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Industrial Engineering in 2000 A.D.

R.S. GUPTA

The author in this paper looks into the future of the industrial engineering as a discipline. He recommends certain thrust areas where work needs to be done in the Indian context.

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Economic Development and Productivity

Productivity has already acquired a pivotal position in the process of economic development in our country. Food, work and productivity have been identified as basic priorities of the Seventh Five Year Plan. Not only on its own merits productivity has been given the place of importance, but its useful contribution in generating more food with minimum consumption of scarce resources and in alleviating poverty by creating productive employment has also been perceived. Even the Twenty Point Programme—1986 renews nation's commitment to raising productivity in all human endeavour as a means of removing poverty and creating fuller employment. The Seventh Five Year Plan makes a significant deviation from earlier policies whereby preference would be given to those investments which yield fuller utilisation of the capacities, facilities and resources already created. Investments in new projects and in creation of new capacities would be considered only when existing projects and capacities in the same sector become fully operative and utilised. There is no other alternative to ensuring fuller utilisation of the existing resources, if we want to convert our economy from high cost to low cost; if we wish our economy to acquire greater competitive capability and strength in the home and international markets; if we are keen that our social and rural development projects, as critical instruments of alleviating poverty, do not suffer or are not curtailed for want of funds. Our economy suffers from scarcity of capital and yet our capital-output ratio is

one and a half times adverse, if not twice, in comparison to well managed economies in the world. How long can we afford this luxury ? Certainly not any longer if we have to emerge as an economically powerful country by the turn of the century. Taking a broader perspective, Economic Development can be defined as a function of Productivity and Developmental Projects. Even in developmental projects, efficient management for effective utilisation of time and cost (productivity) becomes a key factor in their timely completion and least cost over-runs. This then is the powerful contribution of productivity in the economic development process.

Productivity and Industrial Engineering

There are many management sciences which steer the productivity improvement programmes in industry and other economic activities. In India and elsewhere in the world, Industrial Engineering, perhaps, is the oldest management science which found its application in industry for resource utilisation. ILO, which laid the foundation for launching a national movement on productivity in the country, initially demonstrated the efficacy of Industrial Engineering techniques as a means of raising productivity and popularised the same. Prominence and predominance of Industrial Engineering discipline in the activities of the National Productivity Council, establishment of NITIE, post-graduate courses in Industrial Engineering offered by the premier academic institutions and professional organisations, establishment of industrial engineering departments in a fairly large number of industrial units in the country and sizeable number of consultants operating predominantly in this discipline amply demonstrate the key role industrial engineering has played and will continue to play in the national effort for raising productivity and improving quality of life. By no means, it is my intention to undermine the role of other disciplines in productivity improvement; but it has to be recognised that the Industrial Engineering has been the pace setter in productivity improvement and let us hope that it will continue to play the leadership role in opening up new vistas and frontiers for productivity improvement and providing better quality of life for the people.

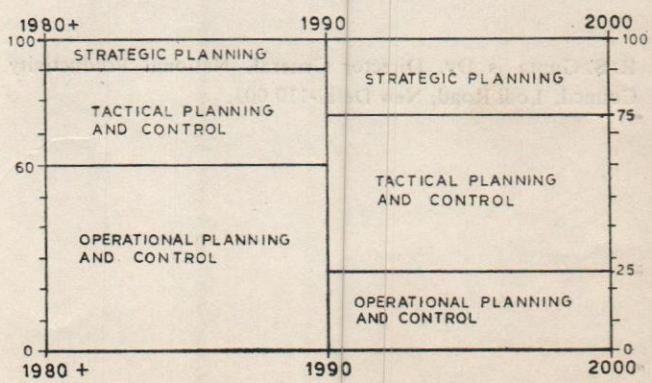
Conventional Role of Industrial Engineering

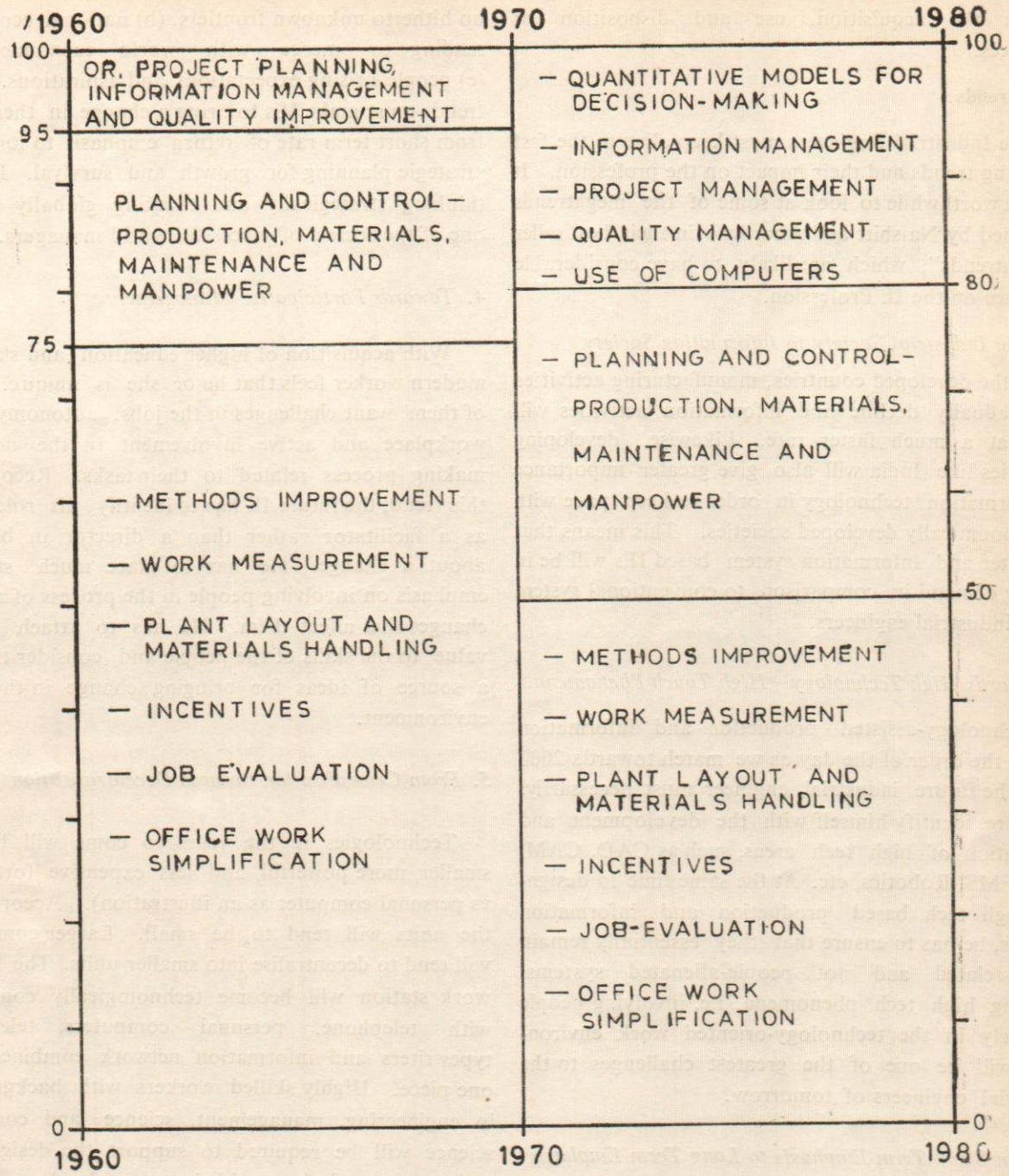
The Industrial Engineers in the past and even now are largely concerned with methods improvement, work simplification, work measurement, plant layout and materials handling, incentives and job evaluation, and to a limited extent with optimisation of sub-systems like production planning and control, materials planning and control, maintenance planning and control, manpower planning and control, project planning and control, etc. Only in very few cases they have been dealing with quality improvement, project planning, information systems and OR models. While conventional IE tools will continue to play an important role in the years to come, their importance will, however, gradually decline with emerging technological dimensions, their impact on people and human expectations and aspirations.

I must add that even in the conventional areas, the industrial engineering function has not been static; it has gone through an interesting phase of development to be able to meet the emerging challenges. The developments in the last two decades, in my opinion, have been as indicated in the following page.

Futuristic Role of Industrial Engineering

In the years to come, the role of industrial engineering will undergo a major shift in accordance with the changes that are taking place in the industrial society. The industrial engineers will be required to play a greater role in tactical and strategic planning as against operational planning and control as we stride towards 2000 AD. The shift in the IE role may be postulated as under :—





By Operational Planning and Control, I mean the process of assuring that specific tasks are carried out effectively and efficiently. Tactical Planning and Control is the process by which managers assure that the required resources are obtained and used effectively and efficiently in the accomplishment of the organisation's objectives. Through strategic planning, the Industrial Engineers will make positive interventions in deciding on the objectives of the organisation, on changes in these objectives, on the resources used to

obtain these objectives, and on the policies that are to govern the acquisition, use and disposition of resources.

Megatrends

The Industrial Engineers must keep alive to the fast changing trends and their impact on the profession. It will be worthwhile to look at some of the megatrends identified by Naisbitt and Aburdene in their best seller "Megatrends", which are likely to have considerable influence on the IE Profession.

1. From Industrial Society to Information Society

In the developed countries, manufacturing activities will gradually decline and information activities will grow at a much faster rate. Likewise, developing countries like India will also give greater importance to information technology in order to keep pace with the economically developed societies. This means that computer and information system based IEs will be in greater demand in comparison to conventional system based industrial engineers.

2. *Towards High Technology—High Touch Phenomena*

Technology-assisted production and information will be the order of the day as we march towards 2000 AD. The future industrial engineer must necessarily, therefore, identify himself with the development and application of high tech areas, such as CAD, CAM, CIM, FMS, Robotics, etc. At the same time in designing high tech based production and information systems, he has to ensure that they essentially remain people-related and not people-alienated systems. Creating high tech phenomena, i.e. involving people creatively in the technology-oriented work environment will be one of the greatest challenges to the industrial engineers of tomorrow.

3. From Short Term Emphasis to Long Term Emphasis

No economic activity can continue to exist for long without taking note of the environmental factors around it. A good management cannot afford to focus on the daily crisis alone and thus succumb to the temptation of "feeding today and starving tomorrow". The challenges of tomorrow are becoming far greater today than yesterday because of (a) unprecedented technological developments opening up hitherto unknown frontiers, (b) national economies tending to merge with world economies and (c) people's rising expectations and aspirations. These trends must make IEs to bring a change in their focus from short term rate of return emphasis to long term strategic planning for growth and survival. In fact, thinking strategically and thinking globally will be one of the secrets of successful world managers.

4. Towards Participative Management

With acquisition of higher education and skill, the modern worker feels that he or she is unique. Most of them want challenges in the jobs, autonomy in the workplace and active involvement in the decision-making process related to their tasks. Recognising this trend, the future IE has to identify his role more as a facilitator rather than a director in bringing about a change. He has to place much stronger emphasis on involving people in the process of making changes that affect them. He has to attach greater value to the skills of the people and consider them as a source of ideas for bringing change in the work environment.

5. From Centralisation towards Decentralisation

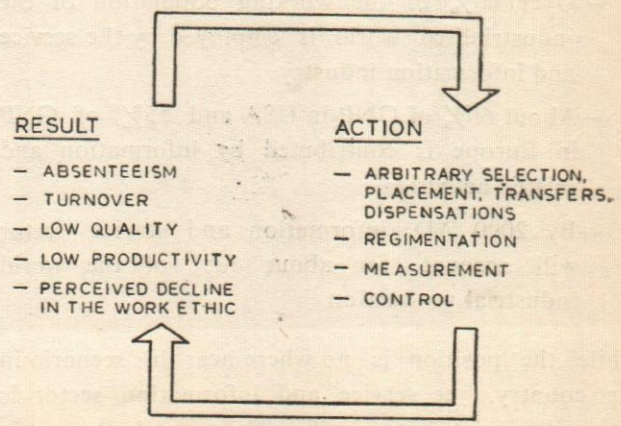
Technologies in the years to come will become smaller, more powerful and less expensive (orthodox vs personal computer as an illustration). Accordingly, the units will tend to be small. Larger companies will tend to decentralise into smaller units. The human work station will become technologically controlled with telephone, personal computers, television, typewriters and information network combined into one piece. Highly skilled workers with backgrounds in engineering, management, science and computer science will be required to support the design and maintenance of the sophisticated technology driven work environment. The tall pyramid structure within organisation will flatten. The hierarchical organisation will become obsolete, slow and costly. Due to cost and security considerations, it will become necessary to have common integrated data bases for all functions of the work organisation including engineering, finance, manufacturing and marketing. In the year 2000,

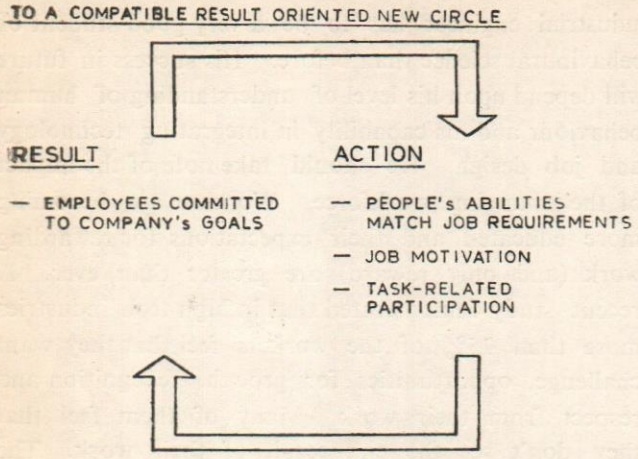
"technology management" will become a buzz word. It will require an integrated process involving both management and employees with the ultimate goal of managing the design, development, production, market, introduction and use of the various forms of technology in the work environment to improve both productivity and the quality of working life. The impact of these trends on the IE will be that of a generalist and not a specialist. He has to be a system integrator charged with the responsibility of ensuring optimal performance of the high tech based factory.

From this brief review of the megatrends, it is safe to conclude IE role in manufacturing systems in the future will be enhanced rather than diminished. The expectations that will result will be very high and varied. If this strong demand continues as a long term trend, the significant question could well be : "will the IE profession be able to meet this demand with sufficient quantity and quality?" Further a strong determinant of the role of IE in any manufacturing company is the vision which that company has of the profession. If the company management views it as limited to a work measurement role, that is most likely going to be its fate. The company that envisions IE taking the lead to creating manufacturing excellence as a competitive weapon will likely attract top IE people and create an exciting role for the profession. This observation underscores the importance of the vision of our profession. It is up to us as individuals and the institutional framework to promote a strong image of IE. Equally important to note is that the fate of the industrial engineer depends on the performance of the individual—it depends on the practice of the profession. And the practice of the profession depends to a great extent on the individual's ability to maintain competence through professional development.

Understanding of Human Behaviour

The emerging technologies will have tremendous impact on the people—on their employment pattern and behaviour. The industrial engineers have to address themselves to the real and imaginery problems related to unemployment and underemployment and tackle them in time lest anti-technology backlash takes place and slows down the process of development. Likewise an industrial engineer has to be a very good student of behavioural science than before. His success in future will depend upon his level of understanding of human behaviour and his capability in integrating technology and job design. He should take note of the impact of the changing workforce. Workers are becoming more educated and their expectations for rewarding work (and only reward) are greater than ever. A recent study demonstrated that in high tech industries more than 75% of the workers feel that they want challenge, opportunities for growth, recognition and respect from their work. Many of them feel that they don't see the end result of their work. The higher education and expectation level result in three attributes of the emerging workforce. One, the workforce is potentially very capable at skills, tasks and jobs which go beyond those available currently. Second, the workforce is used to learning and capable of additional learning/training. Third, and perhaps most important, the emerging workforce needs more than security. Security is needed to be satisfied, but more is needed in order to be motivated. These attributes demand from the industrial engineers that manufacturing jobs must be designed to match the education and expectations of the wokforce. The challenge is to match the job skills required with worker abilities—not because it's nice for the workers, but because good job design makes good business sense. They must work hard to change *incompatible and vicious circle* where jobs are designed to match worker ability and intellect so that employee's commitment to company goals, in the long run, is assured. Many





principles and guidelines have already been evolved for designing technology/jobs for human comfort. For want of space, I am deliberately refraining from mentioning them, but they are indeed important and cannot be overlooked or ignored if we wish to provide to the employees not only job satisfaction but job motivation as well.

A few More Thrust Areas in Indian Context

Service and Information Sector

While industrial engineering has made considerable dent in the manufacturing sector, its applications are few in the service and information sector. This sector in the developed countries is expected to play a dominant role by the turn of the century as could be gauged from the following statements :—

—Over 60% of the working population of the industrialised world is employed by the service and information industry

—About 60% of GNP in USA and 55% of GNP in Europe is contributed by information and related activities

—By 2000 AD, information and service sector will account for about 40% of the world industrial production

While the position is no where near this scenario in our country, yet service and information sector is expected to contribute significantly towards economic development. While in 1984-85 this sector contributed only 31% of the total gross value added, its contribution by 2000 AD is expected to touch 35.5% of GVA. In terms of GDP, its contribution is expected to almost double from 5.5% to 10.4% during the same period. It is, therefore, important that IEs should give their attention to this vital sector whose contribution to economic development will be significant and provide a need-based framework for better management decisions for improving its performance.

Decentralised Sector

One among many important reasons for poor performance in the industrial sector by the end of the Sixth Plan (3.7% actual as against 6.9% targetted growth rate) was lack of demand for wage goods particularly in the semi-urban and rural India. Improvement in the purchasing power in this part of the country which accounts for majority of the population demands pursuing a policy of creating fuller employment (including self-employment). The Twenty Point Programme—1986 has been announced for eradicating poverty, reducing income inequalities and achieving fuller employment. In support of this policy, massive investments during the Seventh Plan will be made in those sectors which directly contribute towards fulfilment of the above objectives. For instance, Rs. 9,000 crores is expected to be spent on rural development programmes and Rs. 2,750 crores in village and small industries development programmes. The industrial engineers, in my view, owe an obligation to the society to extend their expertise to this "hitherto uncared for" sector so that the economy derives maximum output or benefit from every rupee invested. Otherwise fulfilment of cherished objectives will remain only a wishful dream. The working in this sector will demand a change in outlook and behaviour on the part of industrial engineers from five-star culture to bare-footed culture—a bit difficult task.

White Collar Worker/Knowledge Worker

Associated with the need for improving productivity in the information and service sector, it is necessary that IEs give attention and emphasis to the

white collar worker and knowledge worker productivity rather than continuing the age old focus on the blue collar worker productivity. The need for this emphasis can be seen from the following statements :—

—Office costs are increasing, on average by 20% per annum

—25-40% of office salaries account for clerical support and the balance for the knowledge worker

—Productivity of the white collar employee, on an average, is less than 50% of the blue collar employee.

In the Ultimate Analysis

The external environment, in India as in any other country, will have tremendous impact on the growth and development of IE profession. One of the most important factors influencing the external environment is the felt-need for improving productivity in the various sectors of the Indian economy. The felt-need for improving productivity will emerge as a result of our deliberate shift from protective to competitive economy and when our leadership creates an environment of "challenge for survival". Let us not forget that nation-wide development and growth of IE profession will depend not upon a few progressive and forward looking top management but essentially on economic compulsions in the country—and the present trends are encouraging indeed.

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Capacity Utilisation in Textile Industry

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In this paper an attempt is made to study the level of capacity utilisation in NTC group of industries and to identify the reasons for poor capacity utilisation.

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Capacity utilisation is one of the important indicators amongst the available tools of measuring the efficiency of operation of manufacturing enterprises. If the public enterprises cannot utilise their installed capacity fully, the capacity utilised therein would be dead or idle to the extent of non-utilisation. Under-utilisation of capacity in public enterprises also leads to locking up of resources, high cost of production, obsolescence of plant and equipments and widespread repercussions on linked industries etc. We find that one of the unfortunate features of the process of India's industrialisation has been the under-utilisation of capacities in many branches of industry. The capacity utilisation in public sector textile group is not an exception to this.

In this paper, an attempt is made to evaluate the capacity utilisation position of NTC group of textile undertakings for the last four years viz., 1981-82, 1982-83, 1983-84 and 1984-85. Causes underlying low capacity utilisation have been identified and the role played by the Government and the management of textile undertakings in this regard has been examined. We have presented a brief picture of trends in the degree of capacity utilisation in textile industry based on selected available statistical data compiled from annual reports of BPE for concerned years. Installed capacity is used for the deriving the ratio of capacity utilisation which are also

used for the purpose by BPE. In order to reach at a meaningful conclusion, a comparative study has been made with reference to the capacity utilisation figures of private sector textile units, public sector consumer goods group and public enterprises (PEs) in India.

As the data of capacity utilisation relating to subsidiaries of NPC are available, we have considered them as NTC group for the purpose of our study. The Exhibit no. I depicts the classified information with respect to capacity utilisation of the subsidiaries of NTC individually and in the aggregate.

An overall review of utilisation of capacity in NTC group of textile undertakings reveals that looms for yarn have the better utilisation of capacity as compared to spindles for cloth during the years 1983-84 and 1984-85. The exhibit shows the fact that almost, all the units under study have been able to utilise at least 70 per cent of installed capacity. The capacity utilisation in NTC Mills was around 45 per cent at the time of their taking over. During 1981-82, it had gone upto 77 per cent in spinning and 75 per cent in weaving departments. However, during the year 1982-83, the capacity utilisation of the NTC subsidiaries in spinning had gone down to 61 per cent and in weaving departments to 56 per cent. Thereafter, the capacity utilisation in spinning and weaving departments has gone up to 72 per cent and 73 per cent respectively during 1983-84 followed by capacity utilisation percentages of 70 and 73 in the subsequent year. A very low level of capacity utilisation has been recorded in case of NTC (MN) and NTC (SM) during 1982-83 due to strike in Bombay NTC Units. Individually, NTC (APKKM), NTC (MN), NTC (TNP) and NTC (UP) have improved their performance in the area of capacity utilisation in spinning departments while in weaving departments only NTC (DPR) and NTC (UP) have been able to improve their capacity utilisation performance during the period under study.

In order to have meaningful conclusions, the capacity utilisation figures of operating units have been grouped into the following three categories : (i) Units recording capacity utilisation above 75 per cent; (ii) Units where capacity utilisation is between 50 per cent and 75 per cent; (iii) Units where capacity utilisation is less than 50 per cent. In order to determine the category of individual operating units engaged in the production of yarn and cloth, the cloth manufactured by looms (the suitable product) has been considered for the study purpose. The position with regard to the operating units has been shown in Exhibit no. II.

If we compare the capacity utilisation performance of operating units (category-wise) with the corresponding figures of the units operating in consumer goods group and with the figures of PEs. in India, it clearly depicts that the NTC subsidiaries are showing better capacity utilisation performance as compared to the units operating in consumer goods group and a poor capacity utilisation performance as compared to the figures of PEs. in India.

There are in all, three units in a total of nine operating units whose capacity utilisation has exceeded 75 per cent during 1984-85 as compared to 5 units in a total of 13 in the consumer goods and 87 units in a total of 180 in PEs. in India. In terms of percentage share, 33 per cent of the NTC subsidiaries have a capacity utilisation exceeding 75 per cent as compared to 38 per cent in the consumer goods group and 48 per cent of PEs. in India. In the second category, NTC units are in a better position. Their share of 56 per cent is not at all comparable to only 8 per cent of consumer goods group and 26 per cent of PEs. in India. The NTC subsidiaries have also enjoyed a much better position in the third category.

The above analysis clearly indicates that the position with regard to capacity utilisation of NTC units, individually at micro level and collectively at macro level is to be termed as satisfactory. This, however, does not mean that there is little scope for improvement in this area. If we look at the figures, we may also find that 33 per cent of the NTC units have a capacity utilisation exceeding 75 per cent as compared to 48 per cent for the PEs. in India. Furthermore, the position may not be considered sound in the light of the fact that a few private sector textile companies have more than 100 per cent utilisation of capacity (see Appendix no. 1) for some of their major products. The adverse capacity utilisation position has been affected by multifarious

EXHIBIT No. I

Utilisation of Capacity

(In per cent)

Units	YEARS							
	1981-82		1982-83		1983-84		1984-85	
	Spindles	Looms	Spindles	Looms	Spindles	Looms	Spindles	Looms
1. NTC (Andhra Pradesh, Karnataka, Kerala, & Mahe) Ltd.	63.8	86.6	81.4	86.5	73.4	82 4	75.2	76.5
2. NTC (Delhi, Panjab & Rajasthan) Ltd.	75.5	75.7	74.3	76.1	78.5	88.9	67.5	81.5
3. NTC (Gujarat) Ltd.	84.5	89.1	82.2	86.4	79.9	64.0	69.1	77.0
4. NTC (Madhya Pradesh) Ltd.	75.9	75.3	73.0	75.3	79.4	81.2	61.4	68.0
5. NTC (Maharashtra North) Ltd.	72.0	72.6	28.1	28.8	72.5	66.9	73.6	67.9
6. NTC (South Maharashtra) Ltd.	75.0	70.0	31.1	30.6	73.3	71.0	75.1	69.7
7. NTC (Tamil Nadu & Pondicherry) Ltd.	83.0	77.8	72.0	68.1	77.3	70.9	88.4	72.5
8. NTC (Uttar Pradesh) Ltd.	60.0	65.7	58.0	62.3	70.4	71.1	62.4	66.1
9. NTC (West Bengal, Assam, Bihar & Orissa) Ltd.	70.9	57.7	66.1	50.9	49.7	43.9	41.6	36.8
	76.5	74.5	61.1	56.2	71.6	73 2	70.0	73.0

EXHIBIT No. II

Capacity Utilisation (Categorywise)

Years	Categories											
	I			II			III			Total		
	NTC Subsi-diaries	Public Sector Con-sumer Goods Group	PEs. in India	NTC Subsi-diaries	Public Sector Con-sumer Goods Group	PEs. in India	NTC Subsi-diaries	Public Sector Con-sumer Goods Group	PEs in India	NTC Subsi-diaries	Public Sector Con-sumer Goods Group	PEs. in India
1981-82	5 (56)	3 (30)	80 (54)	4 (44)	3 (30)	43 (29)	—	4 (40)	25 (17)	9 (100)	10 (100)	148 (100)
1982-83	4 (45)	3 (25)	90 (55)	3 (33)	3 (25)	43 (26)	2 (22)	6 (50)	41 (19)	9 (100)	12 (100)	164 (100)
1983-84	4 (45)	4 (33)	88 (51)	4 (45)	3 (25)	49 (29)	1 (10)	5 (42)	35 (20)	9 (100)	12 (100)	172 (100)
1984-85	3 (33)	5 (38)	87 (48)	5 (56)	1 (8)	47 (26)	1 (11)	7 (54)	46 (26)	9 (100)	13 (100)	180 (100)

Note : (1) Figures within brckets indicate percentage share.

(2) Figures of consumer goods group relate to 12 PEs. They are (i) Artificial Limbs Manufacturing Corporation Ltd., (ii) Bharat Opthalmic Glass Ltd., (iii) Hindustan Latex Ltd., (iv) Hindustan Paper Corporation Ltd., (v) Hindustan Photofilms Manufacturing Co. Ltd. Ooty Unit, (vi) Mandya National Paper Mills Ltd., (vii) Modern Food Industries (India) Ltd., (viii) National News Print & Papers Mills Ltd., (ix) National Jute Manufacturers Corporation Ltd., (x) Nagaland Pulp and Paper Co. Ltd., (xi) Rehabilitation Industries Corporation Ltd , and (xii) Tannery and Footwear Corporation of India Ltd.

factors. Management of these units can improve it by considering these factors in proper perspective. The important factors affecting the utilisation of capacity are as follows :

1. Old and Obsolete Machinery : This factor resulted in keeping the units technologically backward and administratively inefficient. In the nationalised sick NTC mills, most of the plant and equipments are very old and some of them are obsolete. The upkeep and maintenance of these machines had been grossly neglected. So far, there has been no modernisation in the real sense, it has been only rehabilitation and modernisation. Prior to the declaration of the new textile policy, emphasis was placed on expansion rather than on modernisation. Adequate finances were not available to textile industry itself for modernisation. Further, the difficulties of getting imported machinery has also been one of the inhibiting factors as far as the modernisation is concerned. The other main cause has been the high manufacturing cost of indigenous machinery. Imported machinery was far cheaper than indigenous manufacture. High taxation by way of excise duty has also stood in the way of introducing modernisation. Old and obsolete machinery not only affects the efficiency but also the quality of cloth of the units.

2. Crisis of Raw Cotton and Power Shortages : The availability of cheap materials of good quality is essential to have a better production efficiency in the organisation. NTC Units have been affected by the poor supply position of raw cotton since inception. Cotton comprises approximately 50 per cent of the end product in a cotton textile mill. Prior to the nationalisation when these mills were managed by different authorised controllers and State Textile Corporations, by and large, the requirement of cotton was met through purchase from private parties. After the nationalisation and the subsequent formation of subsidiaries, NTC apex body initiated co-ordination for the purpose of purchase of cotton from the public sector undertakings viz., Cotton Corporation of India and Co-operative Agencies. During 1979-80, as much as 95 per cent of the total purchases of cotton were made through these. Even at present, bulk of the purchase of cotton is made from them. This process, however, takes a lengthy lead time in supply of cotton and this creates bottle-necks in production. As, the cotton prices ruled steady till the middle of 1980-81 and showed upward trend thereafter, the impact of increase in cotton prices was felt by the mills, particularly for coarse and medium varieties.

In almost all the operating NTC undertakings, power failures and power shortages have affected the production efficiency to a significant extent. Power shortages an ! power fluctuations have caused a total production loss of 49 million metres valued at Rs. 19.24 crores and caused an overall loss of Rs. 6.6 crores during 1981-82.

A steady increase in the cotton cost coupled with power shortages, affected the performance of NTC Mills adversely resulting in a loss of 32.26 million metres of cloth valued at approximately Rs. 13.75 crores during 1982-83 and 30 million metres of cloth valued at approximately Rs. 14.70 crores during 1983-84. During the year 1979-80, the cloth production of NTC group has come down to 843 million metres as against 940 million meters in the previous year mainly on account of power cut regulations prevalent in most of the states.

3. Demand Constraints : The low production efficiency in NTC Units can be partly attributed to the lack of demand for the cloth manufactured by NTC Mills. Inadequate demand may be due to the following factors : (i) ascertainment of the product-mix had not been made according to the tastes and requirements of consumers as we found that coarse and medium varieties of cloth produced under the Government controlled cloth scheme were not even purchased by the poor; (ii) NTC Units have to face tough competition from the private sector; (iii) NTC showrooms are not able to attract more and more customers due to lack of decoration; and (iv) poor quality of products.

4. Strained Employer-Employee Relations : Lack of cordial industrial relations in many of the central Government undertakings have affected their production efficiency to a greater extent. In the Draft outline of Sixth Five-year Plan, it has been recognised

that "Strained industrial relations have also contributed to inadequate capacity utilisation in several key sectors". A historical review of strikes, agitation and lockouts in public sector textile group clearly indicates that the relationship between the employer and the employee is not completely cordial. The strike in 12 NTC Mills situated in Bombay was responsible for a loss in cloth production of 53 million metres valued at Rs. 20.80 crores during 1981-82 and 225 million metres valued at Rs. 95.60 crores during 1982-83. There was a strike in Rae Bareilly Textile Mills, a taken over Mill of NTC (UP), to demand a bonus of Rs. 200 per employee. A recent strike of 24 hours in Swadeshi Cotton Mills, Naini, Allahabad, a taken over Mill of NTC (UP), in June 1986 was called for a compensation of Rs. 50,000 to the family of a deceased employee. Over 20,000 workers of five textile mills (including Ajudhiya Textile Mills managed by NTC) of Delhi were on strike from 28 May to 15 August (24 July in case of NTC managed Mills) 1986 to press the demands which include upward revision of wages with an interim increase of Rs. 100 p.m. and payment of H.R.A.

5. Multiplicity of Products : The committee on Public undertakings have felt that "public undertakings had not formulated their diversification programmes in time to check the impact of recession. Had they done so, there would not have been gross under-utilisation of capacity in major public undertakings". As regards efficiency in production, this factor works in opposite direction. It has been felt that different products attract the attention of management from different angles and management is generally unable to cope up with the diversified production efficiency requirement for different products. In case of NTC Units, the different products in product range are cotton fibre, hosiery, yarn, polyester-cotton, polyester viscose yarn, pure viscose staple fibre yarn, khadi cloth, rifle cloth etc. In addition, the cloth manufactured consists long cloth, dhoti, sarees, popli ne, bed-sheets, shirting, drill, mazri, mosquito netting etc. The low capacity utilisation in NTC Units can be partly attributed to diversified product range of the units.

6. Sickness of Unit : The management of these units is forced with the complex task of managing financial affairs of sick units. The units which are financially unsound and are coming under the purview of Government control, cannot be managed effectively even in terms of production efficiency. Frequent strikes and lockouts, poor welfare amenities to employees, obsolescence of equipments etc. always hamper efficient utilisation of capacity.

Role of Government in Efficiency Improvement

The Government has taken a number of measures to assist the textile industry to *set up the pace of modernisation and achieve higher production* through improved technology and reduction in costs. Under the soft-term loan scheme, Industrial Development Bank of India (IDBI) disbursed loans amounting to Rs. 439.4 crores till March 31, 1986. Now a special fund of Rs. 750 crores has been created on 1st August 1986 by IDBI to meet the modernisation requirements of the industry over the next five years. In the first fortnight of September 1986, the IDBI has already received 25 applications for a total of about Rs. 125 crores amongst which, two applications for Rs. 11 crores have already been approved. Besides the Government has issued directives to banks and financial institutions to finance the requirements liberally. The Government is also directly funding such requirements.

The Government announced in Parliament a package of *customs and excise duty reliefs* totalling Rs. 131 crores p.a. on polyester fibre, polyester cotton, acrylic fibre and assigned a bigger role to the NTC Units to take on the responsibility of production of 80 million metres of cheap cloth for the poorer sections in the year 1984-85. It is stated in the new textile policy that cotton needed by the textile industry would be made available in adequate quantity and at reasonable prices. Liberal import of raw wool has been proposed in the existing policy.

The incorporation of Cotton Corporation of India in public sector was a serious effort in this direction. It is stated in the existing textile policy that *stability in cotton prices* is sought to be achieved while assuring remunerative prices to the farmers. The role of

Cotton Corporation of India would thus be redefined in the context of new textile statement.

The Government is very anxious to *improve the demand of the cloth manufactured* by NTC group through making available the cloth at reasonable prices and diversifying the product range. The existing policy sets out a number of objectives. While each of these objectives has inhibited the achievements of the main task of the textile industry, that is to increase the production of cloth of acceptable quality at reasonable prices to meet the clothing requirements of a growing population. In the pursuit of this main objective, the availability of cloth at affordable prices for the poorer sections of the population shall be augmented.

Role of Management

In most of the NTC Mills, obsolescence of machinery is a major constraint in the way of optimum utilisation of production efficiency. Prior to nationalisation, certain renovation programmes were sanctioned by the Government mainly to enable the mills to restart. Subsequent to the nationalisation and formation of the subsidiaries, NTC in close consultations with the regional subsidiaries has prepared a long corporate plan containing, inter-alia, an investment programmes for Rs. 320 crores for rejuvenation and partial mechanisation of their mills to be completed by the end of Sixth Five-Year Plan. *Modernisation programmes* are formulated to serve a combination of the following main objectives : (i) reduction in cost of manufacture and damages, and improvement in quality; (ii) Overall improvement in productivity; (iii) diversification and upgradation of the product-mix; (iv) to rectify the existing imbalance within the production department; and (v) to improve the material flow. Amount spent on modernisation upto 31st March 1985, was Rs. 301 crores. By 31st March 1984, machinery worth Rs. 287 crores have already been received. As a result of modernisation, the average count of NTC Mills has steadily gone finer by one count every year. The utilisation of installed capacity has improved since inception. The quality of yarn produced also improved resulting in improved quality of fabrics. Since the quality and price of various items produced by the NTC Mills have become competitive, private shops are taking advantage of the situation as it has come to the notice of NTC that some of its products are being sold by shops of private mills in the guise of their manufacture at higher prices. It is due to the implementation of modernisation schemes that NTC Mills are today in a position to produce blended yarn.

NTC has formulated a modernisation scheme consisting of Rs. 301.90 crores for implementation during the Seventh Five-Year Plan to pull the corporation out of red. The *Selectivity-based corporate plan for modernisation* would yield a gross profit of Rs. 33 crores by the end of the Seventh Plan. Production value is expected to touch Rs. 1,062.96 crores. The plan has been drawn up for each mill keeping in view the condition of machinery in a particular mill. Owing to non-availablity of uninterrupted power supply, priority has also been given to creation of inhouse power capacity over modernisation. NTC has drawn up a five year *rationalisation scheme* at a cost of Rs. 76 crores. This would be undertaken by NTC on "voluntary rationalisation" basis.

The management of the NTC Mills is *introducing the schemes of product diversification* in order to meet the clothing requirements of more and more people. However, as regards the improvement in capacity utilisation position, this factor may work in the opposite direction. For the inherited problem of *strained industrial relations*, the management of NTC textile mills is taking more and more interest in the provision of welfare amenities, recognition of trade union activities and redressing the grievances of employees. As a part of ambitious programme to associate workers in vital areas of management, 36 management committees have been formed in different NTC Mills. The function of these committees has brought about greater involvement of labour in discussions on matters such as purchase, sales, production programmes utilisation of improved productivity and improved profitability. After the introduction of the scheme of Management Committees, there is an improvement in some of the mills in productivity, attendance, reduction in waste, reduction in value loss, increase in weaving efficiency etc. Further, wage

revision agreements and bipartite committees are also improving the position of industrial relations.

In order to improve the operational efficiency, the management of NTC Units is striving hard specifically to *monitor energy consumption pattern*. Biogas energy is used in one of the NTC Mills in Bombay (Appolo Mills). The energy is derived from gas produced from willow dust. Another biogas plant is in operation in Model Mills at Nagpur. The gas is used for cooking in the workers' canteen. The Corporation has installed *solar hot water system* in one of its mills (Jehangir Textile Mills). This is used for heating water in boilers and in the process house. Proposals for installation of such system in a few other mills are under consideration/implementation.

Outlook for Future

In view of the technical changes constantly taking place abroad in the textile field, we have to evolve and implement a bold modernisation scheme. Under the scheme, the modernisation in the spinning, weaving and processing sectors will be undertaken on the basis of carefully identified needs of each unit". In spite of a number of measures taken by Government to assist the textile industry, NTC Mills are facing the problem of inadequate provision of funds. Here we may suggest that the scheme should be implemented on selected units.

It is essential in the revival of sick-units that modernisation plans should be approved speedily. Loan to NTC should bear lower rates of interest and amounts for improving should be made available by way of equity. The debt-equity ratio in NTC group should be kept at least 1 : 2 instead of the present 1 : 0.257. It means, NTC group can raise its funds to the extent of 8 times at the present level of equity (Rs. 289.75 crores as on 31-3-1985). This will help the NTC to meet its full requirements of modernisation programmes easily. Meanwhile, banks should provide adequate working capital to the sick units. Fund for the creation of in-house power generation capacity should also be made available at concessional rates of interest.

Regarding the power shortages and power cuts, the installation of generators is the only solution. Incorporation of delay relays in the critical equipments in order to prevent momentary voltage dips would increase the longevity of the equipments. As it is a general problem faced by the country, there is a need to encourage big business houses of the country to set up more and more thermal stations in the country to meet the power shortage problem.

The management of NTC Mills have to manage the affairs of the sick undertakings. These sick mills were taken over by the Government to meet few social objectives, viz. protection of employment, improving labour productivity, position of welfare amenities to employees etc. With limited resources, old and obsolete machinery, poor labour efficiency, and the given structure of taken over mills, the managers are concerned with 100 per cent utilisation of the capacity. It is a formidable task and the managers of NTC Mills are striving hard to accomplish the goal.

APPENDIX I

Utilisation of Capacity in Major Products for Selected Private Sector Textile Units During 1984-85

Name of the company	Unit	Installed capacity	Production	Utilisation (Percentage)
1. *Reliance Industries Ltd.*				
Yarn (POY, PFY, Cotton & Blended)	Tonnes	25,125	30,345	120.8
2. *Baroda Rayon*				
Viscose Filament Yarn	,,	4,500	4,411	98.0
Nylon Yarn	,,	2,436	3,288	135.0
Polyester Yarn	,,	1,777	1,469	82.7
3. *Century Spg.*				
Rayon Yarn	,,	7,000	12,389	177.0
4. *J.K. Synthetics Ltd.*				
Nylon/Polyester Filament Yarn	,,	9,400	8,492	90.3
Nylon/Polyester Staple Fibre	,,	12,000	6,901	57.5
Nylon Terycot Yarn/Fabric	,,	5,000	5,441	108.8
Acrylic Staple Fibre	,,	16,000	9,116	57.0
5. *Indian Rayon*				
Viscose Filament Rayon Yarn	,,	7,300	7,907	108.3

Source : Annual Reports of the individual companies.

Note : Utilisation has been worked out only for such products where units of capacity and production are same and comparable. Only selected products are taken into account for compiling the capacity utilisation.

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Enhancing Innovation Capability

DEEPTI BHATNAGAR

The paper dwells on the need for improving innovation capability of the banks and suggests measures for fostering an innovation supportive climate across the organisation.

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One often hears the chief executives of banks, senior government functionaries, the media, and representatives of the public at large exhorting the nationalised banks to become more innovative in their outlook. However, besides exhortations, little attempt is made to help banks develop an integrated strategy to enhance their innovation capability. This paper proposes an integrated approach to help individual banks develop and maintain an organizational capability to look for and experiment with new ideas which lead to better achievement of organizational objectives. The approach proposed here rests on the assumptions that (a) innovation is important for a bank for better achievement of its goals, and (b) to ensure continual experimentation and innovation, a bank needs to cultivate a climate supportive of innovation, and it needs to have a separate structural mechanism to garner its innovative capability.

Innovation Capability and Banks

Innovation capability refers to a state of eagerness in an organization to experiment with new ideas, with the objective of improving organizational performance. An organization with high innovation-orientation actively encourages its members to conceive, develop, test, modify and adopt new ideas. In order to be innovative, an organization needs to have high creativity among its people as well as appropriate support systems like a supportive climate, suitable formal and informal reward systems, and well-defined

procedures for nurturing new ideas and developing them into full-blown innovations.

Development of innovation capability is particularly relevant for public sector banks in the present context. The environment in which banks are operating is undergoing a rapid change. Numerous technological advances are taking place in diverse range of economic activities like industry, telecommunication, transport, the technology of banking itself. Computers in particular are likely to usher in a sea-change in the field of data handling. In order to keep pace with these changes, and also to benefit from the technological breakthroughs, banks need to be in a state of readiness to assimilate these changes easily.

The expectation from banks to perform well on seemingly conflicting fronts presents another imperative for banks to look for fresh approaches to banking. Banks are expected to maintain a high rate of growth resulting in rapid branch expansion which necessitates placing of new, often untrained people in new posts. There has been a phenomenal expansion of branch networks in recent years. Alongwith this unprecedented expansion, the complexities of banking business have vastly increased. These together result in tremendous managerial and operational problems at the branch level which are bound to get reflected in lowered customer service. Yet, there are strong pressures on banks not only to maintain the current level of customer service, but to bring about noticeable improvements. Designation of 1986 'year of the Customer' highlighted the fact that the government (and public) expect a fundamental change in the tenor of customer service. Bankers thus face the difficult task of achieving simultaneous business growth and improved customer service. A high innovation orientation can help a bank look for new ways to achieve these ostensibly conflicting objectives.

Nationalised banks also have little elbow-room for decision-making. Many important organizational issues such as the product-mix (controlled largely by the government through allocations to different sectors); market penetration (decided by the Reserve Bank of India which regulates the opening of new branches by banks); selection and recruitment of employees (carried out by the Banking Services Recruitment Board at the industry level); wage and salary structure (standardised at the industry level), etc., are outside the decision-making authority of individual banks. Recently, even the discretion to decide service charges has been withdrawn. This leaves banks with a considerably restricted decision-making area wherein to exercise their autonomy. In order to make an impact, individual banks need to innovate a great deal and find ways to exploit maximally their limited autonomy.

The role of a banker has been enlarged from a traditional lender to that of a monitor with responsibility to ensure that credit is used as an instrument of economic development. This shift is opening up tremendous need and opportunities for innovation at the micro level. Variety of new roles are being enjoined upon a banker, especially in rural areas, like extension worker, information disseminator, counsellor, liaison officer, etc., with little effort on the part of banks to equip their managers with skills required for playing these roles with felicity. Not only training systems of banks have to be geared up for this challenge, but the larger climate in banks has to be conducive for experimentation and innovation at the branch level.

Finally, intense competition with other banks and with non-banking financial institutions require an innovative posture from banks. Individual banks have to think of new and imaginative approaches to banking if they have to stay ahead of their competitors. These approaches can relate to new, need-based schemes for deposits and lending; they can aim at improving customer service. With their increasing awareness, customers' expectations from banks are going up. In an industry characterised by uniformity in every other respect, distinctly superior customer service can provide a bank the cutting edge over its competitors. Combined pressures from the Government and public for improvement in customer service provide impetus to innovate in this field and maintain superiority over other banks.

Innovation in Banks

Indian banks in the past have been experimenting

with innovations in different fields. These include banking schemes-related innovations, operations-related innovations; structure-related innovations and people-related innovations.

Time and again banks come up with new *deposits/loans schemes* to attract business. However, the success of such schemes depends significantly on the extent to which the new scheme is addressed to a real or potential need of the customer. In the past many such attempts at innovation failed because either the scheme was merely old wine in new bottles, or even if a new idea, it did not meet any latent need of customers. The failure of most such schemes can be ascribed to the remoteness of the framer of schemes in head office departments from branch operations and potential users of schemes.

Operations-related innovations are aimed at improving the productivity of operations and the quality of customer service. At the branch level, these include changes relating to O & M, layout, physical service operations, extent of computerisation, and other measures to improve customer service. Sometimes these innovations are introduced by the head office, for example, improved stationery and new methods for maintaining ledgers, single-service counters, etc. Most of the operations-related innovations, however, are introduced at the initiative of branch members in response to felt needs at the branch level. They are identified with certain persons and their success depends upon the acceptabi ity of the agents within the branch. Since they remain person—and branch-specific, these innovations fail to get diffused across the bank or get stabilised over time and are discarded as soon as the change agents leave the branch.

Structure-related innovations characterise changes in work assignments, authority structure, formal communication patterns, etc. Pressures of growth, voluminous increase in business and growing diversity of business are some of the compulsions prompting banks to introduce structural changes. Some well-known structural innovations include Gram Vikas Kendra and Multi-service Agency (Bank of Baroda), Rural Clinic (Syndicate Bank), Rural Development Centre (Dena Bank), etc. Also satellite branches, extension counters are examples of aggressive banking innovations. A number of banks have reorganized their zonal and regional set-up to provide new thrusts to their operations. However, true innovation predisposition with regard to structure implies not just introducing a stuctural change in the bank as a one-time thing, but a bank's willingness to examine from time to time the suitability of a bank's organization structure to its major tasks ahead and a flexibility to change accordingly.

The final category of innovations can be termed *people-related innovation*. At the organization-level, these include introduction of new systems like performance evaluation and reward systems, new technologies and approaches to training; and at the branch level consist of innovative motivational and problem-solving approaches like job enrichment, quality circles, etc. In a service industry like banking, the importance of adopting innovative approaches for handling human resources is self-evident: the need becomes much more pressing in the context of the legacy of an outdated motivation approach still prevalent in most banks, and the rising educational and aspirations level of the workforce. Though some banks have adopted modern appraisal methods, some banks have separate human resources development departments, and a number of banks are opting for modern training methods, yet for want of an innovation-supportive climate, majority of people-innovations in banks have remained by and large mechanistic in nature. For example, often the data generated by new appraisal system is not being used effectively. HRD departments collect, compile and store useful information about employees but stop short of a purposeful analysis which can result in appropriate managerial interventions; and though a number of banks are using innovative training methods to improve participants' self-awareness and interpersonal competence, little behavioural change is actually taking place for want of a suitable climate in the back-home situation.

Admittedly, innovations, particularly people-related innovations take a long time to get assimilated in the life and fibre of an organization. They can take root

only if accompanied with supportive and encouraging signals from higher echelons of the organization. Therefore, the first prerequisite for promoting innovations is developing a pro-innovation climate in the bank.

Second, the above examples highlight the ad hoc and one-time nature of innovation activities in banks which take place either at the whim of some top decision-makers, in reaction to severe environmental pressures, or due to extraordinary initiative of some individuals. In the absence of a planned approach, innovation remains an unpredictable activity. Since no individual or unit is changed with the specific responsibility to look for opportunities for innovation, for a long time no fresh ideas may come up and many significant opportunities may pass the bank by, unnoticed and unexploited. Also, the act of innovation depends largely on the initiative of few creative individuals; they have to fight several levels of organizational resistance before the top management gets to hear of new ideas. In the course of their upward journey, many promising ideas which can disrupt the status quo get suppressed or distorted, and many good ideas die an untimely death. For want of organizational sponsorship, many worthwhile innovations emanating at the branch level fail to get disseminated and diffused to other branches. Also, if an innovation is identified closely with its originator, its implementation generates interpersonal hostility and resistance irrespective of the merits of the innovation.

Strategy for Enhancing the Innovation Capability of a Bank

To overcome the above mentioned problems, we propose a two-pronged strategy for enhancing the innovation capability of a bank. First, a bank needs to foster an innovation-supportive climate across the organization which encourages people at grassroots level to think differently, to adopt new perspectives while handling old problems and if necessary, to undertake moderate risks while trying to bring about improvements in their respective departments/offices. Secondly and equally important, is the creation of a separate Innovation Division at the corporate level whose main responsibility would be to constantly scan the external and internal environment for innovation opportunities and new ideas; to generate, examine and develop worthwhile ideas into implementable projects and to ensure the implementation and institutionalization of innovations.

a. Innovation-Supportive Climate

The climate of a bank can contribute significantly to either encouraging or stifling the innovative urge and capability of its people. In a number of banks, the climate acts as a depressant to any innovative activity. Status quo is valued and attempts to bring about change are feared and often actively thwarted.

It is difficult, but not impossible to bring about changes in the climate of a bank to make it more innovation-supportive. However, strategies which can be used to bring about such climatic changes need to be used with conviction, sincerity and consistency. First, members of the top management team through their every day behaviour need to give a message that they value goal-directed creativity. In day-to-day behaviour they need to show openness to new ideas, encourage moderate risk-taking and show some tolerance for mistakes. This needs to be reinforced by formal and informal communications emanating from the top management team. These communications can time and again reiterate the need for innovation activity in the bank. Gatherings of employees can be used as an opportunity to articulate the significance the bank attaches to innovative thinking.

Such communications need to be supported by mechanisms to provide positive reinforcement to innovators. To attach organizational prestige to the act of innovation, a bank can develop recognition and reward schemes for outstanding innovators. They can be honoured and rewarded within the bank, and can be given visibility outside the bank. Outstanding innovators can be bestowed organizational power by associating them with appropriate decision making bodies and committees. A bank can institute attractive suggestion schemes and provide monetary incentives as well as credit to people suggesting bright, implementable ideas. However, since each bank has

its unique culture and character, fostering an innovation-supportive climate has to be a bank-specific exercise. The Innovation Division discussed in the following section can help the top management team by suggesting specific measures and action plan to promote innovation-orientation across the organization.

b. Innovation Division

For bringing innovation into the mainstream of a bank, a separate division can be formed at the corporate level. This division would have the following objectives:

1. Ensuring an ongoing search from external and internal sources for ideas which can be developed into worthwhile innovations for the bank.
2. Development of such ideas into implementable project proposals, seeking the top management and the implentation of the project with the help of relevant operational units.
3. Constant search for innovations taking place at the grassroots level; examining their value and broader applicability and ensuring bank-wide dissemination of worthwhile ideas while giving organizational recognition to actual generator of the idea.
4. Developing from time to time, schemes which can help promote greater innovation-orientation across the bank.

The formation of a separate Innovation Division rests upon the following considerations :

* Rather than being left to chance, innovation needs to become an integral part of a bank's functioning.
* New ideas are often conceived at the workplace yet their development requires time to think through the idea, to follow up the idea through different layers of organizational hierarchy till they are brought to the attention of the top management and finally the approval of the top management often depends more on the political sagacity of the originator of the ideas than the merit of the idea. The unending flow of routine work at the operations level hardly offers the slack of motivation required for this purpose. The Innovation Division can help bring the operational level creativity close to the top level so that good ideas are not lost for want of sponsorship or time for follow-up.
* Research evidence (Zaltman, Duncan and Holbek, 1973) indicates that different structural and process characteristics are desirable for different phases in the innovation process. At the ideas generation and development stage, a low degree of structure and control is required so that members can contribute and develop ideas freely as equals. The implementation stage, on the other hand, requires a well-defined and clearly-structured unit which can carry out the task of smooth and uniform implementation. The suggested Innovation Division needs to be sufficiently "destructured" to promote a hierarchy-free climate in which creative thinking, search, generation and development of ideas can take place. At the implementation stage, active help of well-structured operating divisions can be taken.

Characteristics and Role of the Innovation Division

The detailed design of the Innovation Division has been presented elsewhere (Bhatnagar, 1986). Here we discuss the major operating characteristics and role of the Innovation Division.

It would comprise of a few creative young officers who would represent major streams of banking operations. These officers would be inducted into the division at different points of time for a period of two years on completion of which they would return to their respective divisions and would be replaced by new officers. In addition to the intimate knowledge about the branch of banking which they represent, these officers are expected to bring to the Innovation Division fresh perspectives and creative new ideas. This group would be led by a competent senior executive who would act as a facilitator. The leader will report to the top management.

The leader would need to have considerable clout in the bank so that he can procure necessary resources for the division, garner suitable rewards like recognition and visibility to keep his team of bright, creative officers motivated and enlist support from the top management and the bank as a whole for the ideas and proposals initiated by the Innovation Division.

The promising new ideas developed by the Division would be submitted to the top management team for approval. Once the approval and support of the top management is obtained, the Division would develop the ideas into implementable project proposals. At the idea-development stage, therefore, close interaction of the Innovation Division with the operating divisions would be necessary to ensure that the innovation so developed is strongly rooted in the organizational reality of a bank. Such an interaction would give the operating divisions a chance to participate in the development of the new project which besides improving the quality of the innovation, would also help lower the operating divisions' resistance to the innovation.

The last point is particularly relevant because although the Innovation Division would have the backing of the top management to implement innovations, such support would be necessary but not sufficient for the widespread diffusion and acceptance of innovations across the bank. It would be necessary for the team members to build and maintain networks and coalitions in the organization which would increase the acceptability of innovations. Also, for each innovation, members of the Division would need to carefully assess the perceived need for innovation, openness and readiness to accept innovation, the capacity to implement the innovation and the commitment towards the innovation in the target system. Indeed at the idea development stage, representatives of the target system can be selectively involved not only for firm grounding of the proposal in organizational reality, but also to develop in the target system a sense of perceived control and ownership over the innovation. For each innovation the Innovation Division would need to chalk out carefully an implementation strategy based on the nature, coverage and the radicality of the innovation and the characteristics of the specific target group.

Summary

While the top management's change-supportive values are important factors in facilitating innovation (Hage and Dewar, 1973), yet, as the experience of banks shows, it requires much more than a pro-innovation ideology and exhortations to promote innovations. This paper has proposed a two-pronged approach to enhance the innovation capability of a bank. The development of an innovation-supportive climate which places value on worthwhile new ideas, and the formation of an Innovation Division at the corporate level which originates and develops promising ideas into useful innovations would help institutionalise this capability in a bank.

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Capacity Utilisation in Indian Industry

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The paper presents a state-of-art of capacity utilisation in Indian Industry and also presents suggestions to improve the same.

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Introduction

Better capacity utilisation is regarded as a precondition for accelerating the tempo of industrial growth, improving the rates of return on capital and generating additional resources. It also provides an opportunity for a quick increase in output and productivity in the short-run, thus improving the prospects for controlling inflation and creating conditions for accelerated growth in output as well as investment in the years to come. Besides, employment absorption rises implicitly with the rise in capital operation. An increasing concern of the employment implications of industrialisation suggests that this (employment) is the most important goal of utilisation policy. Thus it is widely accepted that economic growth and employment in less developed countries (LDCs) depend on additions to the capital stock. While the poor utilisation of capacity represents a waste of resources and thus adds to the resource constraint.

Generally it is assumed that businessmen make appropriate calculation and attempt to maximise profits. Then if single shift operation is widespread during periods of normal business activity, it may be because multiple shifts would not be profitable. But how can this be if the country has abundant labour and scarce capital? Because of conflict between private

and social costs excess capacity is prevalent may be the possible answer.

The problems of under-employment and unemployment have received wide attention, while those of under-utilisation or non-utilisation of capital or capacity have not probably received much attention in India. This may appear surprising in view of resource endowments of the country.

Further, it is a paradox of no small significance that a great deal of industrial capital is left idle most of the time in India. Would it not be desirable to use the abundant labour to keep the factories going for 24 hours, thereby increasing employment and output at the same time? How can the low levels of capital use be explained or justified? The issues involved relate to the concept of capacity and its measurement, imports and exports, factors influencing capacity utilisation, nature and extent of gains consequent upon improved utilisation and remedial and precautionary measures. There is an urgent need to foster full utilisation because of unemployment, shortage of output, etc. Hence, the optimum utilisation of capital in developing countries like India is an important but complex aspect of development strategy in view of priorities and limitations in industrial planning. Considering the importance of the problem, the literature on the subject in the Indian context is rather inadequate. Therefore, a modest attempt is made to estimate capacity utilisation with a view to suggest a variable policy so as to curb the growing idle capacity.

2. The Present Study

To examine excess capacity, capacity utilisation year-wise, sector-wise and product-wise were used and growth rates of capacity utilisation have been computed for further analysis. The enquiry is confined to all the Indian industries reported on in the Report on Currency and Finance in the case of year-wise and product-wise analysis, while selected industries in the sector-wise study. The reference period is 10 years, from 1976 to 1985.

2.1 Year-wise capacity utilisation

Trend of capacity utilisation in Indian Industry is of considerable concern and discouraging (See Table—I). The capacity use for all the industries put together has increased gradually from 73 per cent in 1976 to an all time record of 82 per cent during 1979. Subsequently, it declined suddenly substantially during 1980 and even reached the lowest percentage of 71 in the preceding year. Again there is a marginal improvement in 1982 by raising to 74 per cent, so as to come down a little in the following year. Later on, it tends to raise as there is an increase in 1985 over the previous year. The linear growth rate[1]

TABLE—I

Capacity Utilisation in Indian Industry—All Industries
(per cent)

Sl. No.	Year	Capacity use	S.No.	Year	Capacity use
1.	1976	73.27	6	1981	71.01
2.	1977	75.45	7	1982	74.30
3.	1978	78.64	8	1983	73.83
4.	1979	81.69	9	1984	74.03
5.	1980	73.06	10	1985	75.09

Source : Computed from relevant issues of Govt. of India., *Report on Currency and Finance*, Bombay, Reserve Bank of India, (Vol.I).

(LGR) of capacity utilisation is—0.25 per cent for the period 1976-1985. This negative growth is not significant even at 10 per cent level of significance since the calculated value of t_8 ($t_{10}{}^{-2}$) 0.667 is less than that of its critical value. 1.86. It may be inferred that there is a decline in capacity utilisation during the period.

2.2 Sector-wise Utilisation

The inefficiency of Indian industry is also clearly seen in sector-wise excess capacity. The data for the years 1976 to 1985 for select industries show, generally speaking, a tendency of decline in capacity use. The ratios are significantly varying within each industry from year to year (See Table-II). The percentage of utilisation gradually declined from 82 to 58 during 1976-1985 for paper industry. In the case of

TABLE—II

Capacity Utilisation in Major Sectors

(per cent)

S. No. Sector	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
1. Saleable Steel	77.0	91.9	90.3	81.5	69.1	72.2	83.4	83.8	71.6	78.3
2. Aluminium	84.5	83.5	61.3	66.4	58.2	61.6	64.6	57.7	60.7	76.4
3. Fertilisers (n)	58.8	83.6	82.3	83.3	76.6	40.3	66.6	66.6	67.9	76.2
4. Fertilisers (P_2O_5)	47.2	66.0	78.0	73.4	61.5	53.1	67.2	69.1	70.4	74.4
5. Cement	87.0	86.6	88.8	85.6	72.6	66.9	69.5	67.8	73.1	74.1
6. Newsprint	76.0	76.9	74.7	64.0	63.2	77.0	40.7	54.3	76.5	85.6
7. Paper and Paper Boards	82.0	79.0	76.0	72.4	68.2	66.6	67.0	62.9	57.8	58.2

Sources : For 1977 to 1980 see Govt. of India., *Sixth Five Year Plan 1980-85*, New Delhi, Planning Commission, 1981, p. 32 and for others see relevant issue of Govt. of India., *Report on Currency and Finance*, Bombay, Reserve Bank of India, (Vol—I).

aluminium industry, it fell from the highest of 85 per cent in 1976 to 76 per cent at the close of 1985 with fluctuations either upward or downward. There is a continuous increase in nitrogenous fertilisers till 1979 and afterwards came down to reach 40 per cent during 1981 and again the progressive improvement led to 76 per cent at the end of 1985. Steel and Phosphoric fertilisers are showing a highly irregular tendency viz., steep increase or sudden spurt. For instance it raised from 47 per cent to 66 per cent in 1977 over 1976 in the case of latter. Steel industry recorded the highest of 92 per cent during 1977 as against the lowest 72 per cent of 1984. Phosphoric fertilisers showed the exalted (78 per cent) percentage in 1978 whereas the least in 1976. Cement industry accounted for 74 per cent at the close of 1985 vis-a-vis 87 per cent initially, thereby exhibiting a decline. Further, it may be noted that it displayed the lowest 67 per cent in 1981 whereas the highest 89 per cent during 1978. Contrary, in newsprint the rate of utilisation had gone up from 76 per cent to 86 per cent over the period with periodic changes both negatively and positively. For example, the latter percentage of 1985 is the foremost while 40 per cent of 1982 is coming after all the others. As a whole, on balance the year-wise alterations are notable in each sector.

Percentage of utilisation is also widely varying across the sectors every year. During 1976 cement industry by working to 87 per cent came as foremost while phosphoric fertilisers with 47 per cent the last. In the preceding year steel industry got the place of cement and the former remained in the same rank. In 1978, steel continued in its place but aluminium was thrown to the position of fertilizers. Cement reemerged as first whereas newsprint at the end during 1979. Subsequently, with 77 per cent nitrogenous fertilisers came before all others and aluminium once again remained after all the others. Newsprint whose percentage was the lowest in 1979 became the first and the first of last year turned as the last for 1981. This evidence shows about the degree of fluctuations in capital use across the sectors over time. Again during 1982 steel and newsprint have reached the first and last places respectively and continued to do so in 1983 also. For the first time, paper industry was forced into the final place as against the prime rank of newsprint for 1984 and 1985.

The linear growth rates of capacity utilisation sector-wise are not significant even at 5 per cent level of significance as the critical values are more than that of calculated ones (See Table-III). The rate of growth is negative for all the industries except Phosphoric fertilisers. It is seen from the Table that

TABLE-III

Industry-wise Average Annual Linear Growth Rate of Capacity Utilisation for the Period 1976 to 1985 (Base Year 1976=100) (per cent)

S. No.	Sector	Growth rate	t cal	't' critical at 5% L.S.8d.f.
1.	Saleable Steel	—0.934	0.972	2.306
2.	Aluminium	—1.530	1.170	2.306
3.	Fertilisers (N)	—0.716	0.450	2.306
4.	Fertilisers (P_2O_5)	1.236	1.188	2.306
5.	Cement	—2.240	1.731	2.306
6.	Newsprint	—0.452	0.287	2.306
7.	Paper and paper boards	—2.702	1.986	2.306

Source : Table – II.

the variation in between the industries is significant. For example P_2O_5 registered a growth of 1.24 per cent compared to the highest negative growth 2.7 per cent in paper and paper boards. Newsprint recorded the lowest negative growth of 0.45 per cent. Thus industry-wise growth in capacity utilisation is disappointing during 1976-85.

2.3 *Product-wise use*

Capacity utilisation is changing significantly within the same product in between the Products from year to year (See Table-IV). In the case of basic industries, it increased from 66 per cent to 69 per cent during 1985 over 1976 with fluctuations to and fro. These industries recorded the highest utilisation in 1977 while the lowest in 1981. As a result the range in between these two levels is 18 per cent. The rate of use declined in capital goods industries from 74 per cent in 1976 to 66 per cent in 1985. The range is 14 per cent in between the highest and lowest utilised years. There is marked improvement in intermediate goods wherein it raised to 82 per cent in 1985 from 73 per cent of 1976. These goods have utilised capacity to the maximum extent during 1978. Consumer goods reached to 81 per cent of utilisation in 1985, showing 4 per cent increase over 1976. Further, during 1979 the utilisation went to an all time record of 91 per cent compared to of all the years and products put together. Consumption goods appear to have operated at higher level than intermediate or capital or basic goods. Besides, it may be noted that the fluctuations in the levels of utilisation are more in basic industries relative to others. The utilisation rates are greater in 1985 over 1976 in all the products except capital goods. Finally, it is interesting to note that the differences between them are not highly significant, even though they have a persuasive look. But these are showing definite pattern and relationship.

TABLE—IV

Product-wise Utilisation
(Per cent)

S. No.	Year	Basic Industries	Capital goods industries	Intermediate goods industries	Consumer goods industries
1.	1976	66.43	73.58	72.78	76.92
2.	1977	76.10	71.80	72.44	77.57
3.	1978	71.38	69.49	85.83	81.78
4.	1979	74.26	78.10	81.11	87.24
5.	1980	58.37	79.57	75.81	91.07
6.	1981	58.22	76.37	71.39	89.20
7.	1982	71.14	74.26	72.98	77.99
8.	1983	67.41	68.77	74.05	82.48
9.	1984	66.91	67.40	81.48	78.32
10.	1985	69.01	65.65	81.79	81.11

Source : As in Table—I

Among all the products, consumer goods topped the list both in 1976 and 1977 while the last place to basic and capital goods respectively. During 1978 intermediate goods utilised the maximum capacity and there is no change in the position of capital goods. Subsequently till 1983 consumer goods occupied the highest rank as against basic goods coming after all the products including in 1984. During 1984 and 1985 intermediate goods came before all the other products, whereas capital goods again the least during 1985.

The linear growth rates of capacity utilisation are

insignificant even at 10 per cent level for all the products except capital goods since the calculated 't' value is lower than that of its critical value (See Table-V). Further, it is seen from the Table. that the variation in these rates across industries is absolutely gloomy. Basic and capital goods industries are showing negative growth whereas intermediate and consumer goods industries positive. The negative growth is nearly 3.6 times higher in capital goods industries when compared to basic industries. As against this intermediate goods industries have accounted for 3.4 times more than consumer goods industries. It may be concluded that the capacity utilisation is declining in basic and capital goods industries as against the increase of intermediate and consumer goods industries. Thus the growth rates of capacity utilisation are also indicating that the usage of capital is related to product use.

TABLE—V

Product-wise Average Annual Linear Growth Rate of Capacity Utilisation for the period 1976 to 1985 (Base year 1976=100)
(per cent)

S. No.	Type of Product	Growth rate	t cal	't' Critical at 10% L.S. 8d. f.
1.	Basic industries	−0.427	0.600	1.860
2.	Capital goods industries	−1.547	2.001	1.860
3.	Intermediate goods industries	0.343	0.588	1.860
4.	Consumer goods industries	0.102	0.170	1.860

Source : Table – IV.

The empirical evidence though somewhat conflicting suggests that the consumer goods firms operate at generally higher capacity utilisation level than intermediate or basic or capital goods firms.[2] Some other writers arrive at contrary conclusions.[3] Consumption goods utilisation rates are higher because there is something in the use of or markets for the products in addition to technological, organisational and trade factors.[4] It is also plausible, as Power has suggested, that insufficient liberalisation—as an aspect of import-substitution—may have reduced capacity utilisation in consumption goods industries than would have been.[5] Thus the relationship between capacity use and end use of the product is evident and these results are supporting Hirchman's assertion.[6]

3. Reasons for Excess Capacity

The poor utilisation might have stemmed from a variety of factors. The explanations for this pervasive idle capacity are diverse. The popular underlying causes of excess capacity are : uncertainties of demand estimation, scale economies that recommend "building ahead of demand",[7] scarcity of skilled man-power,[8] antimonopoly policies, rapid industrial growth itself,[9] project bias of aid-giving countries,[10] import-substituting industrialisation policy, shortages of imported raw materials,[11] import licensing policies,[12] technological determinism,[13] cost of shift work,[14] differences in the ratio of avoidable to unavoidable labour costs,[15] basic infrastructure of power and transport, differences in wage rates, intensity and distribution of people's preferences for or against night work,[16] and employment payoff.[17]

Maintenance of excess capacity is a deliberate policy decision by private entrepreneurs to pressurise Government to adopt certain policies favourable to industry.[18] There is a feeling shared by many[19] that the reporting units tend to present a misleading picture of capacity output and capacity utilisation to serve certain ends.[20] The other reasons for excess capacity may be breakdown of machinery, labour absenteeism, shortage of working capital.[21] Divergences between private and social costs also usually tend to discourage shift work and consequently reduce the rate of utilisation.[22]

4. Utilisation Policies

For full capacity utilisation, the following policies may be implemented :

(i) *Promotion of Shift Work*

Shift work could be promoted by increasing demand for firms' products while simultaneously giving firms the incentive to respond by adding shifts rather

than by installing new fixed capital. On the other hand, profitability of shift work can be increased through macroeconomic policies such as elimination of subsidies to fixed capital.[23] Government has to remove legal prohibitions against night work for women and legal minima for night wage premiums. Other policies to encourage shift work should include provision of bank credit at lower rates of interest, reduce taxes on payrolls[24] so as to correct market price of labour over its social cost. Moreover subsidy or tax credit for each worker employed on a second or third shift is desirable viz., capacity taxation.[25] In making it more expensive to let plant sit idle, the tax may increase utilisation : (i) through an income effect in entrepreneurial utility maximisation[26] and (ii) by increasing the cost of the capital.[27]

(ii) Shift Differentials

To the extent that labour is homogeneous and its supply is unlimited, there should not be any shift differential in wage rates, since an incentive to induce an adequate supply of night work is necessary only if the worker makes a decision between day work and night work. If there is widespread unemployment, in contrast, the workers decision is between night work and being unemployed—competition to get any job at all should eliminate the need for payment of a shift differential regardless of underlying preferences between night work and day work. In traditional societies where preferences against night work are so very strong that most people would rather be unemployed than work at night, then change the preferences.

(iii) Provision of Labour Amenities

To change people's preferences towards night work provide or increase the amenities of night work especially in scale sensitive services like police protection, transport, food, and widespread night work.

(iv) Redistribute Management Preferences and Incentives

By infusing techniques of professional management, appeals to nationalism, the antagonism of managers to night work responsibilities may be reduced. Through incentives the willingness of management to work at night may be influenced since the incentives operate positively or negatively and as a result increase the relative cost of operating during day.

(v) Various items of capital equipment must be installed and used in a balanced manner.

(vi) Entrepreneurs must come to realise that multi-shift operations are not only essential for the economy which is trying to grow extremely limited capital, but that it is also profitable to make fuller use of capital equipment.

(vii) Allocation of Resources

Governmental measures such as more careful licensing, selective policies in the allocation of foreign exchange and local resources and revisions in employment laws are required.

5. Conclusion

Since excess capacity is a pervasive and serious deterrent to growth in LDCs, it is high time to examine the utilisation of industrial capital. Excess capacity would be attributed to fallacies, rigidities, inefficiencies and errors in industrial policies and development planning and these could explain why a critically scarce resource needed for growth was allowed to sit idle most of the time. In view of scarcity of capital in relation to labour in a poor country like India, a failure to utilise capital fully should be regarded as a matter of serious concern. The planners, in fact, have all along given high priority to full utilisation of capital while evolving plans. However, this concern appears to have made little impact since Indian industry worked at three fourths of its capacity.

Steel and paper industries have utilised capacity more than that of paper, newsprint, and fertilisers. Consumer and intermediate goods industries worked at much more than basic and capital goods industries. An acceleration of the general growth of the economy can occur only if increased investments are made in consumer and intermediate goods industries so as to correct the existing structural imbalances. Granting all the possible defects in the statistical data, it may

be concluded that the major problem of utilisation is not moving to more efficient position; increased utilisation, rather requires a social decision that exacts a social cost. Further, underutilisation is not primarily the result of irrationalities and misconceived planning, but it appears, instead, to be largely a rational response to a widespread preference for working at a 'normal' time of day. The utilisation policies should induce night work so as to raise per capita income, thereby standard of living.

The major implications of the present study for public policy are in the realms of future allocations of investment and of minimising underutilisation of capacity. Besides, the strikingly uneven patterns of capacity utilisation prevailing in Indian industries warrant a closer look by responsible authorities and experts at the limiting factors at work in individual industries. A better understanding of these limiting factors will shed more light on the complex interrelationships of the economy and pave the way for improved decisions in the realms of public policy.

In spite of conceptual and measurement difficulties, the concept of capacity utilisation is of some operational significance and does serve a useful purpose for analysis, planning and policy making. Its usefulness can be enhanced by analyses at the level of the plants and techniques of production rather than at the level of industries.

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Privatisation of Public Enterprises

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The paper studies the phenomenon of privatisation of the public enterprises and recommends that privatisation is not a panacea for the ailments of the industry.

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Introduction

By public enterprises—particularly while referring to their inefficiency—it is commonly meant to be the industrial and commercial establishments, rather than the public services and public utilities. This restriction of the scope of public enterprises, is essentially because of the following reason.

Efficiency or otherwise is normally the result of a comparison, and in this case, it is a comparison between the public enterprises performance and the private enterprises performance. Such a comparison is possible only in the case of industrial and commercial establishments and not in the other activities, as there is no private participation in these other activities altogether.

Further, in an exercise of comparing the public enterprise performance and private enterprises performance, the fundamental issue has always been the issue of financial profitability or social profitability? There can be and in fact there are, unending arguments on both sides. In essence, it is that, people who favour financial profitability argue that scarce resources are going down the drain in the name of social justice, and they go on to show the statistics of the accumulated financial losses to prove their point. On the other hand, people who favour social profitability argue, that the very purpose of creating

public enterprises is not to go by the objective of profit maximisation; but to achieve some degree of socio-economic development which would otherwise not be possible because of lack of private interest and they go on to show the statistics of the foreign exchange savings, the direct and indirect employment created, the infrastructure developed, the backward areas developed, and so on to prove their point. This controversy is as old as the concept of public enterprises itself.

Policy of Privatisation

However, the Government's opinion, today, all over the world, appear to be in favour of choosing financial profitability as the chief criteria to evaluate the performance of public enterprises, though not, the only criteria; and this is clearly reflected in the way the concept of privatisation (in the sense of either selling part or full of pubic enterprises assets to private entrepreneurs or curbing the growth of public enterprises in preference to the growth of private enterprises) is catching up all over the world—particularly in the developing countries. The UN Report[1] on the World Social Situation (1985) clearly brings out that the policy of privatisation is actively pursued by UK, France, Federal Republic of Germany, Italy, Japan, Netherlands, Spain, Greece, Portugal, Korea, Bangla Desh, Pakistan, Ecuadar, Peru, Kenya and a host of other counries.

Even in India, the talk of privatisation is spreading fast and the present government appears to be seriously considering it. This is evident from the Narsimham Committee's[2] Recommendations on Liberalising the Industrial Licencing procedures, liberalising capital goods' import, increasing the MRTP limits (Monopolies and Restrictive Trade Practices); the Arjun Sengupta Committee's[3] Recommendations on the classification of public enterprises as core and non-core sectors, and develop only core enterprises; the governments on the long-term fiscal policy,[4] and finally the ministerial speeches[5] propagating the concept of privatisation on several occasions. Furthermore, it is an open secret by now that the international financial institutions like the Asian Development Bank (ADB); the International Monetary Fund (IMF): etc., stipulate several conditions before sanctioning loans to the needy countries and one such condition has always been the slow but steady privatisation of public enterprises.[6] India is a loanee member of these financial institutions.

Objective of This Paper

Conceptually, people who favour privatisation, essentially base their arguments on two grounds; though the actual modalities may differ.

(a) Public enterprises are inefficient by nature, and can not achieve the purpose for which these enterprises are created; and

(b) Private enterprises are almost always efficient and in the present day socio-economic development context, they are in a better position to deliver the goods.

The objective of this paper is to analyse these impassionately, so as to lead to further discussion on the question "Is Privatisation the answer for the Public Enterprises' inefficiency?"

Public Enterprises In India

Public enterprises in almost all developing countries are essentially the outcome of sheer necessity than any ideology. If one scans through the existing literature on the role and purpose of public enterprises in developing countries, one comes across the following prime reasons for their creation: (a) Where competitive markets do not exist and the government assumes an obligation of regulating if not curbing the private entrepreneurs' tendency to make monopolistic profits; (b) Where the society is a society of inequals and the government assumes an obligation to provide equal opportunities to all its citizens; (c) Where private entrepreneurs are not interested in investing in the socially profitable ventures and the government takes initiative to build industry and infrastructure in the larger interests of the nation; (d) Where the government undertakes the backward areas development as a national priority to get rid of regional imbalances within the country including the employment problem; and above all (e) Where the country needs

to catch up with a certain rate of economic and technological development so that it will be able to achieve self-sufficiency and self-reliance, in the long run.

These are the same reasons for creating public enterprises in India also. India at the time of independence considered economic self-reliance as a vital component of political independence as well as integrity of self-expression whether in national or international spheres. Building up such an economic self-reliance is by no means an easy task particularly when she has practically no capital industry, her per-capita income was extremely low and she has no public savings to gear up the economy towards this national objective. Referring to the state of affairs obtained at that time Krishnamachary[7] observed that "India at the time of independence had a population of 370 million people, mostly illiterates, their wills broken, their past glory and contribution to civilisation and also the philosophical thought forgotten and conditioned by apathy, superstition and fatalism. Agriculture and industrial sectors were in the primitive stages of development and the per-capita income at this time is estimated at Rs. 200." Thus, in India, public enterprises did not emerge from the ideological caprice of some indoctrinated individuals, but from hard headed appraisal of the economic realities.

However, today, she has emerged as a politically and economically strong nation. Her achievements[8] in matters of socio-economic development during the past three and half decades are commendable inspite of the population growth, which has almost doubled during the same period.

Public enterprises did contribute in achieving what has been achieved. To be specific, today, Indian public enterprises cover 100% of the national production in respect of petroleum, lignite, copper and lead: 97.6% of coal; 75% of steel; 88% of zinc: 47% of nitrogenous fertilisers and so on.[9] Further, but for the existence of financial institutions like IDBI (Industrial Development Bank of India), IFCI (Industrial Finance Corporation of India) SFCs (State Financial Corporations), Industrial development—particularly the backward area development could not have been a stage where it is today. Again, but for the Oil & Natural Gas Commission's (ONGC) effort, India would have spent large amount of foreign exchange in import of oil and also continue to be dependent on foreign countries for this prime mover of economy. Nationalisation of banks has helped the weaker sections and particularly the agricultural sector to a great extent. (It should be remembered that the social control over banks before their nationalisation was a great failure because no private bank was willing to look at the genuine credit needs of the poor artisans and agriculturists). Even the consumer and consumer durable items like bread of Modern Bakeries. refrigerators of Allwyns; televisions of Electronics Corporation of India, have certainly made the private entrepreneurs think twice of their pricing policies. The National Textile Corporation which took over all the private sick textile units, has certainly given a lease of life to many a unskilled and semi-skilled worker.

Governmental Interference—Chief Reason for Inefficiency

However, it is not the intention here to convey a misleading message that 'all is well with public enterprises'. Public enterprises in some lines of manufacture/service are operating inefficiently, which can be seen in not only the low rates of return but also in the quality of goods and services produced by some of these enterprises.

There are number of studies on this issue of inefficiency among some public enterprises, and from the findings of these studies, one can easily say that the chief reason is the Government's interference in the day to day management of some of these enterprises. Here, it is to be noted that there is a difference in the governmental intervention and the governmental interference. Governmental intervention in public enterprises management is certainly acceptable, as not only the government is the owner of these enterprises, but also the government has the responsibility to look into the inter-linkages between the unit level investments, pricing, profitability to the nation's overall economic development. But government need not interfere in the day to day affairs of an enterprise. This leads us to an issue of autonomy and control in public enterprises.

In India public enterprises are controlled by the Parliament (though its associated control agencies like the Committee on Public Undertakings (COPU); the Audit Board, etc., the concerned Departments of the Administrative Ministry (along with the Finance Ministry and the Bureau of Public Enterprises) and the Board of Directors of the respective individual enterprises. The control by the concerned department of the Administrative Ministry is inevitable as the Government is the owner of these enterprises. Similarly, in a democratic society, Public enterprises become automatically accountable and answerable to the highest democratic institution,—the Parliament. Control by the Board of Directors of an individual enterprise is essential for the techno-managerial expertise that it provides to the enterprise in their long-term as well as short-term functioning.

Though, in theory, the role of each one of these control agencies is clearly demarcated, in practice, however, particularly in using the instruments of control, conflicting interests arise between them and the enterprise is ultimately pushed to a stage where it cannot show good performance. To be specific, many a time these conflicting interests lead to decisions which are not intended to better the performance of these enterprises but intended to satisfy one group or the other. More often than not, these decisions are crucial in nature, and encompass both strategic and operational areas. These decisions will thus have long-term impact on the performance of these enterprises.

For example[10] a) The Surkachar coal project was initially set up to meet the requirements of Bhilai and Rourkela Steel Plants. As these Steel Plants were not interested in this coal, the anticipated production was decided to be used in a coal based fertiliser plant at Korba. The fertilisers plant did not materialise, but the Surkachar project was completed. Consequently, the coal project had to operate at a severely restricted capacity; b) M/s. Hindustan Paper Corporation had to choose one among three possible sites (Tuli, Dimapur and Naganimara) for setting up a paper mill. The then Chairman of the Corporation, had serious reservations about Tuli being the possible location as it was located at six hill-tops. However, when the Site Evaluation Committee visited the area, a letter addressed to them by the State Minister was handed over to them informing that the decision to set-up a paper unit at Tuli is final. The decision was surprising as all the sites were in backward tribal areas and also that the cost of a 100 T.P.D. paper mill in Naginimara was Rs. 594.80 millions as against Rs. 618.30 millions in Tuli; c) The State Trading Corporation imported Sulphur from an unknown firm to the extent of 30,000 tonnes per month for a period of 12 months in which contract, the necessary warranties and guarantees were not incorporated apparently on the oral orders of the then Finance Minister; d) M/s. Kinnison Jute Mills, a private firm was favoured with preferential treatment despite its non-payment of huge arrears on a directive from the Ministry; e) The Government has thrusted a decision to produce commercial grade seamless tubes in Nuclear Fuel Complex despite the reservations about its viability, held by its Management.

The above examples are only illustrative and any serious observer of public enterprises environment can name many. For instance, Venkataswamy[11] found through his studies on public enterprises in the State of Andhra Pradesh that between 1975-76 and 1980-81, there were 3 Chairmen and 5 Managing Directors in the Andhra Pradesh State Road Transport Corporation; 5 Chairmen and 7 Managing Directors in the Andhra Pradesh Film Development Corporation; 3 Chairmen and 5 Managing Directors in the Andhra Pradesh Industrial Infrastructure Corporation; 6 Chairmen-cum-Managing Directors in the Nizam Sugar Factory and so on. The point here is that, the frequent changes in chief executive positions, not only affect their sense of responsibility and accountability, but also creates difficulties for the incumbents in acquiring sufficient knowledge of the enterprises. Interestingly, these appointments are always made "in the interest of the public" which according to the government appear to exclude the "interest of the enterprise", itself.

Similarly, a study of Venkataratnam and Rama Naidu[12] on the functioning of Public Enterprises Boards, concludes that "at Board level Bureaucrats and interest groups, other than managers and employees dominate. Beyond the Board level, it is

again the Bureaucrats and Ministers who exercise control and supervision. The people who man the Public Enterprises Boards and the people who exercise control and supervision, are not necessarily experts in the subject that they deal with. Frequent shuffling of chief executives and ad-hocism in allotment of portfolios to Bureaucrats and Ministers, is the rule than an exception. Everytime there is a change in the set up of the Ministry, there is a change in the Board, for the official directorships are in effect ex-officio posts".

Further, many a time, it is observed that people from the Civil/Administrative Services, are installed as Chief Executives in these enterprises, and naturally they do not possess the required level of technical knowledge to run the enterprise efficiently. Bhilai Steel Plant at one time had one ICS Officer as General Manager, a retired Accountant General as Financial Advisor, an engineer from Railways as the Chief Engineer, and several IAS Officers as Deputy General Managers. These officers tried to manage an integrated steel plant.[13] Referring to this, Vikram Sarabhai[14] once observed that "It is often publicised that, because a man is skilled as an administrator, he has got wisdom and judgment and therefore he can immediately apply himself to all complicated tasks and make the required decisions too. I think it is a fallacy".

Furthermore, Mane,[15] through his studies on Pricing policies adopted in public enterprises, observed that the Pricing policies adopted in public enterprises are essentially arbitrary and unless realistic prices are fixed, these enterprises will continue to show poor financial results. As prices of all individual products is difficult to get, he used the cost of production, and value of production data published by government for different groups of public enterprises, and in many cases he found that the value of production is less than the cost of production. Interestingly, these groups include not only the basic and infrastructural type, like steel, coal, oil etc; but also competitive commodities like textiles, consumer goods etc.

All the above instances lead us to only one conclusion and that is public enterprises are not inefficient by nature, or, inefficiency is not inbuilt in the public enterprsies system as it is often made out to be. In majority of the cases, public enterprises are made inefficient. If the government wishes to revamp/revitalise these enterprises, it can easily do so, as the environment in which these enterprises are working today, is chiefly the creation of the government.

The Other Premise—Private Sector Efficiency

Now, let us look at the other premise that private enterprises are almost always efficient and also that they are now in a better position to deliver the goods.

The chief indicator of efficiency among private enterprises is the continued profitability, and the absence of profitability eventually drives these units to sickness. In this connection a atudy carried out by Sharma[16] clearly brings out the fact that the quantum of money locked up in the sick industrial units as on June, 1984 was to the extent of Rs. 29,007.40 millions; of which the small scale sector accounted for Rs. 7,883 millions (81,647 units) and the share of large scale sector was to the extent of Rs. 21,124.40 millions (513 units). It is interesting to note that, within the large scale sector, units subjecting to MRTP (Monopolies and Restrictive Trade Practices) regulations, have locked up as much as Rs. 5,421.30 millions in their sick Divisions and contributed as much as 25.7% to the overall industrial sickness in India. These are the enterprises that are supposed to be well equipped with all the techno-managerial expertise. Another interesting finding of this study is that, in terms of number of units the public sector accounted for 16.8%; the joint sector accounted for 4.4% and the private sector accounted for as much as 78.8%; to the overall sickness. Again, in terms of money locked up in these units, public sector accounted for 22.5%; the joint sector accounted for 6.9%; and the private sector accounted for as much as 70.6%.

It can thus be seen that the private sector is not almost always efficient in running their enterprises. Inefficiency or the resultant financial losses or the eventual sickness, is not the prerogative of the public

sector, and the private sector equally contributes to this sickness, if not more. People, who propagate privatisation seem to have forgotten this aspect, conveniently.

An Environment That Suits The Private Sector

This situation then raises the question, that, on what basis the private sector claims that it is in a better position to deliver the goods? Perhaps the answer lies in their private interest. The pattern of Indian economic development during the past three and half decades has led to a phenomenal growth in assets and economic power of a few private industrial empires. It is also seen that a good number of erstwhile foreign companies have liquidated their equity and qualified for being treated at par with other Indian companies. In view of these developments, the capabilities of the private sector to undertake large investments, has got considerably enhanced. Many of the limitations of the late 50s and 60s have disappeared. As a consequence of these developments, the private sector—particularly the monopoly capital—is aspiring to enter economic activities which were hitherto earmarked for exclusive development of the public enterprises. In addition, the Indian private sector gets easy financial support from banks and other financial institutions; and with options to involve foreign collaborators and receive direct loans from international agencies, is able to establish its claims for a change in the basic economic policy very successfully in the recent past.[17]

Private or Public?

Should India go for such a change in its basic economic policy? Perhaps, more important is the question of, can India afford such a change in the present day context of socio-economic development? The answer is clearly 'no'. It is 'no'. for the simple reason that a private entrepreneur, being a prudent businessman, always keeps his investment choices/ options open. He may enter a particular line of manufacture or service today, as it gives him a required level of return. But after a few years, if there are other lines of manufacture or services that give him a more lucrative rate of return, he would naturally make a shift in his investment priorities. The sickness in textile industry is a good example of this phenomena. The Jharia and Ranigunj coalfields[18] still carry the scars of this so-called Private Sector Managerial excellence and India cannot afford, not to learn from such experiences.

It is not only the Jharia coalfield that is ruined by the lust for quick money. The experience of other countries is also there. Wadhera[19] quotes one such experience.

"In Japan in the 50s the coal production reached a level of 57 million tons per year. Now the production has gone down to 16 to 18 million tons. The reason appears to be that the entire industry at one time was in private hands. They worked the mines, produced coal, and gave it to other private sector. In the early 60s, a glut in oil—a cheap, neat, easily storable source of energy, was available at one dollar a barrel. The private sector has switched over to oil and the demand for coal dwindled sharply and the coal industry abandoned the mines.

Now when we leave a mine, to return to it later to take out the balance reserves, we have to spend money—on ventilations, dewatering, roof and side walls are to be protected and staff are required to do all this. All this means expenditure when coal is not produced. The Japanese private coal industry did not spend this money and the abandoned mines are unreachable today and are lost to the country forever. Japanese now are in distress and going to all places. They are willing to spend money, expertise only with a condition that 20—30% of coal produced should be given to them on international prices".

Summary & Conclusions

It can thus be concluded that, the problem of inefficiency in public enterprises is basically because of environment in which these enterprises operate and not so much because of lack of managerial or technical expertise. Efficiency or otherwise is a factor that affects both public sector and private sector and thereby the factors that cause inefficiency are to be attacked rather than thinking of privatising public

enterprises. To be specific, to improve the efficiency of public enterprises.

1. Public enterprises should be given sufficient autonomy—particularly with reference to those decision, which are likly to have long term impact on their performance.
2. As people at the helm of affairs, do matter, sufficient care should be taken in selecting the Chief Executives and constituting the Boards. Professionalism in more important, than a person's capacity to adhere to rules and regulations on one hand and to satisfy his superiors in Government on the other hand.
3. The tenure of Chief Executives should be long enough, to facilitate continuity in the operational decision making process.
4. While prices of products and services offered by these enterprises should continue to be administered by Government in the overall national interest; pricing formulae/mechanism should necessarily consider the long term commercial viability of the enterprise.
5. Last but not the least, the need for and significance of 'public production', in contrast to 'private production', should be highlighted through media, to dispel the far from true opinion, that, public enterprises are inefficient by nature. They are not.

Thus, privatisation is no answer to the public enterprises' inefficiency, but taking effective steps to change the present environment in which these enterprises, is the answer. A doctor, worth the name will not kill a person just because he cannot cure him. Even if it were to be so, it should be an exception rather than a general rule. Similar should be the case with privatising public enterprises.

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Planning Materials Handling

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This is a case study focussing on planning for materials handling facilities in a batch type engineering organisation

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1. The Case

RSR Industries Ltd. is a medium sized engineering company manufacturing about 175 models of various types of pumps, compressors and other similar industrial machineries. It has about 100 general purpose machine tools spread over 3 gangways, and another 2 gangways are occupied by assembly, testing and despatch activities (Fig. 1). Cranes (Electrical Overhead Travelling Type and Jib Cranes mounted on factory columns) were the main sources of materials handling within the plant. The company had following facilities (also shown in figure-1.)

Cranes	*Capacity*	*Nnmber*
1. EOT Cranes	5 Ton	6
2. EOT Cranes	15 Ton	1
3. Jib Cranes	½ Ton	11

The eleven Jib Cranes were added to the company only a year back, as the company faced many problems at that time, like those given below:

* High waiting time for cranes, specially on Heavy Machine Tools, Assembly and Test Bed areas.
* Low utilisation of Heavy Machine Tools, and the skilled labour of Test Bed and Assembly.
* Heavy production losses, in case of breakdown of the ONLY facility of EOT Cranes in a given Gangway.

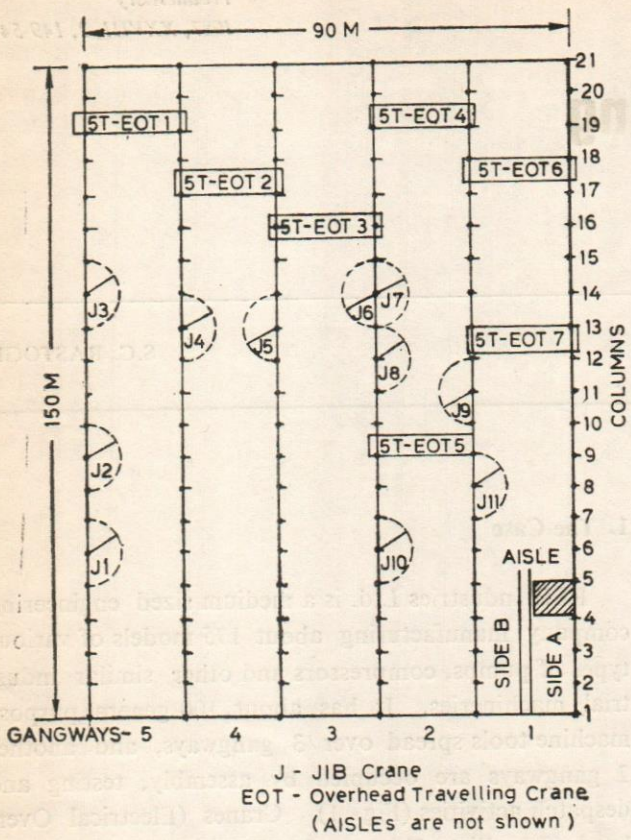

Fig. 1

Eleven Jib Cranes were recommended to be added instead of adding further EOT Cranes, for the following reasons :

* Their very low investment and operating cost. One 5 Ton EOT Crane was about 25 times costlier than the ½ Ton Jib Crane, at that time.
* Ease of installing and removing/relocating them.
* Would not add to EOT Crane interference problems.
* Less production losses, because of multiple (standby) facilities.

These recommendations were based on a detailed analytical study, using SYSTEMATIC HANDLING ANALYSIS, developed by Richard Muther (1). This involved a detailed analysis of flow of materials in terms of all assemblies (about 175 in number) sub-assemblies (about 700) and loose components (about 3000), being handled, keeping in view their weights etc. in mind.

These Jib Cranes, all standardised in ½ ton capacity, were welcome by shop people as they helped in increasing the utilisation of man and machine. In fact after a period of one year of their installation, there were, 32 shops requests pending for Jib Cranes from the shop supervisors, for various locations in the plant. On the other hand complaints for non-availability of EOT Cranes were still continuing in spite of the addition of 11 Jib Cranes of ½ ton capacity.

Then the problems were :

* How to justify the demand for new Jib Cranes ?
* How to establish the right locations for Jib Cranes?
* How many new Jib Cranes should be purchased in future?
* How to evaluate that the Jib Cranes provided in past, were performing as predicted by analytical estimation.
* Any further investment in EOT Crane justified ?

And this time, management wanted a FASTER and REALISTIC answer (not analytical and hypothetical), and of course LESS EXPENSIVE but ACCURATE answer. Conventional Work Sampling Technique (2) was used with some unusual modifications, which gave the right answers to above questions, as is described below in details.

2. Methodology Adopted

Work sampling has proved to be a convenient and reliable method for conducting similar surveys. However, conventional work sampling only records the activities which 'ACTUALLY OCCUR'. It does not record the activities which 'COULD OCCUR', but have not actually occured. In this sense the conventional method was modified. In modified method it was also needed to record the activities, which 'COULD OCCUR', but actually had not occured.

The activities for the Work Sampling Study, were defined in the following manner :

2.1 The term 'working' meant that crane was

engaged in either of the four activities namely: Lifting, Lowering, Holding and Travelling in either direction.

Following activities were recorded during work sampling for EOT Cranes :

1. EOT Crane 'working' normally	—
2. EOT Crane working, where Jib Crane is also available and 'COULD' have been used, if desired.	Jib Crane Number*
3. EOT Crane working, where Jib Crane 'COULD' have been used, if it *were* available there	Shop Floor Area Number**
4. EOT Crane idle.	Idle Codes : B—Crane under breakdown C—No demand or Crane Operator not available.

* All Jib Cranes were painted with two digits identification number, which were recorded, whenever required.

** Whole shop floor area was divided into 210 rectangles (all possible contenders for Jib Cranes), defined by 21 columns, and yellow painted lining on either side of Aisle, in each Gangway (Fig. 1).

2.2 Activities defined for Jib Cranes :

Only two activities were defined for these Cranes viz.,

(1) Crane Working (i.e., lifting, lowering, holding of travelling/positioning)

(2) Crane Idle.

2.3 About 2000 observations were recorded for each EOT Crane and about 1800 observations were recorded for each Jib Crane, spread randomly over 40 working days. This assured that the results were true within ± 5% accuracy at 95% confidence level.

A special mental picture was prepared to classify the weights of the items into two classes, that of below ½ Ton (where Jib Crane could be utilised) and above ½ Ton (which required EOT Crane). This was not difficult after some practice.

3. Findings of the Study and Discussion

Utilisation values of all the EOT Cranes as observed in work sampling study are shown in Table-1, utilisation of Jib Cranes are shown in Table-2. The extent of misuse of EOT Crane is indicated in the column No. 5 of Table 2. These tables also show the anticipated per cent utilisation of Jib Cranes, which was worked out theoritically, before their actual installation (Refer Section 1.0). Table-3 shows ten most potential new locations for the new Jib Cranes, Anticipated percentage utilisation at these locations are also shown there.

TABLE 1

Utilisation of EOT Cranes

EOT Crane No.	Gang-way No.	Crane Capacity (Tons)	% Utilis-ation	% Idle	% Break-down	% No. Demand No Operator
1	5	5 T	58	42	0	42
2	4	5 T	74	26	4	22
3	3	5 T	46	54	7	47
4	2	5 T	43	57	21	36
5	2	5 T	37	63	1	62
6	1	15 T	37	63	3	60
7	1	5 T	51	49	5	44

3.1 Jib Crane Utilisation :

A in-depth study of Table-2 presents many interesting features, some of which are presented below :

(a) Crane numbers 1,5 and 10 were having very low percentage of utilisation, viz., 1.9%, 1.9% and 2.6% respectively. Further, the potentials of their further utilization was also very poor, viz., 0.5%, 2.3% and 0.1% only. Hence these Jib Cranes were not justified in their

TABLE 2

Utilisation of Jib Cranes

Jib Crane No.	Gangway No.	Crane Capacity (Tons)	% Utilisation	Extra Possible % Utilisation ("COULD" activity)	Maximum Potential of % Utilisation	Earlier Analytically Estimated Percentage Utilisation
			(a)	(b)	(a+b)	
1	5	0.5	1.9	0.5	2.4	7.1
2	5	0.5	5.1	13.0	18.1	32.3
3	5	0.5	11.4	—	11.4	10.6
4	4	0.5	12.9	—	12.9	16.0
5	4	0.5	1.9	2.3	4.2	10.1
6	3	0.5	12.8	3.3	16.1	17 3
7	2	0.5	6.6	7.6	14.2	16.8
8	2	0.5	6.3	0.2	6.3	16.4
9	2	0.5	19.8	—	19.8	7 5
10	2	0.5	2.6	0.1	2.6	12.7
11	1	0.5	17.6	—	17.6	7.3

TABLE 3

10 Next Most Potential Locations for Jib Cranes

S. No.	Gangway No.	Column No.	Anticipated % utilisation ("COULD" Activity)
1	1	9 A	16.9
2	2	2 A	15.2
3	3	7 B	13.2
4	2	4 B	11.6
5	2	7 A	10.5
6	3	8 A	9.7
7	5	9 A	8.2
8	2	4 A	7.0
9	5	7 A	6.7
10	1	4 B	5.5

present positions and should be relocated. The guidelines for new locations could be taken from Table-3. This will increase the utilisations of these cranes and reduce the overall cost of materials handling without any investment.

(b) There was great scope of increasing the utilisation of crane number 2, 7 and 6 viz, by 13.0%, 7.6% and 3.3% respectively. On investigation it was later on identified that Jib Crane 7 and 6 needed micro-switch attachment in Electric Hoist, because jobs handled were required to be aligned precisely within close tolerances with each other. These attachments were later on provided. While for crane 2, there was no apparent cause for not using it other than the supervisor's reluctance to impose that control.

(c) Table-3 indicates, that no more than 8 Jib Cranes are justified to be added in near future.

A utilization of 7% was considered to be break-even point for justification of investment in Jib Cranes, based on a cost-benefit analysis. Out of these 8 cranes requirement, 3 should be taken from existing Jib Cranes, by relocating them (Crane 1, 5 and 10, as explained in "a" above). Effectively, only 5 new Jib Cranes are justified and not more than that.

(d) While considering Gangwaywise utilisation of cranes, it was observed for gangway No. 5 that,

(i) Utilising Jib Crane 2 fully (Refer point 'a' above) will result in transferring 13% lead from EOT Crane 1 to Jib Crane 2.

(ii) Relocating Jib Crane 1 to new position on column No. 9A (Serial No. 7, Table-3) will result in transferring 8.2% load from EOT Crane to Jib Crane.

Thus, a total of 21.2% out of existing 58% of load can be transferred from EOT Crane 1 to Jib Cranes, WITHOUT any CAPITAL INVESTMENT. This would not only reduce the cost of materials handling but would also make EOT Crane 1 more available to its service points in Gangway 5, resulting in reducing the waiting time for cranes, substantially.

(e) It was also observed that the maximum potentials of % utilisation for most of the Jib Cranes were different than those estimated analytically in the previous study. This difference was specially significant in the case of Jib Crane number 2, 8 and 10. One possible reason could be due to assumption made in the analytical model about the 3 values of average handling time of cranes, based on the weight category of times handled, irrespective of the type of item handled. This was not a good assumption, however it was needed to be made for the sake of simplicity of computations. The percentage utilisation computed by Work Sampling Study was more realistic and accurate, as it represented the real situation, which was spread over two months.

3.2 EOT Crane Utilisation:

Some of the interesting observations that could be made in Table-1 are :

(a) Utilisation of none of the EOT Cranes (except crane 2, in Gangway 4) is more than 58%. This indicated that there was SUFFICIENT CAPCITY of EOT Cranes in the company. If any problem of waiting for EOT Crane was felt, that required better scheduling of crane and better coordination among users, rather than additional EOT Crane capacity.

(b) The utilisation of EOT Crane at bay 4 is 58%. In addition to this, this crane was also used to unload materials from Trucks that brought materials to stores located in the same bay. In this event the crane was held up for a long time, making it unavailable for Production. The management had an idea of replacing this old crane with a higher capacity crane of 10 T to cater to the needs of a proposed new product to be made in this bay. Thus an additional facility will help to reduce work-load on this crane.

4. Recommendation & Conclusions

Based on the findings and discussions done in 3.0 following recommendations were given:

4.1 It was established and suggested that EOT Cranes availability can be substantially increased by relocation of 3 of the existing Jib Cranes, providing some accessories to Jib Cranes at very little capital investment. This would result in much higher utilisation of existing resources (Machine Tools and Manpower).

4.2 It was also established on further investigations that besides the reasons of no demand or no operator on crane, there are 2 main reasons for poor utilisation of Jib Cranes, viz, non-availability of Micro Switches attachment (in certain cranes), reluctance of supervisors to use Jib Cranes in favour of EOT Cranes in some other cases. Remedies were suggested for them.

4.3 Eight new potential locations were established.

It was further established that not more than 8 locations are justified in near future for Jib cranes. Therefore after relocating 3 Jib cranes only 5 new Jib cranes would be required. Thus pending requests from the supervisors for 32 Jib cranes are not justified.

4.4 Later on, whenever another 10 Ton EOT Crane would be added, in the plant one of the existing EOT Cranes is also recommended to be relocated for improving their overall availability.

4.5 It was established that existing Jib Cranes had definitely improved the availability of EOT Cranes, and at lesser handling cost.

The whole study, including designing, conducting and analysing took only 2 months to complete and gave results which were more ACCURATE and even more important is that these were more ACCEPTABLE to the shop personnel, as they were based on actual observation and not on pure theoritical work with a list of assumptions.

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Rigging Systems in Arid Areas

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The authors in the present paper make an attempt at economic evaluation of alternative medium duty tube well Rigging systems in arid areas of Western Rajasthan.

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Introduction

Water availability is one of the most important determinants of agricultural production in Arid Areas of Western Rajasthan. (Singh 1977). Skewed and insufficient rainfall (Krishnan '77) along with absence of any perennial river system exerts constraining influence on the crop husbandry. Despite recent spurt in tank and canal irrigation (Chatterji '78), tapping of Ground Water resources still happens to be a major source of irrigation in this region. Tapping of ground water resources again is possible through traditional open wells. Recently energised tubewells have provided an attractive alternative for tapping water ground resources in water scarcity-oriented areas of Western Rajasthan. The existing technology of digging Medium duty tubewells (MDT's) provide three rigging alternatives for creation of irrigation infrastructure in Western Rajasthan. The choice of any rigging device would, however, be conditioned by its economic viability. The present study is an attempt for economic evaluation of alternative MDT rigging systems in arid areas of Western Rajasthan.

Methods and Material Location

This study[1] was undertaken in Jodhpur district

1. For detail see report entitled 'Resource use efficiency of Ground Water potential by tubewells Irrigation in Jodhpur District by B.R. Joshi, H.K. Jain. District Planning Cell, Jodhpur (Raj,) 1979.

of Rajasthan State. Jodhpur district is situated between 25°45' N to 27°26' latitude and 71°52'E to 73°50'E longitude and covers an area of about 22564.05 sq. km. Geographically Jodhpur represents a typical arid district. Tapping of Ground water in this district has so far been restricted only to Bilara and Osian tehsils. With the advent of Integrated Rural Development Programmes, many more locations of digging MDT's have been identified in the district. The study pertains to the newly identified areas where the digging by alternative rigs has been in progress.

The Data

(i) *Income and Cost Structures*

The cost and return flows estimated in present st udy were based on the prevailing market rates. For calculating construction costs, three different systems of tubewell construction[2] were considered. The economic-analysis was based on criteria including in ternal rate of return (IRR), Net present value (NPV), and Pay back period (PBP) for the Planning horizon of 15 years. The coal items comprised construction operation and maintenance costs. Additionally costs incurrence on material inputs like seeds, fertilizers, pesticides, labour, bullock or tractor use and interest paid on short term loans were also included. Returns on the other hand comprised value of kharif and rabi crops. In each case the number of farmers amounted to ten.

The Concepts

In order to estimate the economic viability of alternative rigging technology for MDT's, four criteria viz; Net Present Value (NPV), Discounted Benefit Cost Ratios, (DB—CR), Internal Rate of Return (IRR) and Pay-Back Period (PBP) were employed as per following specifications :

$$NPV = \sum_{t=1}^{n} \frac{Bt}{(1+r)^t} - \sum_{1=t}^{n} \frac{Ct}{(1+r)^t} \quad \text{(i)}$$

$$DB-CR = \sum_{t=1}^{n} \frac{Bt}{(1+r)^t} \Big/ \sum_{t=1}^{n} \frac{Ct}{(1+r)^t} \quad \text{(ii)}$$

$$IRR = \sum_{t=1}^{n} \frac{Bt\ Ct}{(1+r)^t} = 0 \quad \text{(iii)}$$

$$PBP = \sum_{t=1}^{n^*} \frac{Bt}{(1+r)^t} - \sum_{t=1}^{n^*} \frac{Ct}{(1+r)^t} = 0 \quad \text{(iv)}$$

Where Bt = Benefits accruable in year 't'

Ct = Costs accrued in year 't'

n* = Number of years, when cumulative income flows would just cover cumulative costs for the planning horizon.

r = Discount rate (@ 14 per cent per annum)

r* = Rate of return which would equalise flows of discounted benefits.

Results and Discussion Cost Structure

A perusal of table 1 indicates that maximum cost flows were incurred on construction, operation and maintenance of 'a' (37.54 per cent), 'b' (36.62 per cent) and 'c' rigs (35.17). This was followed by labour costs which accounted for 17.30, 17.55 and 18.11 per cent for 'a', 'b' and 'c' rigs respectively. To the costs related directly with rigging process, the crop costs were added. The crop costs were distributed in fertilizer (16.73 per cent for 'a', 16.97 per cent for 'b' and 17.00 per cent for 'c' rigs respectively), Bullock and tractor use (11.55, 11.75 and 12.08 per cent respectively for 'a' 'b', and 'c' rig), seeds (7.70, 7.81 and 8.05 percents for 'a', 'b' and 'c' respectively, interest paid on short-term loan (5.43, 5.41 and 5.58 percents for respectively 'a', 'b' and 'c' rigs) and the pesticides (3.84, 3.89 and 4.01 percents for respectively 'a' 'b' and 'c' rigs). The

2. The three type of alternative rigging systems were :
   (a) Cable/Rotary rig electrical operated, having discharge capacity of 160,000 m³/yr, equipped with 12" w./15 hp. Submersible pump of 100 m depth,
   (b) Diesel operated Air hammer rig with discharge capacity of 160,000 m³/yr. and equipped wilh 12" w/15 hp line submersible pump of 100 m depth, and
   (c) Diesel operated cable rottary rig, having discharge capacity of 160,000 m³/yr. and equipped with 12" w/15 hp line shaft pump of 100 m depth.

TABLE 1

Cost structure of Different systems of MDT constructions

(Rs. in 000')

Cost	Years 1	2	3	4	5	6	7	8	9	10
1. Construction operation and maintenance	a. 70.00 b. 62.00 c. 45.00	9.87	10.68	10.57	10.46	10.34	10.20	10.12	10.01	9.90
2. Seeds	—	3.04	3.29	3.25	3.22	3.18	3.15	3.12	3.00	3.05
3. Fertilizer	—	6 60	7.15	7.07	7.00	6.92	6.86	6.77	6.70	6.62
4. Pesticide	—	1.52	1,64	1.63	1.60	1.59	1.57	1,56	1.53	1.52
5. Labour	—	6.83	7.39	7.31	7.24	7.16	7,08	7.01	6.93	6.85
6. Bullock/ Tractor	—	4.55	4.93	4.88	4.82	4.77	4.72	4,66	4,62	4.57
7. Interest on ST loan	—	2.11	2.27	2.25	2.23	2 22	2.18	2.16	2.14	2.11
Total expenditure	a. 70.00 b. 62.00 c. 45.00	34.52	37.35	36.96	36.57	36.18	35.79	35.40	35.01	34.62

TABLE 1

(Cost structure of Different systems of MDT constructions

(Rs. in 000')

Years 11	12	13	14	15	Total and	(a) Percentage at the cost of 70000/-	(b) Percentage at the cost of 62000/-	(c) Percentage at the cost of 45000/-
9.50	9.67	9.56	9.45	9.34	a. 209.70 b. 201.70 c. 187.70	37.54	36.62	35.17
2.94	2.97	2.94	2.91	2.87	43 01	7.70	7.81	8.05
6.36	6.47	6.40	6.32	6.25	93.49	16.73	16.97	17.00
1.46	1.48	1.47	1.46	1.44	21.47	3.84	3.80	4.01
6.57	6.69	6.62	6.54	6.47	96.69	17.30	17.55	18.11
4.38	4.48	4.42	4.36	4.32	64.48	11.55	11.75	12.08
2.02	2.08	2.04	2.02	1.98	29.81	5.34	5.41	5.58
33.23	33.84	33.45	33 06	32.67	a. 558.65 b. 550.65 c. 533.65	100.00	100.00	100.00

distribution of costs indicates that major expenditure was accrued on construction, operation and maintenance which was followed by labour and other costs in all the rigs considered.

Returns

The structure of returns is indicated in table 2. The returns accrued were estimated for both, Kharif and Rabi crops. It is revealed from table 2 that 39.19% of the income was accrued from Kharif crops and predominent share (60.81 per cent) of returns was accounted for by Rabi crops.

TABLE 2

Income Pattern of a MDT Tubewell

(Rs. in 000')

	Years															
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	Total
INCOME FROM																
(a) Kharif crop	10.75	16.78	16.78	16.78	16.78	16.78	16.78	16.78	16.78	16.78	13.31	12.55	12.02	10.86	10.76	221.27 (39.19)
(b) Rabi crop	16.68	26.02	26.02	26.02	26.02	26.02	26.02	26.02	26.02	26.02	20.70	19.47	18.65	16.83	16.74	343.25 (60.81)
(c) Total income	27.43	42.80	42.80	42.80	42.80	42.80	42.80	42.80	42.80	42.80	34.01	32.02	30.67	27.69	27.50	564.52 (100.00)

* Figures in parentheses shows perecntage to total.

Economic Viability

The employment of four criteria for estimation of economic viability for alternative rigs employed for digging tubewells in the study area are set out in table 3. A perusal of table 3 would indicate that the NPV retained its positive value at the rate of 14 per cent per annum of discount rate in all the rigs considered. The highest NPV was registered in MDT's having rig 'c' (Rs. 50130.00), which was followed by rig 'b' (Rs. 35230.00), and rig 'a' (Rs. 9780.00). The DB-CR was registered highest in Rig 'c' (1 : 1.0293), followed by Rig 'b' (1 : 1.0202), and rig 'a' (1 : 1.0055). The similar trend was registered in case of IRR estimates. The highest IRR of 34.25 per cent was registered in rig 'c' followed by rig 'b' (10.49 per cent), and by rig 'a' (4.35 per cent). For rig 'c' the PBP was 3.75 years. Alternatively for rig 'b' it was 6.5 years and for rig 'a' the PBP was 7.5 years.

TABLE 3

Economic Viability of MDT Tubewells Tunder Different systems

Different systems of construction	Criteria for Evaluation N.P.V.	B.C. Ratio	I.R.R.	Pay back period
1. Cable rotary rig Diesel, operated 'a'	9780 = 00	1 : 1.0055	4.35%	7.5 Years
2. Air hammer rig Diesel operated 'b'	35230 = 00	1 : 1.0202	10.49%	6.9 Years
3. Cable/ Rotary rig electrical operated 'c'	50130 = 00	1 : 1.0293	34.25%	3.75 Years

Conclusion and Policy Implications

Looking at the economic attributes for all the three types of MDT's it can conclusively be inferred that

from among all the three alternatives rig 'c' stands out to be a economically viable proposition for creation of efficient irrigation infrastructure in Jodhpur district. However, choice of selecting one type of technology of rigging over other would rest on its ready availability. If rigs of different types are fully available then rig 'c' has a definite edge over rig 'b' and 'a'. However, if imports of machinery is to be discouraged the choice would inevitably be falling on rig 'b' and 'a' The rig 'c' has to be imported and it takes only seven days in drilling one tubewell. The another indigenous rig 'b' which takes 30 days and third rig 'a' takes 60 to 180 days. It is more time and labour consuming and often plagued with machinery failures. If time taken for rigging MDT's by indigenous rigs are reduced and dependence on imported rigs is to be avoided rig 'b' can be advantageously employed for creation of efficient tubewell irrigation network, in arid areas of Western Rajasthan.

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Productivity
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Business Management : A Systems Approach

U.R. DHAR

The author in this paper presents a broad view of some key concepts of the systems approach to the organisation with an aim to provide some insights into the analysis of the same.

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Introduction

Quantitative estimates require the representation of the system in mathematical terms. A mathematical model consists of representing analytically the system relationships in terms of the attributes of the system and hence representing the changes in the system in analytical terms. Qunatitative tools of analysis are required when the complexity of a certain problem precludes any solution by intuitive or similar means. This is particularly the case for dynamic problems when interrelationships between variables involve difference, time-delay, differential and integral equations, expressing the tendency of the processes to evolve over time. When such a process is quantitatively defined, one can manipulate some of its variables and determine their effects on the processes of evaluation. The model should represent the system as closely as possible so that the estimates are meaningful. However, it should be noted that accuracy of prediction can be generally improved only by making the model more complicated and hence less convenient to use, particularly when a simple model may not be satisfactory. There is hence a necessity for a compromies between accuracy and simplicity.

The advent of digital computers and the developments in system analysis and optimisation techniques has radically changed the approach to mathematical modelling of physical systems. While lack of solution techniques was a prime hindrance in the use of

sophisticated and more realistic system models, at present the level of simplicity is governed very often by lack of knowledge or understanding of the system.

2. What is a System ?

The word system may be defined as an interconnected complex of functionally related components designed to achieve a pre-determined objective. There are several significant points in this definition. First, there must be an established arrangement of the components, activities, or functions. Second, implicit in any defintion of a system is the concept of an organised or complex whole—the assembly or combination of the components into a unitary whole. Fig. 1 outlines a simple system description of business

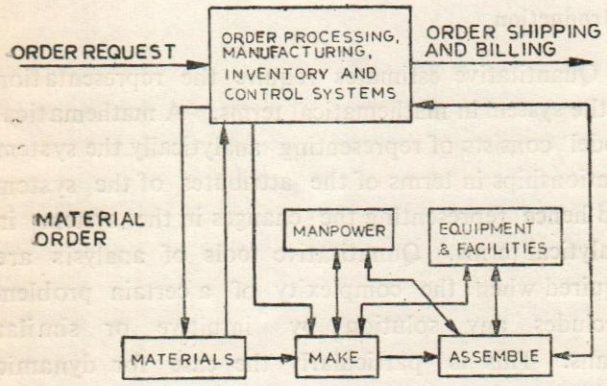

Fig. 1 Business Management Information System

management information system. A *closed system* is one which contains all the attributes necessary for evaluation and manipulation for a designated purpose. An *open system* is one which is subject to outside influences. In real life, the complexity of relationships and influences is so great that no system involving people and society is a closed system. Yet one may deal with a system for specifiic purposes as if it were closed in order to analyse its components and interactions.

2.1. Sub-Systems

The production system may be viewed as a structure of sub-systems (sets of components and interrelationships viewed as components of an aggregate larger system), each of which has the follow-

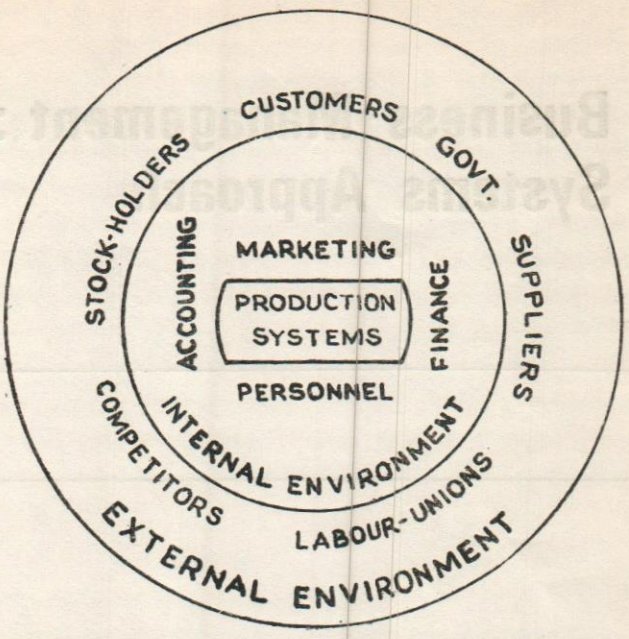

Fig. 2 Environmental interfaces with Production Systems

ing basic characteristics : input, a transformation process, outputs, and a feed-back process. Within the production management system, we discover many configurations of the input-output process model. For example, a straight-line or serial configuration which the output of one process becomes the input of another process. Or, a parallel configuration in which the output from different sub-systems are brought together as inputs into another sub-system. As illustrated in Fig. 2 the production system must be viewed as being a subsystem of the total organization system which in turn is a subsystem of the 'Global' system.

The mathematical modelling of the system component is a very important scientific activity. The attributes of a system or component may be related through functional relationships derived on a scientific basis. When not enough data are available, simpler "black box" or functional representations of the system may be necessary. This will improve the predictions about the total or integrated system.

2.2. Integrated System

The several components of the system are related structurally, logically, and functionally. The relation-

ships between the components and the variables in the system, will indicate their independence and degree of coherence. This will facilitate identification of sub-systems with reference to which the rest of the system may be considered as the environment, which can be analysed and designed relatively independently of the rest of the system and whose response can be represented by "functional" representations. Care should be taken in ignoring parameters and variables since some of them may have a significant influence on the system.

A factory illustrates (Forrester, 1976) how the system formulation depends on this view point. To a person dealing with the broad scope of a company and its market, a factory may be but an open-system component in a larger feedback loop. The factory might be represented as nothing more than a simple delay between the receipt and the shipment of orders. But from the view point of the factory manager it is a complex interaction of many sub-systems involving scheduling, purchase of materials, investment in machines, authority and morale. Each subsystem has local goals and together they form a feedback system that tries to satisfy its goal of matching output to demand, but each united in the achievement of the common goal.

3. Management System

Management scientists have long searched for a structure to unify the diverse manifestations of psychological industrial, and economic processes. Indeed, structure has long been pursued, even though the nature of a suitable structure was elusive (Forrester, 1976). But with the emergence of the concept of "feedback" system (the study of feedback systems deals with the way information is used for the purpose of control). There is a basis for structuring one's observations of complex social and technological systems. Over the last century the theory of systems has slowly been developed to apply to mechanical and electrical system, and to chemical processes. However agreement is widespread that physical systems are far simpler than social systems and it is only in the last two decades that the principles of dynamic interactions in systems have been developed far enough to become practical and useful in dealing with systems of people; and around the principles of this system it should be possible to structure one's confusing observations about socio-techno-economic systems. The advent of new computer capacities and technologies coupled with the increasing mathematical tractability of dynamical problems have been the major forces which have stimulated the applications of systems principles to management in recent years.

Business management can be viewed as a system of people for allocating resources and regulating the activities of a business. The first requirement in assessing a business system is to state the problem. This means that existing operations must be seen as systems and that the systems analyst must decide the systems elements that are present and missing. This would enable one to begin by looking at the whole or the largest part of the whole, whichever is more manageable and practical. Understanding the existing system's operation will lead to the ability to state the systems requirements from which the design of the integrated system, the invaluable tools in problem solving would follow. The steps in systems design are thus identified and explored. Management analysis may involve different types of problem solving; and according to the nature of solution required, the systems module can be used as an analytical tool in investigating the existing system as follows (Optner, 1975).

1. Identification of (i) the system under study (processor), (ii) the purpose for which the system exists (output), (iii) the ingredients (input) whose functional relationships can be arranged to produce the required end result, (iv) the purchaser of the system and his objectives and restrictions (constraints).

2. Detection of (i) the existence or non-existence of mechanisms whose purpose is to maintain reliability, accuracy and other desirable operational attributes (controls), (ii) the existence or non-existence of mechanisms to correct the malfunctioning output (feedback).

Fig. 3 represents a simple system module of production system.

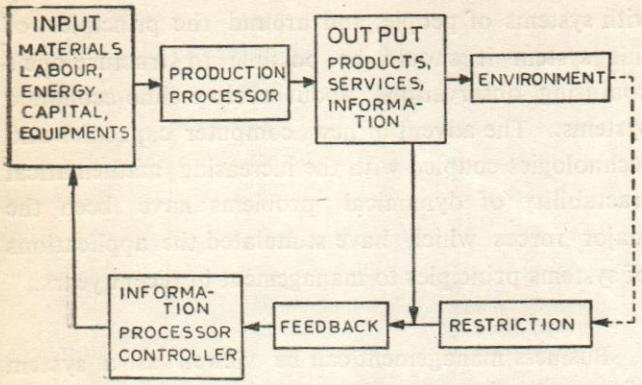

Fig. 3. Production System

4. System Analysis Techniques

System analysis is a methodology for solving major problems, based on the notion of systems and as such it may be regarded as the methodology of operating the business enterprise, since business systems are the entities that use the problem solving methodology. As a methodology of problem solving, systems postulates necessarily serial relationship of interrelated subsystem operations. These are; the isolation of the problem; the evaluation of alternative solutions; the design of the selected solution; and finally, the implementation of this solution. After the system has been well formulated in terms of the relationships, the system is to be analysed. The range of modern analytic techniques available for the manager include: Mathematical analysis, Simulation analysis, Control system analysis and Dynamic system analysis.

4.1. Mathematical Analysis

Some times a system may be represented as an equation or as a set of equations. Quantitative relationship between system variables can be analysed in an experimental sense and simple and fairly complex problems can be solved using mathematical methods. Whenever possible, they are to be preferred because solution is easy, quick and cheap. However as the systems model gets more and more complex, exact analytical techniques become difficult; some problems cannot be solved by exact analytical methods. Although simple models for the system give exact answers, the dynamic behaviour in business system can only be represented by models that are non-linear and so complex that the validity of the analytical solutions are questionable. Such answers may, however, be useful in determining the asymptomatic behaviour of systems.

For example, consider the optimization of a general production system with many inputs and outputs. It is convenient to think of the system as a mathematical operator M, which is generally multidimensional and highly non-linear, which operates on the set of inputs (U_i) to yield the set of output (V_i) ; symbolically

$$M\,[(U_i(t)] = [V_i(t)] \qquad (1)$$

The functional notation (t) indicates time dependence which may be caused by quasirandom fluctuation in the input variables. The system has an objective function (financial profit) Q associated with its operations determined on the basis of economic and management considerations. The profit is symbolized by the identity.

$$B = B\,([U_i], [V_i]\,Q) \qquad (2)$$

In general not all operating levels of the system are allowed since constraint are quite often imposed either by the system itself or by characteristics of environment related system. Limits of this type are represented by

$$C_j\,([U_i], [V_i]) < O \qquad (3)$$

where C_j in the symbolic notation for j th. kind of constraint.

With the system so defined the generalized optimization goal is stated in symbolic form.

$$\underset{X_i}{\text{Max}}\ B\,(U_i, V_i\,Q) \qquad (4)$$

subject to equations (1) and (2). The equation (4) is read : Locate the set of input variables X_i which for given condition Q maximizes the profit function and also satisfies the constraints.

When analytical solutions are very difficult or impossible; numerical or experimental methods are to be used. Until about 1960, the cost of computation was so great that most effort was applied to finding analytical solutions to simple systems and the more complex system were either ignored or subjected to

'intuitive' solutions. But due to the growth of digital computers; the economics of computation has been changing drastically and has made quite complex mathematical problems amenable to solution.

4.2. *Simulation Analysis*

When one must deal with systems whose analytical solutions are beyond the reach of today's mathematics; one turns to the process of simulation. There arise many situations which cannot be represented mathematically due to the stochastic nature of the problem; the complexity of the problem formulation; or the interactions needed to adequately describe the problem under study. Simulation as the "method of last resort" might then be used to obtain relevant answers.

Simulation does not give the general solution. But it is a numerical technique for conducting experiments on a digital computer, which involves certain types of mathematical and logical relationships necessary to describe the behaviour and structure of a complex real-world system over extended period of times.

It is only recently that simulation models have come to occupy a prominent position as a tool of design and problem solving. Early simulation studies attacked problems such as inventory systems, production scheduling systems, waiting line problems, and so on. But recent advances in simulation methodologies, software availability and technical development have made simulation one of the most widely used and accepted tools in systems analysis; and it appears entirely possible that a business can also be simulated in a manner that will lead to a new understanding of the functional relationships involved.

There are generally a number of steps in the simulation of a business system. Though the detail may vary from study to study, a number of steps are common to several simulation studies, Fig. 4 is a block diagram representation for system simulation.

Simulation analysis always begins with a representation of the system which needs to be studied. In digital computer simulation, this step is accomplished through the construction of a computer program which

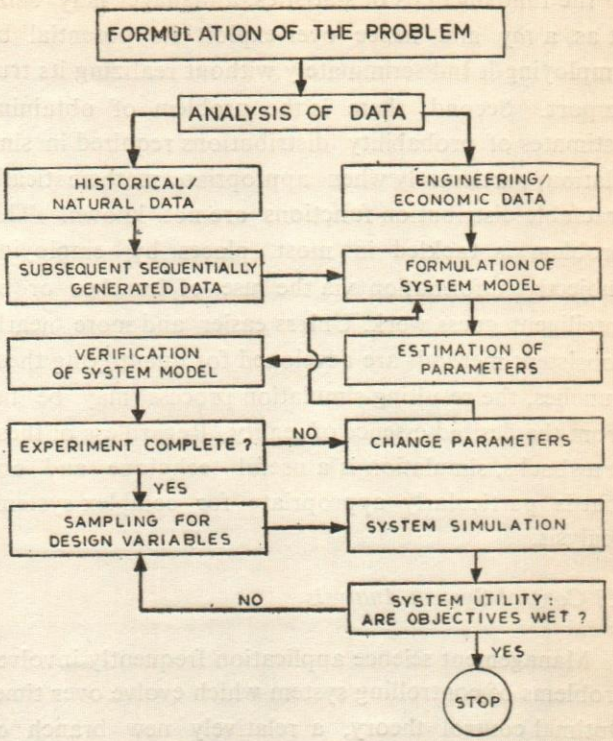

Fig. 4 Flow-chart for Simulation

"describes" the system under study to the appropriate computer configuration. The representation might be in the form of a FORTRAN program, graphical interactive displays, or a complex simulation language, like SIMSCRIPT, GASP II/IV, GPSS III, SIMULA or SOL. Once this step has been completed, the model of the system is acted upon and the results of these actions are observed over long simulated period of time. Although simulation analysis is usually performed via high-speed computer, such a representation is not always essential to study all problems.

Simulation analysis has been applied for a number of purposes; however, a great deal of experience is desirable in order to adequately exploit the real potential of simulation. There exist two problems in this relation (Smith, 1969). First, there is the problem of simultaneous. *over-exploitation* and *under-exploitation* of simulation. With the widespread installation of digital computers, simulation is readily available to most managers and unless a manager gains a great deal of skill in systems modelling he may think of it almost as a *game* and hence under-exploit its potentials. On the other hand, without a good background

The description, even a preliminary overview, of the whole procedure of System Dynamics is beyond the scope of this paper. However, basically a System Dynamics study is comprised of the following stages:

1. Formulation of a model
2. Validation of the model
3. Model analysis and model modification
4. Implementation of the model.

System Dynamics model has found application in corporate planning, R and D management, functional problems in business, agriculture and in many areas of social and economic systems. It allows the relatively easy development of models possessing some hundred or even several thousand variables. Such large models are acceptable since the formulation, analysis and modification of System Dynamics models are based completely on the use of computer simulation to compare the costs, benefits, and time path generated by available alternative management strategies. The System Dynamics notation largely coincides with the notation of the computer simulation language DYNAMO. This language was specifically developed for programming System Dynamics models. But DYNAMO is only a tool. By itself it is ineffective unless the model formulation is soundly conceived and properly related to the real-world system that the model represents. Thus the principal requirements for successful work in System Dynamics is understanding of the way in which the organization actually works, rather than advanced mathematical skill. In fact the optimal solution of a model is *not* an optional solution of a problem unless the model is a perfect representation of the problem.

5. System Testing and Implementation

An important part of systems analysis is to ensure that systems that are designed are adequately tested before "Implementation" i.e. the process of converting the system design into an operational system. The purpose of system testing is to examine the pre-operational system in order to check that it meets the desired objectives. During this phase, if necessary, one may incorporate modification in the original model to eliminate or reduce errors. The real solution to the problems of implementation is, however, forethought. A problem anticipated is a problem half solved. The other key point in successful implementation is the adaption of a suitable planning and monitoring technique (for example, CPM or GASP) to control the project effectively.

Concerning the implementation of System Dynamics study, although there is a range of possible degrees of implementation, Forrester gives no clear answer. He says (Forrester, 1976) the goal of building and analysing a model is "to understand the reality better" and "to get a better intuitive feeling for the time-varying behaviour of industrial and economic systems". Whether this system improvement should be realized throughout by implementing the new decision rule in the system remains unanswered.

6. Concluding Remarks

The last two decades have witnessed a huge growth in publications on system approaches to management and organisation. And the literature has by no means been decreasing. However, this paper has attempted to present a brief overview of systems approach to organization, with an aim to provide only an orientation to the beginners unaware of these methodologies. The enormity of the existing literature forced this author to be selective rather than comprehensive in the choice of literature supporting the exposition.

The ambitious claims of the systems advocates (In 1976 R.L. Achoff even wrote about "Systems revolution", changing the "Machine Age" into "System Age" however, did not only draw applause but also conjured up bitter criticisms like, "intolerably inefficient" or "a promise that could not be kept". This may be because the systems approach is modern, rational and systematic but at the same time people-oriented and not mechanistic. And although there has occured tremendous improvement in hardware performance in the recent past, perhaps, the further development of the ideas and command of the techniques of the systems analysis has not grown at the same rate. Consequently experience and motive of

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SMALL MISTAKES CAN CREATE BIG PROBLEMS

Productivity
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Productivity of Agarbathi Workers

DR. G. MOHAN KUMAR

The paper presents the study of productivity in four different agarbathi factories in Mysore. The study points out that certain dexterity tests are useful in predicting production efficiency and job success.

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Introduction

In the ancient scriptures the burning of incense has been mentioned as one of the offerings to God and no religious function goes without using these incense in different forms. The Agarbathi industry in India is one of the oldest and has been handed down through successive generations of skilled perfume manufacturers. It owes its preservation and development to the patronage of the aristocratic ruling class in the past. As in the case of all arts, the Agarbathi industry also enjoyed the patronage of the Royal house of Mysore and progressed rapidly to such an extent that at present Karnataka State holds the pride of place as leading centre for quality agarbathies.

The process of manufacture is entirely manual and is carried out by women workers, who comprise about 90% of the total strength. Bamboo sticks on which the perfumery mass is applied is by itself a subsidiary craft. The basic raw materials used in high quality agarbathies are 20 to 60 in number, consisting of odoriferous roots, Barks, herbs and flowers which are at first pulverised to specified quantities and then to it are added Resims, essential oils and aromatic chemicals. Afterwards, the mixture is grounded into a fine paste, with the addition of water and colour wherever necessary. With this ground mass 10 to 25% of wood gum is mixed and kneaded. The resulting hard paste is applied with the palm on a smooth surface to the required thickness. "In Mysore the rolling with the palm is characteristically finished off by the forearm to give a much smoother finish,

which is a distinguishing feature of certain varieties produced in Mysore city alone". (The Hindu, 1971).

In an agarbathi industry as it calls for dexterity as a main factor, a study was made to know how far this industry depends on this ability. Though dexterity is one of the main factors further analysis was made to know how far other factors influence production, so that any conducive factor could be more entertained and other non-conducive factors could be eliminated.

The study of skills operating in various industrial jobs and the problem of industrial efficiency, minimising the factors which were detrimental to industrial efficiency had gained much importance in recent years. From our daily experience, we know that with practice skills can be developed and further development depends upon abilities like manual, mechanical, motor etc., comparatively, an employee with great skills of those will be more efficient with respect to production than with one who is possessing inferior skills.

The attention of the early researchers was centered mainly upon those human factors objectively observable and directly concerned by the production activities, such as sensory-motor co-ordination required to perform a task or the speed with which the hands or fingers could manipulate materials. Likewise, then attention was focussed on those activities which had immediate consequence in production within a few days rather than within a few months or years.

In the second decade of the 20th Century, Industrial Psychologists undertook the task of analysing several professions and to frame psychological tests for the selection of workers for several jobs, which have contributed to the development of the knowledge of motor ability. The use of the new statistical methods devised by Spearman in the analysis of motor ability scores have also contributed to the understanding of the nature of motor ability.

The first study of manual dexterity was conducted by Byran in the year 1892. W.R. Foster in the year 1924 employed the (1) peg board test to measure the speed of hand in packing, (2) threading beads to judge speed in accurate works, (3) drawing circles to measure the coordination, as the tests of manual dexterity. The correlation between the tests and the estimated ability by the foreman in packing on an average is 0.50.

J.N. Longdon (1937) administered three tests of manual dexterity to two groups of women workers working in a chocolate factory. The correlation between the battery of tests and the ability to pack 40 slabs chocolates were 0.49 $\pm$0.13 among the group of 27 workers and0.37 $\pm$ 0.06 among the group of 77 workers.

M.L. Blum and Candee (1941) administered Minnesota rate of manipulation test to a group of packers and wrappers employed in a department store. The criteria used were production records and supervisory ratings. The correlation between production records and placing and turning in the Minnesota rate of manipulation test were 0.21 and 0.06. When supervisor ratings were used as a criteria no significant differences were found between superior and inferior employees.

The United States employment services carried out an investigation in which 43 packers, 30 merchandise packers and 41 inspector wrappers were administered Minnesota test. A production criteria for the first two types of jobs and ratings for the third type of job were used. The γ for placing test were 0.36, 0.14 and -0.09, for the turning test 0.22, 0.11 and 0.01 respectively.

The results of these studies and the conclusion made by the investigators are diverse in nature. But yet they show to a considerable extent that the manual dexterity tests can be considered as good measures of proficiency in industry. These tests act as an aid to the placing of employees in suitable jobs, persons tested successfully in this way will tend to stay for a longer period. There are many kinds of different jobs, before accepting any one of these tests as suitable for any job one should be sure whether the test resorted to evaluate the underlying principles of the job.

Problem

An investigation was made to study the relationship

between the manual dexterity tests and production as found from the production records of workers in the Agarbathi factories in Mysore City.

Method

Sample : As it has been stated earlier, only female workers are engaged in agarbathi making a sample of 150 female workers were selected from 4 different agarbathi factories in Mysore City.

Tools : Minnesota rate of manipulation test and O'Connor's finger dexterity tests were administered. The production records of the workers for three months was taken into account. A worker can produce at the rate of 3,000 to 4,000 sticks per day, the average production for the three months is considered. The scores on the Minnesota rate of manipulation test (time in seconds) and Finger dexterity test scores (time in seconds) were correlated with production scores. The coefficient of correlation were computed from the raw scores by the Pearson's product moment method.

Results and Discussion

Minnesota rate of manipulation test scores correlate with production scores to the extent of 0.26 and it is significant at 0.01 level. These figures indicate that an individual who takes less time in Minnesota rate of manipulation test placing series will produce more than the one who takes much time on the same test. The O' Conner Finger dexterity test scores correlates with production scores to the extent of 0.20. This coefficient is also significant at 0.01 level. These figures also indicate that one who takes less time to insert the pins in Finger dexterity test will produce more number of sticks and one who takes more time to insert pins will definitely produce less number of sticks.

Since both Minnesota rate of manipulation test and Finger dexterity test scores are positively related with production scores and both are significant at 0.01 level. We can say to certain extent these two tests can be used as a predictor of job success. Eventhough, they are positive they are not high enough to place much faith on these tests alone. One must supplement some other psychological tests in addition to these dexterity tests.

TABLE 1

Table showing correlation obtained and significance level for different tests of manual dexterity with production scores

Tests	Coefficient of Correlation	Significance level (N-2) Degrees of freedom
Minnesota rate of manipulation test	.26	.01 level
Finger dexterity test	.20	.01 level

Incidentally, the effect of other variables such as Religion, Age differences and years of service or experience and their influence in the production of agarbathies were also studied.

Since olden days agarabathi making is the traditional occupation of Muslims. Now also Muslim women continue to dominate in this field. Muslims prefer to work in Agarbathi factories because they are exposed to this since childhood. The process of industrialisation, urbanisation, economic emancipation of women and to attain a set up standard of living women from other religions have also taken up this job.

In the present study, out of 150 workers, Mudaliyars and Muslims consist a large part 39 and 33 respectively. Since it is the traditional occupation of Muslims, one generally expects that Muslims will fare better and thus the production rate and efficiency will be greater than the Mudaliyars.

From the table we can notice that there is not much difference in the Mean scores among Mudaliyars and Muslims for Minnesota rate of manipulation test and production scores. In each case, the difference between the Mean is 2.1 and 2.0 respectively and hence they are not significant. But the difference between the Mean scores on Finger dexterity test is 38.40 and it is significant at 0.05 level. Although, Agarbathi making is the traditional occupation of Muslims; Mudaliyars are also equally proficient.

TABLE 2

Table showing the Mean, S.D's Critical ratios and the significance levels of the scores for Mudaliyar and Muslim workers

	Mean		S.D's		Critical ratio	Level of significance
	Mudaliyar	Muslim	Mudaliyar	Muslim		
Minnesota rate of Manipulation test	58.00	60.26	5.26	6.50	1.41	Not Significant
Finger dexterity test	601.60	563.20	70.40	70.80	2.28	.05 Level
Production scores	90.40	88.40	72.00	62.00	.98	Not Significant

In every walk of life there is an effect of age, both physically and mentally there will be growth upto the age of twentytwo. After twentytwo there will be complete balance between physical and mental growth. It is a period where maximum striving for one's goal is exhibited. After a period of experience it becomes habit in the individual unless a job calls for rapid change. In case of dexterity also the maximum output is seen in the adulthood after 40's there will be decline. Hence an attempt is made to know the growth of manual dexterity at different age levels :

The results have indicated that there is no significant difference between the Mean on Minnesota rate of manipulation test scores for various age groups. But there was significant difference between Mean of the Finger dexterity test scores. The difference between 20-29 and 30-39 years group and 30-39 and 40 and above groups are significant at 0.05 level. Except the difference between 10-19 and 20-29 years groups other are significant beyond 0.01 level.

Similarly the experience on the job has an effect on production rate for the group with 11 years and above experience.

Conclusion

On the whole, it can be concluded that people with more dexterity fare better in manufacturing agarbathies. Since wages are directly related with the production and also the test scores on Minnesota rate of manipulation test and finger dexterity test are positively related with production and in many cases the coefficients of correlation are significant. One can use these dexterity tests in predicting the job success and productive efficiency and some other psychological tests may be used in addition to these dexterity tests.

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Job Evaluation Through Dynamic Programming

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This article demonstrates the techniques for locating the point ranges between the grade in a job evaluation system of the points rating type.

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Introduction

Job evaluation is a systematic method for determining the relative worth of jobs and the most popular type of job evaluation system is the point rating system.

To get a basic understanding of this sytem, let us first assume that there are four factors which determine the relative worth of jobs—skill, effort, responsibility and working conditions. (In practice, of course, more factors are usually considered but they are essentially sub-divisions of the four main factors). We would then have to construct a rating scale for each factor by which we could distinguish between jobs involving low and high degrees of skill, effort, responsibility and working conditions. In the point rating system this is done by assigning a number of degrees for each factor (this number is not necessarily the same for each factor) and defining the requirements of the jobs under each degree for each factor. For example, suppose we decided to have 5 degrees for skill; the first degree might stand for a 'very low' requirement of skill in the job, the second degree for a 'low' requirement, the third degree for a 'moderate' requirement, the fourth degree for a 'high' requirement and the fifth degree for a 'very high' requirement.

Of course the factors and the degrees will in actual practice have to be defined much more specifically and comprehensively so that the actual rating of

jobs can be carried out smoothly and accurately. But the basic principle essentially remains the same.

Before we can directly compare jobs that have rated against the various factors, we must reduce the ratings to some common denominator. This is done by allocating some point value for each degree of each factor and that is why the system is called the point rating system. The table below will be illustrative of the approach. The point values in such a matrix also be called 'factor weights'.

FACTOR/DEGREE	1	2	3	4	5
SKILL	35	70	105	140	175
EFFORT	19	38	57	76	95
RESPONSIBILITY	35	70	105	140	175
WORKING CONDITION	11	24	37	50	

Once the rating for a job is made against each factor, the points earned against each factor are summed up and the total points represent the relative worth of the job, in as much as any job earning higher points is considered to be worth more and vice-versa.

But how do we actually allocate points to the various degrees of each factor? It may be noticed from the table that the sum of the points under Degree-I for the various factors is 100; that the points for the highest degree are five times that for Degree-I and that the intervening steps are following an arithmetical progression. Some such structure is fairly popular. A Committee would sit and decide the relative weightages out of 100 for the various factors after which the table can be filled-up.

More refined mathematical techniques can also be used. The literature on the subject deals with many ways of constructing the rating scales for factors. In particular, the problem of evolving "factor weights" (i.e. specifying the point values at various distances along the rating scales) has received a good deal of attention. In India, for example, Das & Khetan[1], Bhargava[2], and Chaturvedi & Ravindra[3] have described the application of various mathematical techniques useful for determining an optimal set of factor weights.

Very little attention, however, seems to have been paid to the problem of allocating points ranges between grades in text books and published papers. It is this aspect that is the subject of this paper.

Background

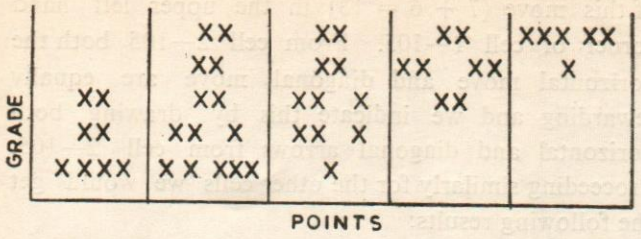
The steel industry is in the process of evolving a job evaluation system of the points rating type. This exercise is being carried out at the national level with the participation of all the major steel plants in India (both from public sector and private sector) and involving the concerned unions fully. Various alternative sets of factor weights had been devised and the remaining task in finalising the system was to allocate the points ranges between grades for the various alternatives under consideration and to make a final choice regarding the factor weights and allocation of points ranges. The general direction to be aimed at was minimising the disturbances to the wage differentials of the key jobs (representative jobs generally agreed to be neither underpaid nor overpaid) but the final choice might also take into account other factors like acceptability to the workers, flexibility of the system etc. It was decided to work out a number of alternative methods of allocating the points ranges and to make the final choice after considering their relative merits and demerits.

The work was spread out over two years or so. In order to try to capture the genesis and evolution of the various ideas used, the exposition in this paper has followed a historical rather than logical order.

The Problem

Let us now place the problem in sharper perspective. Consider the scatter diagram plotted between the point value a job earns and its wages. (The mid-point of grades were taken to represent wages). It will consist of points scattered on a number of horizontal lines, each line representing a grade. And in order to complete the evaluation exercise, certain points ranges will have to be allocated to each grade (shown by dotted lines in the diagram on next page.

We want that as few evaluated jobs as possible



should lie outside the points range specified for their grade.

Previous Thumb Rules

Two thumb rules for placing the dividing lines has been handed down from previous work on this problem. These were :

—Draw a dividing line at the mid-point of overlap between the scatter of two adjacent grades.

—Take the range between the highest point score and the lowest point score and divide this range into equal steps.

New Thumb Rules

Attention was first focussed on the system of unequal steps, as such a system seemed much more promising than one of equal steps. The new thumb rules evolved and tested for dividing lines between two adjacent grades were :

—Take the mid-point of the range of scatter of one grade; repeat for the next grade and draw a dividing line at the mid-point of these two points.

—Take the median value of the point scores of one grade; repeat for the next and draw a dividing line at the mid-point of these two points.

—Take the mean value of the point scores of one grade; repeat for the next and draw a dividing line at the mid-point of these two points.

—Draw the regression line of wages on points. Take the points of intersection of this line with adjacent grades and draw a dividing line at the mid-point of these two points.

As was to be expected, the thumb rules using the medians and means gave consistently better results than those using overlap and range since the latter are more dependent on extreme values of the point scores. The results using the medians and means were practically identical, suggesting that the point scores for each grade were symmetrically distributed.

The thumb rule using the regressions line was the most attractive conceptually, and is the method suggested by many text-books, but its results were quite disappointing.

The choice at this stage seemed to limit itself to selecting the thumb rule based on medians or means.

An Optimal Set of Dividing Lines

While the various thumb rules were being developed and tested it was natural to wonder whether an optimal set of dividing lines that would minimise disturbances to the wage differentials of the key jobs could be obtained in one way or another. A major break-through was achieved when a positive answer to this question was obtained. The technique used for obtaining an optimal set of dividing lines was Dynamic Programming and its application to this problem is worth detailing.

Dynamic Programming

Dynamic Programming is a technique which efficiently solves problems where a number of stages exist at which decisions have to be taken, and one stage is related to the next stage. To understand what are the stages and what is the inter-relation between the stages for our particular problem, consider the following simplified illustration :—

POINTS / GRADES	100	101	102	103	104	105	106
5	9	0	5	9	0	2	6
4	7	6	5	5	8	9	5
3	0	6	5	8	8	3	6
2	2	9	0	5	6	4	6
1	8	6	2	1	2	7	4

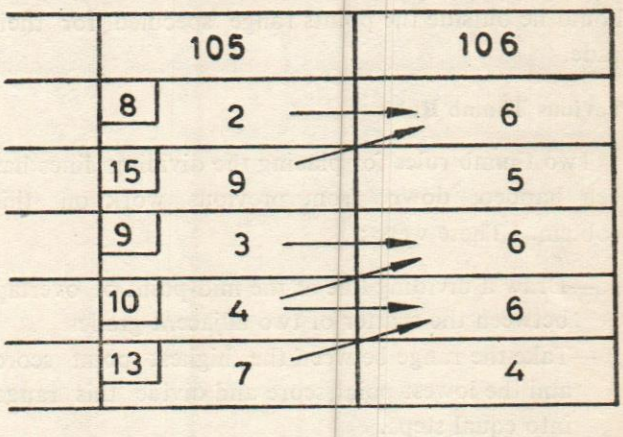
Five grades have been assumed, grade-1 being the lowest grade. The points range of the scatter has been assumed to vary between 100 & 106. (In practice, of course, the range will be much more). The numbers in each cell represent the number of jobs from a particular grade having a particular point value, viz the entry '9', at the inter-section of the grade-5 row.

and the 100 point column means that 9 jobs belonging to Grade-5 got an evaluated point value of 100.

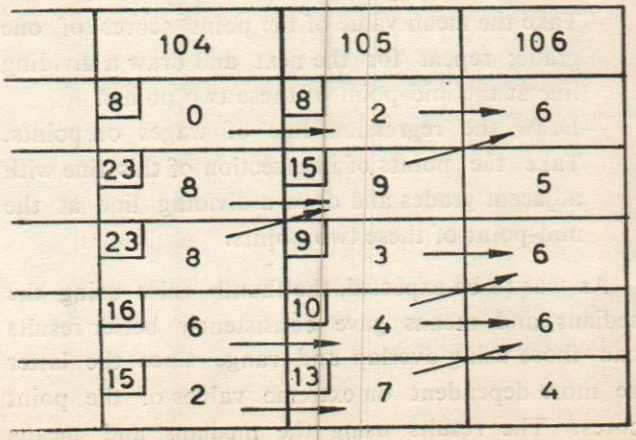
Let us consider the 100 points column. Obviously we have to take a decision as to which grade it should be allocated to. Similar decisions have to be taken for every point value and so every point value (i.e., every column) can be regarded as a stage. It should also be evident that one stage is related to the next stage. For example suppose we decide that the 100 point value should be allocated to Grade-2 it follows that for the 101 point value we have only two choices. viz it can remain in Grade-2 or go up by one step to Grade-3. In other words when we move right from one cell to another, we have only two choices—to move horizontally or diagonally up, and we have to decide at each stage which of these two moves we wish to make.

So far we have been vaguely expressing our objective as 'minimise disturbance'. Before we can proceed further we have to express the objective precisely. Now a job can either be slotted in its existing grade, i.e. remain 'level' or else be upgraded/down graded. One concrete objective could thus be to 'maximise the number of level jobs, (which of course, is the same thing as minimising the number of jobs up-graded/down graded). We are now in a position to apply the Dynamic Programming technique solving the problem stage by stage.

The general rule for solving Dynamic Programming problems is to start from the end and proceed backwards stage by stage. The last decision we have to take is how to move from column 105 to 106. Clearly this decision depends on the cell in column 105 from which we start, which in turn depends on previous decisions, and since we do not know these we shall have to cover all possibilities and make 5 decisions corresponding to the 5 cells we can start from. If we start from cell 1—105 (i.e. the cell at the intersection of the Grade—1 row and the 105 point column) we can either move horizontally to cell 1—106 or diagonally up to cell 2—106. The former move will result in 4 more level jobs and the latter in 6 more level jobs, which makes the latter the preferred move. We indicate this by drawing an arrow diagonally up and also note the total number of level jobs from the 105 column onwards to the end as a result of this move (7 + 6 = 13) in the upper left hand corner of cell 1—105. From cell 2—105 both the horizontal move and diagonal move are equally rewarding and we indicate this by drawing both horizontal and diagonal arrows from cell 2—105. Proceeding similarly for the other cells we would get the following results:

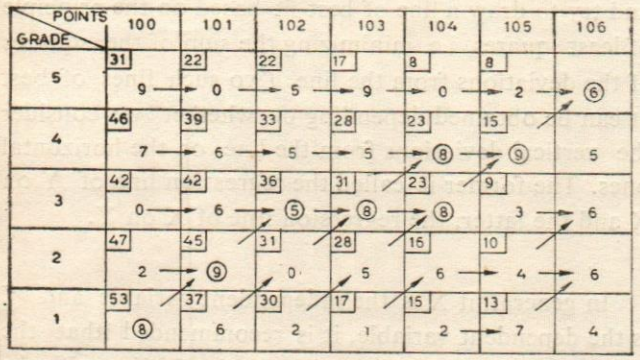


Let us see how the stage involving movement from column 104 to column 105 would be solved. From cell 1—104 the horizontal move will result in 13 more level jobs whereas a diagonal move will result in only 10 more level jobs which makes the former the preferred move, and the total number of level jobs achievable from cell 1—104 onwards is 15 (2 + 13 =15). Note that while solving for this stage we are considering the figures in the left hand corner of the 105 column, since we want to work out the optimal solution from column 104 to the end of the problem. The results after solving this stage will look like this :—



At this point, let us understand what is the significance of the work done so far. We do not know the decisions prior to the 104 column but whatever they may be, we now know the best route from each cell in column 104 to the end, as also the maximum number of level jobs that can be achieved starting from any cell in column 104. For example, if the previous decisions were such that they led into cell 3—104, the optimal route thereafter passes through cells 4—105 and 5—106 and the maximum number of level jobs achievable from cell 3—104 onwards is 23.

We can proceed backwards in the same way stage by stage until we finally reach the end where our results will be :—



In column 100 the highest value is 53 (in cell 1—100) and this represents the maximum number of level jobs that can be obtained. The optimal route is easily determined by following the directions of the arrows from cell 1-100. The entries along the optimal route have been circled for clarity. Note that two optimal routes are there because from cell 3—103 we can move either to 3—104 or 4—104. The two optimal solutions are :—

	Point range	
	Alternative-I	*Alternative-II*
Grade—1	Upto 100	Upto 100
Grade—2	101	101
Grade—3	102—104	102—103
Grade—4	105	104—105
Grade—5	106 & above	106 & above

Having understood the principle of Dynamic Programming, let us now take a critical look at the objective we have used. The objective selected maximized the number of level jobs and minimized the number of upgradations/downgradations. However, an upgradation/downgradation by, say, 3 steps is much more serious than one by 1 step and the objective chosen had not taken this into account. A better objective would be minimizing the "weighted disturbance", i.e. upgradation/downgradation the number of steps by which upgraded/downgraded summed up for all jobs. It is this objective which we actually used.

This, too, was solvable by the dynamic programming technique after the original table had been suitably modified. Consider, for example, the '3' entry in the 105 points column.

	105	
	2	
	9	
	3	
	4	
	7	

Allocating this cell would, regardless of any prior or subsequent allocation, imply a "weighted disturbance" of :

$2 \times 2 + 9 \times 1 + 3 \times 0 + 4 \times 1 + 7 \times 2 = 31$

Similar calculations for the remaining cells would transform the 105 points column to :

	105	
	55	
	34	
	31	
	34	
	45	

After transforming the entire table in this way, the dynamic programming technique could be applied as before with the only change that this time we would be seeking to select the route that minimized rather than maximized the total values.

The optimal set of dividing lines using Dynamic Programming was worked out for various sets of factor weights and yielded significant improvements over the thumb rules used thus far.

End of The Quest Not Reached

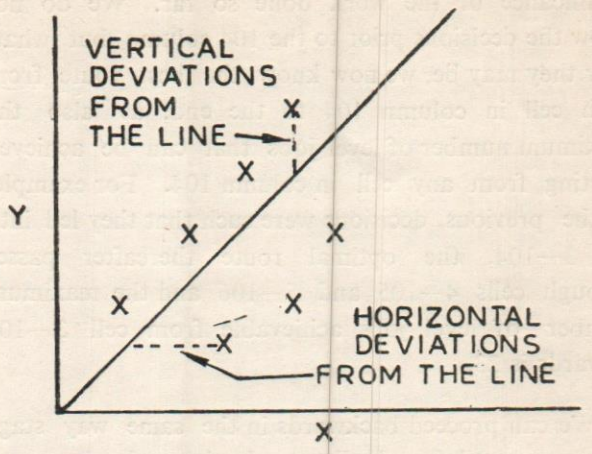
It might be thought that we had reached the end of our quest using the dynamic programming technique, but the approach suffered from two disadvantages :

— Since the dividing lines are not linked in any way to the means of the point scores for each grade, projecting the disturbance pattern obtained with the key jobs to the universe of jobs is fraught with danger if the key jobs are not a representative sample from the population and if the number of key jobs in each grade is not proportional to the number of posts in each grade.

— Addition of a new grade higher than the highest existing grade was under contemplation and the method was not suitable for specifying the placing of a dividing line outside the range of the existing grades. All the thumb rules except that based on the regression line suffer from one or both of these drawbacks, and the regression line, as has been mentioned, was giving disappointing results. An attempt was now made to understand why this should be so.

Reg ression Line

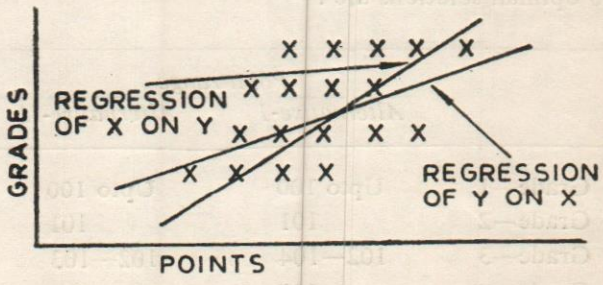
A hard look at the results based on the regression line revealed the peculiar fact that such a method tended to upgrade the jobs in the higher grades. This was so far all the alternatives being considered and it was felt that there must be a mathematical explanation for this phenomenon. On pursuing this matter, the interesting explanation that emerged was as follows :



Suppose we have a scatter diagram as shown above and try to draw a line of best fit based on the principle of least squares, i.e. minimizing the sum of the squares of the deviations from the line. Two such lines of best fit can be obtained depending on whether we consider the vertical deviations from the line or the horizontal ones. The former is called the regression line of Y on X and the latter, the regression line of X on Y.

In general, if X is the independent variable and Y is the dependent variable, it is recommended that the regression line of Y on X be used. In line with the textbooks on job evaluation, we had treated the points score as X and grades as Y and used the regression line of Y on X.

Let us, however, examine the implications of this for our particular problem where the points are constrained to lie on a number of horizontal lines.



When working out the regression line of X on Y, the squares of the deviations we are trying to minimize

are those measured along the rows of points, and since for any given row the best intersection point will be the mean, for the scatter diagram as a whole, too, the regression line will tend to pass through the mean of each row. The regression line of Y on X, on the other hand, will tend by a parallel argument to pass through the mean of the columns of points which at once explains why this line always be slanted towards the right. (For simplicity's sake, we have used a common-sense argument but this result can be proved mathematically).

It is because of this slant that the regression line of Y on X gave unsatisfactory results biased towards upgrading the lower grades and downgrading the higher grades. The regression line of X on Y, on the other hand (as could be expected) gave results akin to those based on medians/means.

The idea of using the regression line of X on Y in direct opposition to the textbooks generated a lot of controversy. Opinions were then gathered from a number of statisticians and the consensus of opinion was :—

—the advice given in statistics textbooks on which of the two regression lines to use are only guidelines and the guidelines are not at all definitive where it is not clear which of the two variables is the independent variable.

—in this case legitimate doubts can arise whether points or grades should be taken as the independent variable. At the stage of development of the evaluation system the grades are known for certain and we wish to allocate points ranges for various grades which suggests grades as the independent variable. However, after finalisation of the system we shall be determining the grade of a job through its evaluated points which suggests points as the independent variable.

—the practial consequences of the two alternatives should be the primary determining factor and these clearly favour using the regression line of X on Y.

We now had a method that was as good as the best of the thumb rules and without any of the drawbacks mentioned in the previous section.

Equal Steps

At this stage an opinion was expressed that dividing lines based on equal steps would be more easy to explain to workers. Using the previous thumb rules, this method gave results so poor as to be totally unacceptable. Attention was now focussed on ways to improve situation. On examining the various scatter diagrams, it was not difficult to improve the results obtained simply by the use of intuition and without any general guiding rule. This brought the results into the acceptable range but there was still quite a gap between these results and the other alternatives. The problem was ultimately resolved satisfactorily by applying the basic ideas used in obtaining a line of best fit using the method of least squares. The way the problem was framed and the resulting formula obtained are given below:

Formula For Best Equal Steps

Starting with an unconstrained set of partition values $x_1, x_2, x_3 \ldots \ldots x_n$ that have been found to be the best according to any chosen criteria, let us attach a penalty to any deviation from this set that is proportional to the squares of the deviations. Then, for any subsidiary set of partition values incorporating constraints, the "best" set could be defined as the one that incurs the least penalty.

Let

$x_1, x_2, x_3 \ldots \ldots x_n$ be the best unconstrained partition values

a = first partition value of subsidiary set

d = uniform distance between two partition values in the subsidiary set

Then the total penalty z will be given by the equation

$$z = (a - x_1)^2 + (a + d - x_2)^2 + \ldots\ldots + (a + n - 1d - x_n)^2$$

or $z = a^2 + x_1^2 - 2ax_1$

$$+ a^2 + x_2^2 - 2ax_2 + d^2 + 2ad - 2dx_2$$
$$\vdots$$
$$+ a^2 + x_n^2 - 2ax_n + (n-1)^2 d^2 + 2a\ (n-1)\ d - 2\ (n-1)\ dx_n$$

$$= na^2 + \Sigma x_i^2 - 2a\Sigma x_i + d^2 \left[\sum_1^{n-1} i^2\right] + 2ad \left[\sum_1^{n-1} i\right] - 2d \left[\sum_2^{n} (i-1)x_i\right]$$

Using the usual method of partial differentiation for determining the values of a and d which lead to the minimum total penalty, it can be shown that for the best partition values of the subsidiary set

$$a = \frac{\sum_1^n x_i \sum_1^{n-1} i^2 - \sum_1^{n-1} i \sum_2^n (i-1)x_i}{n \sum_1^{n-1} i^2 - \left[\sum_1^{n-1} i\right]}$$

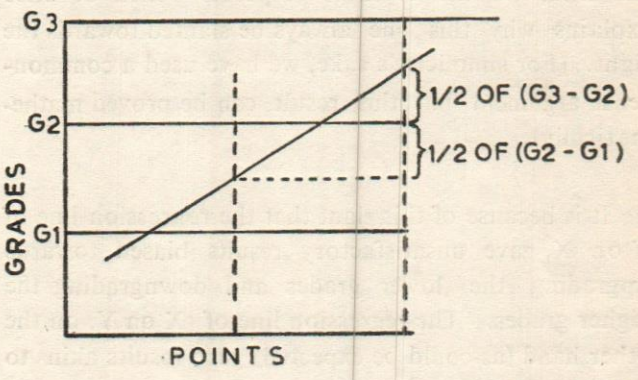
and

$$d = \frac{n \sum_2^n (i-1)x_i - \sum_1^n x_i \sum_1^{n-1} i}{n \sum_1^{n-1} i^2 - \left[\sum_1^{n-1} i\right]^2}$$

Apart from Dynamic Programming, it was clear by now that the best alternative was the regression of X and Y which although not as good as the dynamic programming approach in minimising disturbance, had certain other advantages which have been explained earlier. The best equal steps were, therefore, worked out based on the regression of X on Y and happily yielded results which were almost as good.

Steps Proportional to The Wage Differences Between Grades

A union member now suggested thats steps proportional to the wage differences between grades should be tried. It may be noted that using the regression line (or for that matter, any other straight line) automatically implies steps that are proportional to the average of the wage difference of a grade from its lower grade and higher grade, as can be clearly seen from the diagram below :—



In the proposed method, since the points range for the lowest grade and the highest grade are open ended, the number of steps will be two less than the number of grades whereas the wage difference between adjacent grades will be one less than the number of grades. This will give rise to two altnernatives.

After some thought it was established that the method used for obtaining the best equal steps could also be applied to obtain the best steps proportional to wage differences as indicated below :

Formulae For Best Steps Proportional to Wage Differences

Let

$x_1, x_2, x_3 \ldots\ldots x_n$ be the best unconstrained partition values

$d_1, d_2 \ldots\ldots$ represent the wage differences between grades G_2 & G_1, G_3 & G_2, etc.

a = first partition value of subsidiary set

& $1/k$ = slope of the wage line.

Two cases can now arise

(1) *The point range for G_2 is linked to the wage difference between grades G_2 & G_1*

It can be shown that the best partition values of the subsidiary set

$$a = \frac{\sum_{1}^{n} x_i \sum_{1}^{n-1}\left[\sum_{1}^{i} d_i\right]^2 - \sum_{1}^{n-1}\sum_{1}^{i} d_i \sum_{1}^{n-1} (x_i+1)\left(\sum_{1}^{i} d_i\right)}{n \sum_{1}^{n-1}\left[\sum_{1}^{i} d_i\right]^2 - \left[\sum_{1}^{n-1}\sum_{1}^{i} d_j\right]^2}$$

and

$$k = \frac{n \sum_{1}^{n-1} (x_i+1)\left(\sum_{1}^{i} d_i\right) - \sum_{1}^{n} x_i \sum_{1}^{n-1}\sum_{1}^{i} d_i}{n \sum_{1}^{n-1}\left[\sum_{1}^{i} d_i\right]^2 - \left[\sum_{1}^{n-1}\sum_{1}^{i} d_i\right]^2}$$

(2) *The point range for G_2 is linked to the difference between grades G_3 & G_2*

It can be shown that for the best partition values of the subsidiary set

$$a = \frac{\sum_{1}^{n} x_i \sum_{2}^{n}\left[\sum_{2}^{i} d_i\right]^2 - \sum_{2}^{n}\sum_{2}^{i} d_i \sum_{2}^{n} (x_i)\left(\sum_{2}^{i} d_i\right)}{n \sum_{2}^{n}\left[\sum_{2}^{i} d_i\right]^2 - \left[\sum_{2}^{n}\sum_{2}^{i} d_i\right]^2}$$

and

$$k = \frac{\sum_{2}^{n} (x_i)\left(\sum_{2}^{i} d_i\right) - \sum_{1}^{n} x_i \sum_{2}^{n}\sum_{2}^{i} d_i}{n \sum_{2}^{n}\left[\sum_{2}^{i} d_i\right]^2 - \left[\sum_{2}^{n}\sum_{2}^{i} d_i\right]^2}$$

Such best steps were worked out again based on the regression of X on Y. There was little to choose between the two alternatives generated and both of them yielded results very close to that of the regression of X on Y.

Conclusion

The four major approaches developed (Dynamic Programming, regression of X on Y, best equal steps and best steps proportional to the wage differences) are so far as is known, new approaches to the problem and it is these approaches that have proved to be particularly useful in allocating points ranges between grades with a view to minimise disturbances to the grade structure.

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QUALITY – IS THE BEST SELLER

Productivity
1987, XXVIII, 2, 185-188

EXECUTIVE READINGS

Planning & Promotion of Productivity—The Indian Experience
Vol. 1 & 2
Dr. A.N. Saxena & L.K. Balaratnam

Published by :
National Productivity Council
Utpadakta Bhavan, Lodi Road
New Delhi-110 003
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Price Rs 350/- each Vol.
pp 901+LXXXVII

Reviewed by:
Shri K.R. Chari
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R.D. Hyderabad

The two editions of the publication are representatives of the chronological Development of Productivity Consciousness and movement in India and deal with the total cycle of the productivity improvement in the country. Starting from the realisation and conceptualisation of the need of productivity in the country, the two volumes deal with the various phases of development and implementation of the productivity approaches.

With the year 1956, when the first ever productivity teams involving personalities like Homi Bhaba started the pioneering work, it does throw enough light on the various phases of Governmental support and involvement and also the status of the NPC at the national level both within the Government and outside. It has been rightly and lucidly brought out with illustrations. While emphasising the need and importance of productivity on the labour front, it does deal with the fact that not only the Labour Productivity but the productivity of other important resources like the capital and energy also are equally important. Even productivity efforts in later phases of the development in the country namely the energy crisis and pollution control and the maintenance activities have been well covered. For those industries and the national trade unions who might be interested to understand what National Productivity Council is, and as to what are its activities and role, this will prove to be a very potential resource. As it deals with the organisation and the nature of its involvement in the international field, the work would definitely be of much help to all those institutions, organisations, establishments, who might like to know about the activities in the area of productivity improvement in India.

The important aspects of coverage in the work are :

(a) The growth of productivity movement in India and the growth of National Productivity Council.

(b) The various activities being undertaken towards achieving higher productivity.

(c) The development and role of Industrial Engineering.

(d) Energy Management.

(e) Maintenance Management and capacity utilistation.

(f) Pollution control towards better environment.

(g) Supervisors role in productivity growth.

(h) Formation of the Productivity Boards.

(i) Management of Technology and Technology forecasting.

(j) Productivity Agreements and

share in the gains of productivity.

(k) Transfer of productivity to rural sector and education.

(l) Monitoring of productivity at enterprise level.

In particular the books deal mainly with the development and growth of the National Productivity Council which has been nominated by the Governmet of India as the body responsible for promoting the Productivity Consciousness in the country. Although, almost all organisations have been in some way or other contributing to the growth of productivity at the national level, the volumes are silent on the role of industries. These volumes mainly deal with the role of National Productivity Council in the area of promoting productivity. It is indeed a good reading for those who want to know about the progress of the National Productivity Council in the field of Productivity Movement, however, if one wants to look at specific approaches to enhance their own productivity, or enhance the productivity in their own organisation, the work does draw a blank, as, although starting from the basic study approaches to the latest management techniques, the work fails to give a model or a systematic approach to some one who might be sincerely willing to use this approach.

Techno Economics : Concepts and Cases
J.C. Wright

Published by :
Asian Productivity Organisation, Tokyo
Ed. : Not mentioned
Price. : Not mentioned

Reviewed by :
Shri. S.N. Nandi
Director, NPC
New Delhi

The Book under reference has dealt with an important subject of Engineering Economics from technologists' point of view. There is no doubt that an official employed in manufacturing and allied organisations must know fundamentals of costs, benefit and various other related aspects of engineering economic analysis in order to make proper decision but many of them find it difficult to go through the same after driving through jungles of specialised terms related to cost accountancy. The Book under reference attempts to eliminate the above problem and make the things easily understood to the technicians in their own languages. Author of the Book is therefore to be congratulated.

The Book has got a total of 11 chapters. Chapters 1—3 mainly deal with fundamental concepts of costs in manufacturing set-up. Chapter 4 is the key chapter discussing about discounted cash flow methods. The chapter has been followed by case study on the same subject. Chapter 6 discusses a few simple forecasting techniques which can be easily used in practical situation. Chapter 8 discusses few criteria to be used for evaluating R & D projects. Chapter 9 is the chapter which has dealt with basically various productivity measurement concepts and techniques.

This Book has also discussed a few studies demonstrating use of Engineering analysis at micro levels. Keeping in view all the above chapters, it can be safely said that a technical man will find this book quite readable and helpful to understand some basic ccncepts and techniques related to Engineering economics termed by the author as "Techno Economics". It is therefore, welcome addition to the literature.

The Book in question too has two major short-comings though the same can be overlooked taking into consideration the level of the intended readers. One of the limitations is related to concepts covered—since sizeable proportion of the readers of the book is expected to have some amount of exposure to cost accountancy as a part of their professional curricula and therefore the way some concepts have been treated in the book under reference will appear to be too simplistic in nature. This book will appear to be superficial to them. Further, many of the examples given in the book seem to be too sketchy. However, keeping in view intention of the author, this book can be justifiably considered to be a good manual to understand Engineering Economics in simple terms.

Distribution of Refinery Products in India
R. Jayashankar

Published by :
Concept Publishing Company
New Delhi.
Price : Rs. 90/-
pp. 152

Reviewed by :
Kuldip Chander
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Centre for Analysis and Systems Studies
School of Planning and Architecture
New Delhi-110 002

Increased use of refinery products in India warrants an indepth study of problems related to their distribution. The document written by Dr. R. Jayashankar, which perhaps is a reproduction of part of his doctoral work or its extension, presents an approach to a few mathematical models to find solutions of such complex problems.

The document provides information regarding the various refinery products, their sector-wise consumption and location of various refineries, the problems of the Petroleum Industry and functions of the oil marketing companies. Suggestions made by various Committees appointed by Government and other researchers in the field of energy demand have been mentioned briefly. Some significant details about the existing distribution system, organisational set-up, have been elaborated adequately. More details could have been given about distribution policy, planning process and monitoring of the distribution of petroleum products.

Distribution of bitumen in India, has been selected as a case study, to demonstrate the use of linear programming model in chapter four. The goal programming model—an extension of linear programming, has been developed, to show its ability to incorporate multiple goals. Criteria for selection of bitumen distribution as a case study is not convincing as other petroleum products mentioned in para 1.1 of the document on page 1 have a more important role to play in the context of Indian economy. For developing the linear programming model, only three constraints, namely, bulk-supply capacity, packed-supply capacity and production capacity of each refinery have been recognised. In goal programming model, first priority has been assigned to maximisation of bulk allocation from refineries and second priority to minimisation of cost of production and distribution. Meeting of bulk demand and packed demand have been kept at priority-levels three and four, respectively. The comparison of the cost arrived at from the solution of linear programming model with the cost needed to implement the distribution plan of Oil Coordination Committee, indicates that there can be a significant saving, in case the solution of linear programming model is effected. However, the quantum of this saving reduces considerably in case the solution of goal programming model is implemented. The reduction in saving has been attributed to assigning of low priority to cost minimisation in the goal programming model. However, the author would have done well to prove his contention by doing sensitivity analysis. Author should have fully identified the set of decision and state variables, their significance—as well as whether or not the variables are quantifiable.

Use of transportation model fo coastal movement of light, middle and heavy distillate products has also been demonstrated. The solution of the model, does not show any saving in the cost needed to implement the distribution plan of Government. Certain suggestions made, viz., to reduce the level of berth-occupancy and turn-around time of tanker, provision of additional dock-lines merit consideration. Use of queuing theory has been deftly made to calculate the expected waiting time of tank-lorries for secondary distribution of middle distillate. Preparation of a daily report by various depots indicating the reasons for variation in actual waiting time and its norms as suggested in the document needs a trial for its usefulness.

The style is lucid and allows for an easy reading. The general get-up of the document is satisfactory. The document, which should otherwise find favor with students of management science, is well out of their reach due to its high price.

A Practical Guide to Financing Integrated Rural Development
M.G. Mulmule

Published by :
M/s. Sultan Chand & Sons
New Delhi—110 002
Edition : 1985
Price : Rs. 40.00 paperback
pp : 562

Reviewed by :
Shri V.N. Srivastava, AIMA
New Delhi-110 003

The book, basically a guide, is addressed to the administrative personnel engaged in Integrated Rural Development Programmes (IRDP), particularly, the Bankers. Material is fairly well organised, covering various interfaces. and facets of IRDP.

Chapter I deals largely with the concepts and strategies, programmes of organisations involved in IRDP with clearly specified roles of a banker and gives also the history of development planning. He feels that the success of programmes for physical, social and economic transformation of rural India revolves round development of strong sense of social discipline, active voluntary participation of rural families and sincerity with which the programme is implemented by various development agencies. Finance being a critical input in the development programme, the responsibility of educating the families towards feasible economic programmes falls on the personnel of the financing institutions. This calls for a strong extension service by commercial banks dealing with rural development, identification of family needs, preparation of appropriate programmes, coordination with various concerned departments, organisations, banks etc.

Chapter II deals with objectives, functions and role of the lead bank, branch expansion, the factors considered for allotment of district to the bank, including district credit plan, block plans etc., the principles of financing, operational areas, approach and tools which include the financial, technical, economic, managerial, organisational, commercial, legal and social aspects. Chapter III to VI elaborate various aspects of financing agriculture, activities allied to agriculture, small scale and rural industries including financing of the services sector for the rural economy. Chapter VII deals with the role of a banker for effective functioning of the branch. The author, a banker himself, specifies this role and feels that it is not confined to the premises of the bank but is extended to the area he has to cater to. A banker is also required to establish a close rapport with the residents of the villages to understand their socio-economic conditions, assess economic potential of the area and individual families and find out the extent to which those families could be financially assisted in their chosen avocations. He has also to keep himself in close touch with the officials and workers of various government departments and other organisations to remain abreast with their programmes in the area. The Bankers major role has been identified as organisational planning, deposit mobilisation, credit to priority and non-priority sector, economy measures, branch audit, recovery of advance, customer's service, liaison work, refinance and a host of others.

Mulmule's book is addressed to bankers, teachers and students to Agricultural Universities, officials of various government departments and various social organisations connected with the implementation of IRDP. It is an excellent practical guide to financing the programme.

The book has several good points; the organisation of material is well structured; it is written in a simple, lucid style and has technical vigour at the same time; the author has clarity of thought and presents his material logically.

'Financing Integrated Rural Development' will definitely prove to be a good text and reference book and will run into several future editions.

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Select Bibliography on Computers

S.N. VIG

Computer knowledge has become a must for everyone. The present bibliography is an attempt at compilation of references on automation, database management, robotics, information technology etc. which can prove highly beneficial to those who are concerned with computers.

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