Rs. 80.

The present monograph represents an example of integrated approach to problems of rational utilization of main production resources in agriculture. It is an inter-disciplinary study of several agro-disciplines such as economics, agronomy, mathematics, physiology, animal nutrition and others. The monograph is addressed mostly to agricultural economists and scientists working in animal feeding and nutrition and technologists and animal breeders. It would be useful for the students of agricultural specialities as well.

Technology, Growth and Welfare in Indian Agriculture

By Gobinda C. Mandal. New Delhi, Agricole Publishing Academy, 1988, 161p, Rs. 125.

This book deals with the author's findings to provoke intensive thinking on the possibility of overcoming hurdles to rural development arising in three ways: (1) Failure of the signals of price-mechanism to indicate the path of investment because of the prevalence of a large non-monetized sector in the rural economy where inputs are self-supplied (2) Domination of farm-business by small-sized units failing to create effective demand for capital goods and (3) Failure of scientific research in the field of technology to be geared to the formation of agricultural capital goods according to the needs of the agricultural sector.

Technology Options and Economic Policy for Dryland Agriculture: Potential and Challenge

By N.S. Jodha. New Delhi, Concept Publishing House, 1989, 365p, Rs. 250.

To review the current status of dryfarming technology and the support system it requires, a workshop was organised jointly by ISAE/ICRISAT/AICRPDA at ICRISAT Centre, Hyderabad in 1983. This publication brings together a selection of papers presented at the Workshop focussing on the main problems relating to dryland agricultural and the technological options that can alleviate them.

UNESCO and Social Sciences: Retrospect and Prospect

By S.P. Agrawal and J.C. Aggarwal. New Delhi, Concept Publishing Co., 1988, 366p, Rs. 250.

This book traces the history of UNESCO and examines its setup and constitution as well as its

objectives and its activities in the field of social sciences. The study also takes a close look into the interaction between UNESCO and India in different fields. The select list of UNESCO documents and publications on social sciences further enhances the utility of the book. The book provides an insight into the working of UNESCO and has sufficient reference material for use by students, teachers, research workers, social scientists, policy makers and administrators.

Union Management Relations in Banks

By R.K. Kothari. Jaipur, Pointer Publishers, 1988, 180p, Rs. 170.

The banking industry plays a significant role in the all-round development of a country. Trade Unions in the banking industry are in a very strong position and have tremendous bargaining power due to their well organised movement. The present work analyses union-management relations in the banks in Rajasthan. For this purpose two banks, one from the public sector and the other from the private sector have been chosen. Both these banks have more than 70 percent of their branches in Rajasthan with central offices in Jaipur. The study deals with the genesis, growth and the present situation of the trade union movement in the banking industry in India and throws new light on issues such as personnel policies, pay-scales, overtime and mechanisation and computerisation. Trade Union leaders, bank employers and policy-makers as well as research scholars would find this book interesting in their field.

Working Capital Management

By S.C. Bordia. Jaipur, Pointer Publishers, 1988, 261p, Rs. 240.

The book contains a comprehensive treatment of some important aspects of working of capital management. The book introduces the fundamental concepts of working capital and emphasises the role of the finance manager in working capital management. Various components of working capital such as inventory, receivables and cash are treated in depth. The pattern of financing working capital is also discussed in detail. The book focuses on the statistical techniques apart from financial management techniques which can be used for analysis of the working capital. Finally, it also offers suggestions for improving working capital management in order to enable a a firm to reduce its dependence on borrowed funds.

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