

# Dynamics of Productivity Management

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*This article examines the productivity concept from a holistic point of view in the context of the dynamics of productivity improvement process to achieve organisational excellence. To institutionalise productivity improvement, a strategy consisting of basic eleven elements has been proposed. The implementation of this strategy in four phases has been suggested to achieve long-lasting improvements.*

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In the context of environmental changes, productivity improvement has acquired a new sense of urgency. However, recent studies reveal that there was negligible growth in productivity inspite of sharp increase in capital-labour ratios during 1985-91 (Ahluwalia, 1991). A study conducted by the National Productivity Council in 1980 identified some factors which hinder productivity improvement at unit level in India (table 1). Another study found that organisations perceive employee related (training, motivation, negative attitudes) industrial relations, management related (team work, delegation) and government interference as significant factors influencing productivity.

**Table 1 : Factors Hindering Productivity**

Factors/Process	Frequency (%)
Human related factors	36.34
Communication & control processes	27.05
Structure related	13.66
Resource availability	7.92
Equipment & machinery related	9.02
Others	6.00

Source : Chandy (1980)

(NPC, 1990). Experience has shown that conceptual and operational gaps which act as barriers to productivity improvement exist. Basically, these gaps relate to :

- (i) myopic view of productivity concept
- (ii) lack of understanding of the process of productivity improvement
- (iii) overemphasis on use of productivity techniques
- (iv) lack of commitment on the part of top management
- (v) technological obsolescence
- (vi) lack of productive work culture.

## Changing Concept of Productivity

The word "Productivity" was first coined in 1776 and since then it has been variously defined (Endosomwan,



1987). Conceptually, productivity is a universal and simple concept. It reflects the relationship between outputs and inputs expended in any work situation. The conventional view has always emphasised the labour dimension or in some cases total inputs including material, capital energy.

The output dimension has been defined as "set of results"; "highest level of performance"; "organisational objectives"; "total tangible output"; and "all measurable output" (Mali, 1978; Steward, 1978; Sumanth, 1979; Edosomwan, 1985). Productivity, today is perceived as reflecting efficiency of work process highlighting use of resources and effectiveness indicating achievement of corporate

goals and has, thus, truly become a multi-dimensional phenomena. With increasing customerisation, and emphasis on "integration", any notion of productivity without relating it to customer and total inputs would be meaningless. Four case studies of organisations which has shown exemplary productivity improvements by Suri & Kumar (1989) adopted a holistic approach to productivity including that of the service departments.

Productivity here means a comprehensive holistic phenomena encompassing all elements required to improve products/outputs (satisfaction of customers and inputs, optimisation of resources and inputs) (Monga, 1991). Japanese have viewed productivity in its holistic meaning and developed "pull" approaches so that everything done in the organisation is linked to and pulled by customer needs rather than pushed by the management. Productivity in the future must concern itself with seeking affluence of a kind which will provide people with material, wealth as well as spiritual satisfaction (APO, 1989). Also negative outputs particularly in the form of physical pollution must be controlled in the context of increasing concern of society for clean environment and sustainable development (fig 1). Therefore, productivity to be a truly multi-dimensional phenomena must relate to :

- (i) Design and products to satisfy customer's quantitative and qualitative needs and which leads to improving quality of life, quality of worklife within the organisation. These products should be environmentally sound, generating low or no wastes in their use and maintenance in addition to meeting functional and aesthetic requirements.
- (ii) Ensure optimum consumption of all resources that are required for manufacturing and providing after-

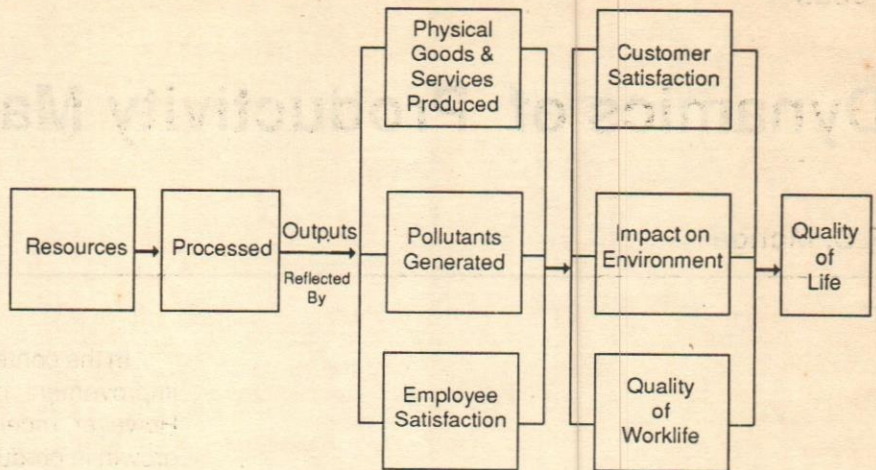


FIG. 1: HOLISTIC VIEW OF PRODUCTIVITY CONCEPT

### PRODUCTIVITY CONCEPT

Conceptually, Productivity is a universal and simple concept. It reflects a relationship between output & input. In today's complex world, with increasing emphasis being placed on customers, productivity in practical terms means :

- \* Doing right things—provide products which meet functional reliability and aesthetic needs of customers and
  - generate less waste and pollute less in use
  - meet qualitative needs
  - are easy to maintain
- \* Doing things rightly—manufacture products in a manner which
  - optimise use of all resources
  - use clean and low waste technologies
  - improves quality of work life
  - reduces wastage and maximises value addition

sales service and particularly those direct materials which go into the product.

### Process of Productivity Improvement

Productivity is influenced by a host of macro and micro level factors (fig 2). The three concentric circles represent-



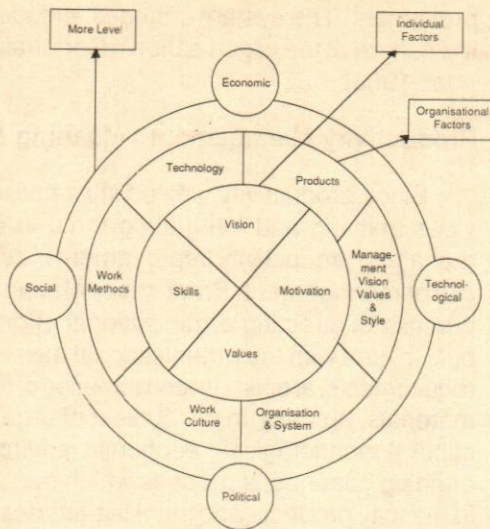


FIG. 2 : FACTORS INFLUENCING PRODUCTIVITY AT DIFFERENT LEVELS

ing environmental, organisational and individual factors are symbolic and indicate that any improvement in a factor on the outer circle has significant impact on the factors in the circles contained in it. For example, improvement in the environmental factors will have major and significant impact on productivity of all organisations. Similarly, vision and values of management will have an impact on motivation of employees at individual level. However, major sources of productivity are product- design, quality of human resources, technology and the way the work is organised including and reflecting quality of management (Monga, 1991).

**Commitment of top management plays the most crucial role in developing and implementing these changes**

Productivity improvements result from implementing changes in the way we organise and do work through a critical evaluation of all influencing factors. The focal point of any strategy for improvement is, therefore, how to make these changes happen and acceptable to managers and workers as well. For these changes to be long lasting, there should be adequate amount of resources, time and effort and an environment supporting change. Therefore, commitment of top management plays the most crucial role in developing and implementing these changes.

Macro level competitive environment creates external pressures while internal pressures come from an understanding that the true source of profits and longterm survival is higher productivity.

Implementation of changes would require departure from past habits and/or methods of doing work. Therefore, total commitment and support of employees is required for long-lasting changes. It is in this context, that human resources with its 'thinking' and 'feeling' attributes play the most critical role.

### Counter Productivity Factors

Much attention has been paid to creating positive forces for improving performance and productivity. However,

improvement process does not take-off because of existence of negative factors or forces within the organisation. These factors relate to environment - both internal and external, employees, jobs, systems and management. It is the negative reaction of employees which produces the resistance to change. Real life management is replete with such examples of miscommunication, misunderstanding, suspicion, anxiety, mistrust, even in the best run organisation. When negative reactions break into the open, it is often too late to do much about them except to try to paper them over (Brown, 1987).

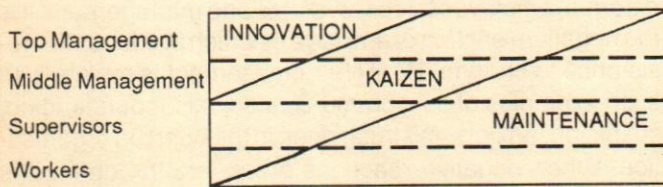
Developing and implementing Productivity Improvement Programme may create apprehensions in the minds of employees regarding job security, wages, roles and job structure, if not implemented properly. Combined with counter-productivity factors, these apprehensions, provide a counter-force to the positive actions, slowing down the improvement efforts. "As these change efforts are initiated, they are greeted by a counter action of restraining forces. These restraining forces tend to be illogical, irrational, emotional and centred around attitudes, assumptions, and paradigms of people within the organisations. Thus we refer to them as cultural restraining force (Groberg, 1991). It is, therefore, essential to identify and reduce the impact of counter productivity factor and remove apprehensions of employees.

### Approach for Improvement

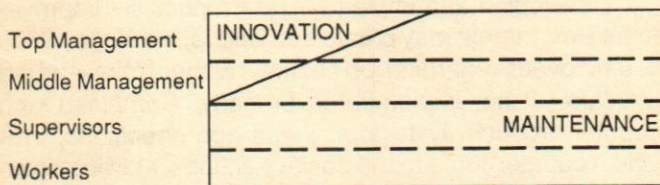
Separate departments commonly known as Industrial Engineering, Management Services etc. established by many organisations—from both private & public sectors, to be the engines of improvements have failed to deliver



goods. Incentives, job evaluations, manpower assessments and other similar jobs are the most common jobs performed by these departments while hard core improvement activities such as implementing changes in work methods and technology, have not received adequate attention. Also efforts to push down the improvements through these departments have been resisted by operational personnel. This approach, has resulted in separating improvement and operational components of the job into two separate jobs. Also technological upgradations or introduction of new technologies for quantum jumps in productivity requiring heavy capital investments have been associated with top management. However, recent experience has shown that the incremental approach i.e. 'small-step-continuous-improvements' can pay rich dividends (Monga, 1989). Japanese industries are well known for 'achieving significant' small step continuous-improvements made in the *status quo* as a result of ongoing efforts. Japanese KAIZEN and process-oriented way of thinking is a major difference in the West's innovation and result-oriented thinking (IMAI, 1986).



Japanese Perceptions of Job Functions



Western Perceptions of Job Functions

FIG. 3: JOB FUNCTIONS

The implementation of a philosophy and strategy of KAIZEN can be achieved through empowerment of employees to effect improvements. It is a practice-oriented strategy where implementation is accorded the prime priority. This approach leads to the creation of an improvement culture, in which every employee always critically examines the work situation to identify and implement KAIZEN i.e. changes for improvements. "It (KAIZEN) changes the attitude of people towards improvements and their routine work. They cease to see routine work as a drudgery alone but begin to see in it opportunities for im-

provement. The system changes attitudes and ultimately the culture of the organisation" (Gondhaleker *et al.*, 1991; Imai, 1966).

### Productivity Management : Meaning & Scope

Since productivity viewed in its holistic meaning provides unifying and integrating force in an organisation, managing productivity improvement is central to the process of management. Productivity Management, thus, is a process of directing organisational efforts to realise outputs in tune with the organisational mission and customer requirements, at optimum consumption of resources (capital, materials, human), in the context of organisational socio-cultural-technological- economic environment. It is an ongoing continuous process which seeks improvements in the way products and services are designed, manufactured, sold, used and maintained. It is the process of adding value to the products and services being provided to customers and eliminating or reducing all those which do not add value but only add cost. It is concerned with achieving organisational excellence rather than departmental or individual result.

#### PRODUCTIVITY MANAGEMENT

It is an on-going continuous process which seeks improvements in the way products and services are designed, manufactured, sold, used and maintained. It optimises product life cycle costs.

It is the process of creating conditions in which every employee - chief executive to peon-contributes towards improvements. Productivity becomes a way of life. Employee becomes the source of improvement rather than a mere resource for management.

It emphasises organisational productivity, long-term gains and synergetic aspects. It includes quantum jumps through capital investments and continuous incremental improvements (KAIZENS) in productivity.

It would require a system approach and a strategic vision to achieve sustained growth in the organisational productivity. The following guidelines for adopting a system approach to productivity has been given by Stephan Moss (1982).

Translate competitive requirements into specific goals for operations in the light of the present and potential operating strengths and weaknesses of the company and its competitors.



Review the entire operating systems from product design through service after sale. Consider the full range of inputs and do not be constrained by conventional wisdom, always keep in mind the interdependencies within the system.

On-going change is both inevitable and desirable. New technologies become available, market requirements and resources change and competitors act and react. Therefore, systems must be innovative and flexible so it can improve and adapt continually.

### Role of Top Management

Translation of commitment of top management into specific actions will demonstrate the sincerity of management which is so vital for obtaining commitment of managers, trade unions and workers. It is the behaviour and actions of members of top management team, particularly,

Chief Executive, which will set standards for others. Pious statements of intentions will cut no ice with the employees. The top management must create an environment and promote improvement culture which motivates employees to achieve excellence in whatever activities they are engaged in. The improvement culture must encourage employees to 'think' and 'make' improvements either in their individual capacity and/or in groups. The process of making improvements must be seen to be important by employees. The top management must—

- (a) Develop specific and unique vision/mission statement reflecting its concern about employees, customers, shareholders and disseminate the same to all employees.
- (b) Ensure that productivity finds a prominent place among the objectives.

### GODREJ KAIZEN MEETINGS

The Godrej Kaizen Meetings are arranged as follows :

The whole organisation is split up into groups of about 6-10 persons. Each group is made up of people at approximately the same hierarchical level. As far as possible, persons from different functional groups are included in each group.

Once a month, each group meets at a specific date and time. The meeting starts on a solemn note, with each participant allotted 6 minutes to talk. The talk is on "What improvements I have done during the last one month". After 6 minutes the person is cut off; no one is permitted to exceed the allotted time to any significant extent. While a Kaizen participant talks, others only listen; nothing else. Intense listening, with body language indicative of intense listening, is what all the others must engage in. No one is permitted to make any kind of remarks. Especially critical remarks are taboo. Even encouraging remarks are to be avoided. Discouraging remarks or ridicule is absolutely banned. At the end of a person's talk, the next person takes up. This goes on till everyone has had his or her turn. There is no discussion whatsoever.

During the meeting, one person, who is hierarchically senior is also present. This person acts as an evaluator. The evaluator listens to the participants and assigns marks on a 0-100 point scale (i.e. a percentage score). The evaluator only listens and does not offer any comments, especially any evaluative or critical comments. The evaluator is only permitted to seek clarification from the participant, if necessary. In the meeting, there is also a coordinator who sees that the meetings are conducted in the way they should be. Apart from the administration, the coordinator also guides the evaluator about the trends in the scoring patterns among all other evaluators so that individual discrepancies between evaluators can be minimised.

Each participant is required to give the improvements made in writing also, apart from speaking them out. The purpose of insisting on writing is two-fold :

1. To force the participant to prepare in advance. When one writes, one's thoughts clarify.
2. It may happen that the participant has done more improvements than he or she can talk about in 6 minutes. In such cases, it is recommended that the participant speaks out only the most important ones and the rest are submitted through the write-up

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- (c) Develop productivity policy statement—emphasising role of employees, thrust areas, specific productivity definition and productivity structure—'what' 'how' of productivity.
- (d) Initiate actions to spread the message of productivity among all employees.
- (e) Create an environment characterised by open expression of ideas, acceptance of divergent views and reflecting respect and concern for employees.
- (f) Integrate productivity with corporate plans, budgets, performance appraisal and other systems of the organisation.
- (g) Develop and promote a productivity culture.
- (h) Develop specific improvement plans.
- (i) Interface effectively with the external environment.

### SUCCESS FACTORS

To make productivity a way of life, a strategy consisting of following basic elements is essential. Each organisation must translate these basic ideas into an action plan in the context of its social-cultural-economic-technological environment—

- \* Commitment of top management and trade unions reflected in productivity policy, objectives and operations plans
- \* Definition of productivity to suit specific needs of the organisation
- \* Creation of a productivity culture & environment - empower employees to do 'KAIZENS'
- \* Creating specific mechanisms to involve all employees from peon to Managing Director
- \* Technological modernization
- \* Development of human resources
- \* Sharing gains of productivity
- \* Minimise counter-productivity factors
- \* Audit & evaluation of productivity
- \* Creation of an organisational structure to promote and institutionalise productivity improvement
- \* Integrate productivity with corporate plans, budgets, performance appraisals and long-term strategies.

### Strategy and Its Elements

Productivity improvement does not take place on its own. A well-managed organisation will be more productive but certain actions are required to achieve continuous growth in productivity performance. It requires a well-coordinated strategy to implement such actions. Experience has shown that different organisations have developed and implemented various approaches to improve productivity. The common thread running through the strategies adopted and essential for institutionalising productivity improvement are :

- (1) Commitment of top management and trade unions and translation of this commitment through formulation of a strategy, policy objectives and operational plans.
- (2) Define productivity to operationalise the concept in the context of organisation's own need, customer and supplier requirements.
- (3) Creation of a productivity culture which respects employees, promotes team work and exhibits 'can do' spirit within an organisation.
- (4) Creating specific mechanisms for utilising the brain in addition to muscle power of the employees. The emphasis should be on utilising "whole" employees. The employees should be involved in preparing productivity plans and empowered to implement KAIZENS. All employees should be involved in their individual capacity as well as in groups to develop and implement productivity improvement ideas. It could take the shape of a suggestion scheme, productivity improvement circles, task groups, KAIZEN groups, Quality Circles, cross-functional teams or any other shape suiting the requirements of the organisation.
- (5) Technological modernisation including incremental and quantum jumps in productivity contribute significantly towards productivity performance. A technological plan should include skill upgradation and all other areas which are likely to be influenced by introduction of a new technology. Information sharing, consultation and involvement of employees particularly workers will obtain their cooperation for implementing such plans. Continuous search for new technologies, adaptation and assimilation, low cost automation and strengthening of R&D efforts are the important elements of a technological strategy. The impact of new technologies on structure, systems, labour relations, skills and nature of work must be analysed and necessary changes made to



realise full potential from technological change process. A climate of trust between organisation and employees will facilitate implementation of such plans. Employees should be involved in identifying surplus skills and manpower, retraining and redeployment schemes.

- (6) Human Resource Development is the key to productivity improvement. Continuous training in technical, problem solving and decision making skills and other areas facilitates the growth of all round personality of employees, their empowerment for effecting improvements, involvement in preparing and implementing productivity plans, and creation of an enabling environment will obtain their best efforts. "An organisation is as successful as the people who constitute it." Good organisations, therefore, lay great stress on improving the quality of their employees at all levels by continuously upgrading their conceptual, managerial, behavioural and technical skills. In the hierarchy of productivity improvement efforts, updating skill and knowledge takes precedence over systems procedures and even technology. That is why "Productivity through people" has become an important slogan in productivity oriented organisations (Gupta, 1989). Specific action plans to create a vision about the future of the organisation and reinforcement of positive values will lead to pride in their jobs.
- (7) Recognition systems including both financial rewards and non-financial motivators are the essential components of any strategy to obtain the commitment of the employees. These recognition systems should be designed to meet the organisational needs and employees expectations. Both the management and union believe that sharing of gains of productivity should have a broader perspective, it must serve a bigger cause i.e. quality of life of the people working inside the factory, living in the *bastis* as well as the surrounding villages must improve (Gupta, 1989). A properly designed scheme can provide a spark for accelerating the productivity improvement efforts within the organisation. If productivity is to advance beyond the "program" stage, we must modify our reward systems to explicitly, continually, and effectively reinforce productivity improvement (Balcher, 1987).
- (8) Diagnosis of counter-productivity factors, eliminating them and if not possible, reducing their impact, facilitates preparation of the soil where the tree of productivity can take roots.

- (9) Continuously locating improvement areas through evaluation and audit performance and the total organisation in desirable direction. Productivity planning and diagnosis on regular basis identifies areas where performance is deteriorating. Most common approaches in productivity evaluation and analysis are Kurosawa's Structural Approach, Lawlers Approach, Cold's Approach, Quick Productivity Appraisal Approach, Inter-firm Comparisons (Prokopanko, 1987). Bench-marking is another powerful tool to compare performance with the best-in-class organisations and to indicate possible standards for achievement.
- (10) Creation of a productivity structure reflecting the will of top management is a necessary pre-requisite. A representative of the top management preferably one who is on the Board of Directors must be made responsible for productivity improvement. A Productivity Steering Council should be constituted to oversee and provide support to the productivity movement within the organisation. The process of productivity management is institutionalised through creating a network of employees roles which act as catalyst to motivate employees in their work areas to develop and implement improvement ideas.
- (11) Integration with corporate plans and long term strategy of the organisation.

### **Productivity Improvement Programme (PIP)**

Having accepted the need to launch an improvement programme, it will be essential to develop a detailed action plan to coordinate efforts of the total organisation. A phased approach to develop PIP will direct the productivity efforts to suit the need of the organisation on a continuous basis. "Based on the experience of the organisation, the productivity process can be seen as a three-step process, *albeit* somewhat overlapping". (Monga, 1989).

The first step consists of taking the 'venom out of the system' and creating an environment of trust and confidence among the employees through information-sharing, communication, and participative systems.

The second step consists of creating mechanisms wherein the employees can participate in improving the organisation's performance and productivity voluntarily through Quality Circles, Suggestions Schemes, Productivity Groups etc.

The third step consists of developing productivity parameters for using and incorporating them in budgeting



and planning systems of the organisation, as this will help in institutionalising the productivity process and a constant identification of the weaker areas.

A large organisation has adopted a 5-S approach to prepare the ground for a long-lasting productivity improvement programme. It is proposed that a four-phased approach should be used to develop a long-lasting productivity improvement programme (Fig.4).

*(a) Assessment Phase*

The basic objective is to assess the organisational climate, road blocks and develop an action plan for preparing the organisation. A critical problem affecting the organisation's productivity should be identified where management directed improvement programme is desirable. The training and productivity promotion needs should also be identified during this phase. Checklists, structured interviews, quantitative analysis can be used to identify areas on which action should be taken to create an environment, reflecting top management will and desire.

*(b) Foundation Phase*

The objective of this phase is to build an environment of trust reflecting will and commitment of top management.

Action plan as prepared in the assessment phase should be implemented. Measures to build positive attitudes on the part of workers should also be taken up during this phase. The emphasis should be to demonstrate the implementation of productivity improvement programme in the organisation. Some examples of the actions required are strengthening communication management, labour-management cooperation, grievance management, training, creating awareness, clarification of roles particularly at supervisory level, housekeeping and clean working conditions. Creation of mechanisms such as suggestion schemes, KAIZEN Groups, Quality Circles may also be started.

*(c) Basic PIP Phase*

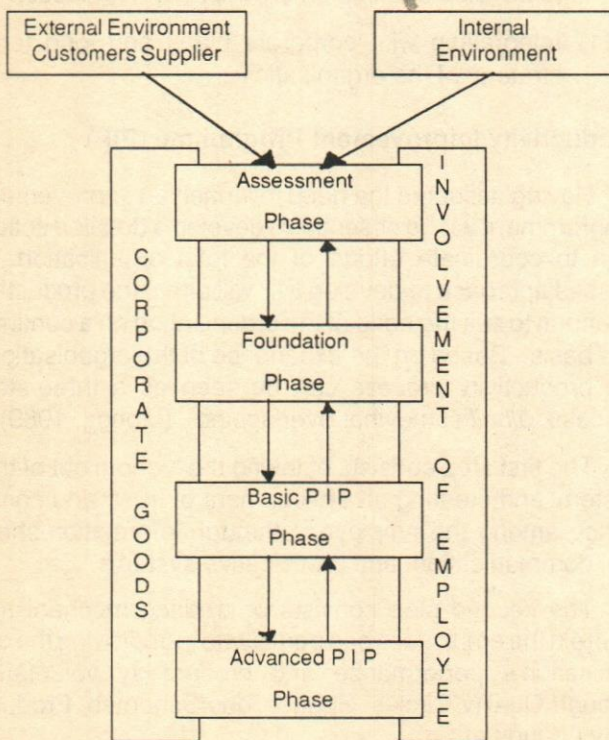
The objective is to expand the scope of PIP in such a manner that improvements become a regular practice. Everybody from the lowest to the highest level becomes an Industrial Engineer and a change agent. Employees are trained in the basic tools of Industrial Engineering and Quality Circles and are encouraged to implement productivity improvement ideas. Participative and involvement systems are strengthened.

*(d) Advanced PIP Phase*

The organisation should concentrate on systems improvement through evolving specific projects for implementing concepts relating to just-in-time, total quality control, total productive maintenance and other advanced techniques. A systems approach should be adopted to diagnose the problems of productivity and employees are trained in advanced techniques and in cross-functional teams. Management-oriented, group-oriented and individual-oriented KAIZEN continues and is further strengthened.

**Conclusions**

Many problems will arise during implementation of PIP but a problem solving approach and constant dialogue between management and the unions will help in finding solutions to these problems. It is the commitment of both management and employees which will be crucial in finding solutions. A win-win situation where everybody (employees, management, customers and society) benefits if productivity improves, already exists. It is, therefore, in our own interest to develop and implement a long-lasting productivity improvement programme and adapt ourselves to the imperatives of the changing economic and social environment.



**FIG. 4: FOUR PHASES OF PRODUCTIVITY IMPROVEMENT PROGRAMME**



## References

- APO**, New Paradigm of Productivity Movement in Japan, 1988
- Ahluwalia Isher Judge**, Productivity and Growth in Indian Manufacturing, Oxford University Press, New Delhi, 1991
- Belcher G. John (Jr.)** Productivity Plus, Gulf Publishing Company, Houston, 1987
- Brown S. David**, Management's Hidden Enemy, Lemond Publications Inc., Maryland, 1987
- Endosomwan J.A.**, Integrating Productivity and Quality Management, Marcel Dekker Inc., New York, 1987
- Fukuda Y.**, Working Papers for Workshops on Kaizen for Integrated Productivity Improvement, NPC, 1992
- Gupta R.S.** 'Productivity Through People - A case study of Tata Iron & Steel Company Ltd., Jamshedpur
- Gondhelkar S. Tripathi A., Homball S.**, The Godrej Kaizen System: Company wide Productivity Improvement, Productivity, Vol.32 No.3, 1991
- Groberg D.H. RAP** : A Reverse Approach to Strategic Objectives Productivity, Vol 32, No.1, April-June, 1991
- Harrington H. James**, 'The Improvement Process'—McGraw Hill, New York 1987
- Imai Masaaki**, 'Kaizen, The Key to Japan's Competitive Success', Random House, New York, 1986
- Monga R.C.** 'An Overview, Emerging Issues and Approach' Keynote paper in Symposium on Wages, Incentives and Productivity Linkages, 'Kuala Lumpur, APO, 1991
- Monga R.C.** 'An Organised Approach to Productivity - A case study of Bharat Heavy Electricals Ltd., Bhopal
- Moss Stephen**, 'A Systems Approach to Productivity, National Productivity Review, New York, E.E. Publications, 1982
- National Productivity Council**, Survey on Factors Linderling and promoting, Productivity in Indian Industry, unpublished, 1990
- Prokopenko Jospheh**, Productivity Management, ILO, Geneva, 1987
- Stewart W.T.**, A yardstick for measuring productivity, Industrial Engineering, Vol.10, No.2
- Sumanth D.J.**, Productivity Engineering and Management, McGraw-Hill, New York 1984
- Suri G.K. & Kumer, Jagdish**, (Ed.) In Search of Productivity NPC, 1989



### Even if your job seems secure...

- \* Stop assuming that it won't happen to you. Be prepared for redundancy
- \* Plan ahead. Think through the implications in terms of personal finance, the job market, and the options might be
- \* Consider possible career changes. The total number of middle management positions is likely to continue decreasing. Consider the alternatives (such as teaching, consultancy or a small business) and evaluate the likely merits and downsides of each
- \* A core of marketable professional skills is vital—keep it up to date. Skill breadth is likely to be just as important. What new skills should you be developing or acquiring ?
- \* Team-building skills are likely to be more valuable in the future. How good are yours ?
- \* Fewer managerial hands make heavier work. As your workload grows, think of ways to cut back on the inessential, and ways of coping with the burden, for example, time management
- \* Push for better career development guidance and more management education

Source : Works Management, March 1992



# Linking Productivity and Quality Improvement

Carl G. Thor

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*Productivity and quality are intimately linked. An effective way to improve productivity is through total quality improvement which must be a comprehensive effort carefully linked to the strategic planning process. This paper examines the factors responsible for providing a major enhancement to the organization by improving its quality and hence productivity.*

It is generally agreed that most nations could do a great deal better as a nation in productivity and quality improvement. Differences of opinion prevail about, how much better is necessary and/or possible, the role of government industrial policy in national improvement, and which industries are ahead or behind on the issue. But we are back to general agreement again with the idea that much (or all) of the responsibility for national improvement rests with the millions of individual firms and public agencies that make up the economy.

Organizations will take up the improvement challenge in different ways and for different reasons, but behind it all is the need to be internationally competitive, either directly or as a supplier to those who compete abroad. All organizations need to improve; all have occasionally done so accidentally or otherwise. Larger organizations have typically been studying and later implementing improvement initiatives under different names for years. Relatively recently, smaller organizations have realized the necessity for improvement on their own or, many times, through a "supplier program" of a major customer.

So, the challenge is clear - everyone must improve. How organizations can go about it is the subject of this article. A composite set of "best practices" is presented, recognizing that what is specifically appropriate will vary widely from organization to organization. Particular emphasis is given to the issue of the apparently conflicting demands of productivity improvement and quality improvement.

## Productivity and Quality

One source of confusion in sorting out best practices in organizational improvement is that very similar activities and initiatives carry a variety of names, depending on whether the major theme is quality, productivity, customer satisfaction, excellence, competitiveness or something else.

Quality, for example, can be defined in a number of ways. Older definitions emphasize fidelity to a set of final

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**Very similar activities and initiatives carry a variety of names, depending on whether the major theme is quality, productivity, customer satisfaction, excellence, competitiveness or something else**

product or service standards or specifications worked out by the organization in the past with (presumably) some reference to the customer's interest. More recent definitions feature the customer's complete satisfaction, excitement, or delight with the final product or service. The most recent definitions accept the need for complete customer satisfaction, but also recognize that the organization itself needs to design, install and operate high quality internal systems that allow customer satisfaction to occur, and the organization must operate in a strategic context that is satisfactory to all stakeholders, not just customers.

Productivity starts from a definition that relates an amount of physical output to its related labor input. More recent work has recognized that other inputs (capital, materials, energy, business services) are appropriately the subject of productivity analysis, and that output, especially in support groups or service-providers, may not be clearly physical. Productivity improvement requires balanced attention to the behavioral and managerial systems, in addition to the technical configuration. Output should not be counted unless it is "good" output. Thus we find quite a convergence between organizational productivity improvement and organizational process quality improvement. Both are aimed at the customer's interest in better (including lower cost) products and services and are achieved through balanced systems improvement (Fig. 1).

The quality specialist concentrates on the interface between customer needs and product or service quality, but in order to improve quality, is forced to deal with the process quality through providing better tools, training, and motivation to the worker. The productivity specialist starts on process productivity for its own sake but soon finds that the lower cost of the improved process satisfies another important customer need. And, of course, the way to make process improvement is through the worker. Thus there is convergence to a simple four-step integrated process. Worker effort leads to process quality and productivity improvement that allows the reliable creation of products and services that satisfy the customer.

**Output should not be counted unless it is "good" output. Thus we find quite a convergence between organizational productivity improvement and organizational process quality improvement. Both are aimed at the customer's interest in better (including lower cost) products and services and are achieved through balanced systems improvement**

### Total Quality/Productivity Management

"Total Quality Management" provides the most popular current example of a comprehensive improvement philosophy. Even this comes in different flavors and sizes, but the "total" in Total Quality Management has four fundamental definitions: horizontal, vertical, intellectual, and strategic.

Horizontal means that the unit of analysis is the business process that cuts its way across the organization, starting with external suppliers, passing through operational and/or support groups of the organization, and ending with the final customer.

Every person or subgroup making up part of the process has one or more immediate suppliers and one or more immediate customers, most of these being "internal" to the organization. Each supplier-customer interface should exhibit the care and attention normally associated with external contacts. Departmental membership is an organizational convenience but should not influence the effort put into a process.

Vertical total means that all levels of the organization have adopted the basic quality ethic and apply it in the processes they touch or otherwise influence. Quality is not the exclusive interest of production workers, or executives, or first-line supervisors. Problem-solving teams are often made from several organizational levels. There is a quality way to issue legal opinions and to advertise the

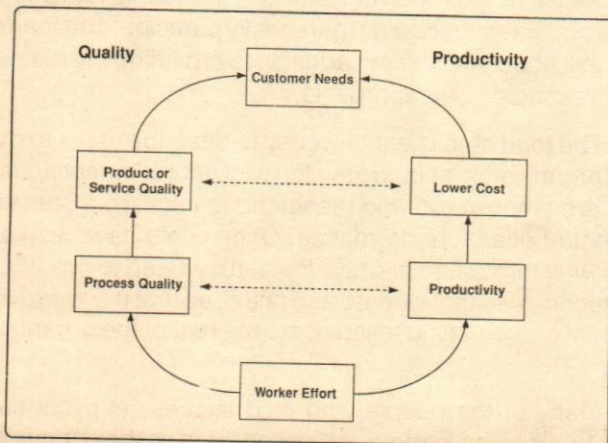


FIG. 1



products, just as there is a quality way to make and sell the products.

An intellectual total means that the thoughts and models that drive the improvement process have been derived from and reflect the best managerial, behavioral and technical thinking. It is easy to spot imbalance as executives describe their organization's efforts. It is easy to talk about "empowering" workers, for example, but if the organizational structure is still designed for control of job processes, there won't be much voluntary redesign by the work force. Process control statistics will be of little use if no one understands them.

Finally the subject of the improvement effort must be that which is strategically important to the organization. Improvement efforts can start out with pilots or "practice" initiatives, but ultimately there must be a linkage between the main subject matter of the various improvement teams and the priority needs of the organization as identified in the strategic planning exercises. That is where the Quality Circles of the late 1970's and early 1980's fell short of the original expectation. They were generally established within single departments and chose their improvement issues from the immediate neighborhood, rather than being prefocused on issues (typically cutting across departments) that were of high priority to the organization.

What all Total Quality Management (or, for that matter, Total Productivity Management) efforts have as underlying principles are : continuous improvement, management-by-fact, and "every work station a control point." The intent is that each worker at each level takes upon himself/herself to do the work right the first time, never pass on bad work, and strive to make improvements in the work processes based on data they receive (or generate themselves) concerning "their" process(es).

**What all Total Quality Management efforts have as underlying principles are : continuous improvement, management-by-fact, and "every work station a control point**

## Planning

One of the trickiest parts of the productivity and quality literature is the shifting role of the "planning" process. In order to start a formal productivity or quality effort in an organization where there has not been one before, it is

clearly necessary to plan what is to be done. Where will this effort begin? What is the role of senior managers? Who carries the day-to-day coordination responsibility? What tools and techniques will be brought in and taught and in what timing? How will the effort be communicated and by whom? Who decides the project priorities?

In the past, productivity and quality work has often been grafted onto an existing management process by loosely authorized zealots. However, the essence of productivity and quality improvement is that line management takes full responsibility for "grass roots" improvement itself. Increasingly, the productivity or quality effort has been started from the top in a systematic manner, making the zealots advisory or even unnecessary. Routine line management takes its main direction from the strategic business plan, so the productivity and/or quality plan eventually needs to be folded into the routine business plan and cease its independent existence. Thus, the common phrase among productivity and quality managers or advisors is that their goal is to work themselves out of a job. In other words, the formal organization initially required for such an effort becomes unnecessary within a few years as productivity and quality thinking becomes fully absorbed into the "routine" business direction of the line managers of the organization.

## Connecting Planning and Improvement

For those who would be world class in productivity and quality, but don't have a believable road map in front of them, here are three recommended steps to get there. Obviously this will be short on technical detail; each country, industry and company has a little different path to success. But the "drill" is generic. The first step is executive commitment not just awareness. Quality needs to be featured in all the reach and stretch statements that paper the walls. Executives must personally participate on teams and ask about progress in addition to providing the necessary resources and approvals.

The third step is equally easy to describe, if not to do. The organization should develop pilot improvement teams that are empowered and resourced to improve a specific aspect of overall performance. Once pilots have worked their way through to improvement, they need to report on the techniques that worked and failed, so that the improvement process can be rolled out to the rest of the organization.

Many of the people who lead successful pilots can train future team leaders and coach them as they proceed. Through internal recycling of this sort, everyone in the



organization will have team experience within two to three years, and with proper energy and patience, the improvement process is then implanted for good.

### Formal Assessment

We have skipped step two: assessment. Most organizations, private and public, believe they know themselves well enough to not need a formal assessment. This is largely why some world-seized efforts do not make it to world-class! massive team activity and training is applied to the wrong problems. Teams stop far short of where they needed to reach. Cosmetic improvements were made that were not fundamental to the real customer. All these could have been avoided with proper assessment. Many major quality and productivity awards applications feature the assessment process, but self-assessment should be conducted in any case.

There are four elements of a complete assessment that, if omitted, can lead to disaster. First is a series of customer input issues, starting with, not surprisingly, identification of the customer. This may seem easy in a traditional manufacturing setting, but even there it is common to find multiple customers. A design engineer in an auto company has at least five customers: the next design engineer in the flow, those who will manufacture his/her part, the marketing people who will live with the design features, the auto dealer, and the ultimate driver of the car. They do not all have conflicting advice (usually), but all need to be considered.

In staff support work, even finding the first customer is sometimes difficult, as the following example indicates: You are a corporate planning analyst. The head of planning thinks that he/she detects that the CEO is uncomfortable with an already-approved investment. Sure enough, you conclude it was a mistake, but it is already on order. Try to find a "customer" now!

Once the customers are identified, it is necessary to sort out how much of the ultimate customer's problem is due to the design of the product or service as represented by the specifications themselves and how much comes from a failure of delivery, not meeting the specs. Airline meals are often cited as an example of "poor quality" but yet they are usually on time, warm and even colorful. You just can't buy and process much food for \$1.57! The design spec is weak.

Even with a good design, meeting delivery specs isn't necessarily enough. Taguchi's target concept shows that a world-class company will aim for the exact target, even if most of its "misses" are within specs also. If the supplier

demonstrates leadership in the drive for tighter specs rather than reaction and grumbling, that supplier may become the sole supplier for the next generation of product.

**When your customer comes in and says, "I know you geared up to provide six at a time of purples...but for the next two weeks I need five at a time with a green stripe," the world-class reply is "would you like to start the change tomorrow or this afternoon?"**

The customer is usually looking for flexibility. Manufacturers now think of flexibility as meaning quick change-over and shorter runs (down all the way to lot-size-one). This way the supplier can provide the results of "ship out of inventory" without carrying the inventory. The same applies to service industry word-processors; instant customized proposals, for example. True flexibility not only includes this "planned flexibility" but even extends to unplanned flexibility. When your customer comes in and says, "I know you geared up to provide six at a time of purples...but for the next two weeks I need five at a time with a green stripe," the world-class reply is "would you like to start the change tomorrow or this afternoon?"

A good assessment will contain enough benchmark data to keep you from premature declaration of success. A 15 percent productivity improvement in one year is extraordinary and merits celebration, but it might simply take you from being poor to fair. You need to know at what level others (in your company, in your industry, and even in other industries) are performing. Common subjects of benchmarking studies are :

- |                   |                  |
|-------------------|------------------|
| * Cost            | * Cycle Time     |
| * Staffing        | * On-Time        |
| * Yield           | * Rework         |
| * Inventory Level | * Internal Moves |

Benchmarking isn't usually easy, but it is necessary. A wasteful process under control is still a wasteful process! You may not realize it is still wasteful after making improvements, unless you find that someone else continues to do it better.

A complete assessment will also review training needs and practices. It is not unusual to schedule training based on either supply (what the experts are offering these days) or apparent demand (all the employees want a "stress" course), rather than what is needed for a successful improvement effort. Courses like team dynamics and



meeting management are usually needed more than is admitted. Courses in SPC are often needed less than is admitted.

The U.S. Baldrige Award criteria present a clear picture of world-class training. The organization makes heavy use of strategic training plans and needs assessments. The organization measures both extent and result of training. The training contains direct applications to the attendees' own workplace, which can be used and discussed back on the job. There may also be downstream review, reinforcement, and even testing of later applications.

An assessment can guide an organization to adopt the best strategic choice of improvement direction. In selecting where to start the improvement pilots, any of the following might be the right criteria :

- \* biggest dollar effect
- \* clearest solution foreseen
- \* best story for later publicity
- \* highest energy-to-do among the likely doers

The biggest dollar may be long and hard to get, and you need some immediate success. The fact that the top executives see an "obvious" solution is only a plus if they have excellent eyesight, and it doesn't do much for employee involvement progress in any case. The "best story" again is in the eyes of the beholder. A clean, simple story may indicate a truly trivial improvement. Smart organizations often opt for the highest do-energy to ensure success and involvement at the same time.

## Conclusion

Productivity and quality are intimately linked as shown in fig. 1. An effective way to improve productivity (a corporate and national imperative) is through "total" quality improvement which must be a comprehensive effort carefully linked to the strategic planning process. Improvement flows from executive commitment, assessment, and improvement teams activity. Assessment is often done poorly but a thorough and objective assessment involving customer identification, benchmarking, and training needs analysis will provide the basis for major enhancement of an organization.



### For world-class quality you must :

- \* *Respect employees* : Having visited more than 40 American factories, I am convinced that American work ethics and attitudes are as good as any I have seen anywhere in the world. But, if America has good workers, why do US firms lag behind the Japanese when competing against them head to head ? The answer is simple . . . *managers must learn to manage. Ninety per cent of the fault comes from the managers.* In Japanese factories, managers facilitate and lead ; that is their strength. In America managers are, at best, traffic police. Managers must learn to take risks but, more importantly, to delegate power.
- \* *Share quality goals with suppliers* : This isn't difficult. What makes Japanese products defect-free is often the fact that suppliers provide parts which can be accepted without inspection.
- \* *Educate and train employees* : This worked for the Japanese in the past and it should work for you.
- \* *Go back to basics* : Before investing heavily in equipment, study the manufacturing process carefully.

Source : Works Management, January 1992



# The Family of Measures

John G. Belcher, Jr.

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*Meeting today's business challenges, more than ever before, requires the involvement and commitment of employees at all levels of the organization. As a result, the participative processes along with the non-traditional reward systems, particularly gain sharing, have become a part of the business imperatives. This paper analyses the approach that has risen in recent years which not only increases the flexibility of gain sharing but also offers the opportunity to create a truly unique gain sharing formula, called the family of measures.*

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Few would deny that the business environment has changed dramatically during the past decade. The rise of international competition, the deregulation of some of our largest service industries, the almost instantaneous movement of capital and technology, and the growing customer demands for quality have rendered many of our traditional business practices ineffective and obsolete.

Meeting today's business challenges, more than ever before, requires the involvement and commitment of employees at all levels of the organization. As a result, the growth of employee involvement, participative management, and the team process has paralleled these changes in business imperatives.

As participative processes have proliferated, so too have non-traditional reward systems, particularly gain sharing. Gain sharing is a compensation system that ties pay to the performance of the organization or work unit. It supports and rewards employee involvement. By rewarding a different set of employee and management behaviors, gain sharing is an agent for cultural change.

Given the power of gain sharing in supporting an alternative culture that better meets business needs, its growing popularity is not surprising. Its growth would probably be even more rapid, however, were it not for one impediment: people often fail to fully appreciate the potential for creativity in designing a gain sharing system to uniquely meet the needs of their business.

The existing literature largely focuses on fairly standardized formulas that have been around for many years; these tend to focus exclusively on labor productivity or cost reduction. IMPROSHARE® is the prime example of the former, while the Scanlon Plan is a well-known example of the latter. These are excellent plans and worthy of consideration where appropriate. However, they considerably limit the flexibility of management to focus explicitly on additional business issues that may also be important, such as quality and customer satisfaction. Our businesses are simply too complicated to boil employee contributions down to a single measure of productivity or cost. In addition, cost-oriented formulas are typically influenced heavily by factors that are out of most employees' control,



such as purchase price of raw materials or selling price of the product or service.

**People often fail to fully appreciate the potential for creativity in designing a gain sharing system to uniquely meet the needs of their business**

An alternative approach has risen in recent years that considerably increases the flexibility of gain sharing and offers the opportunity to create a truly unique gain sharing formula. We call it the family of measures.

Basically, the family of measures category describes any gain sharing formula that uses multiple, independent measures. A gain (or loss) is calculated for each measure separately, and then aggregated to determine the size of the bonus pool.

The main attractions of the family of measures are flexibility and focus. This category is flexible in that a gain sharing plan can be built around any performance variables that are important to the success of the business. If, for example, the business strategy requires improvement in labor productivity, quality, materials utilization, and customer service, a family of measures formula could be constructed around those four specific components.

With a family of measures, the range of possible performance variables is much broader than it is with the more narrow approaches. Productivity formulas are limited to just that; cost formulas are much broader but are still basically limited to rewarding cost reduction. Family of measures programs, on the other hand, have been structured to explicitly reward quality, safety, delivery performance, attendance, employee involvement, customer satisfaction, and a variety of other variables. Clearly, these non-cost items cannot be as easily emphasized with the other gain sharing categories.

Apart from the inherent flexibility, the family of measures provides a greater opportunity to focus on improved

**Basically, the family of measures category describes any gain sharing formula that uses multiple, independent measures. A gain (or loss) is calculated for each measure separately, and then aggregated to determine the size of the bonus pool.**

performance than is possible with a cost or financial measure. Financial formulas can be quite broad in scope (profit-sharing is a reflection of everything that happens in the business), but the focus is diffused. The measure may be affected by too many things, and employees may not have a clear sense of what they need to do in order to earn gain sharing bonuses. With a family of measures, the company can be quite specific about what types of improvements will yield bonuses.

These advantages do not come without a cost—the design process for a family of measures program is generally more time-consuming and complicated than it is for the other categories. The design team has to sort through a welter of potential performance variables and must consider various design issues a number of times—once for each variable selected to be included in the formula. The implementation and communication requirements can also be expected to be greater as well.

**With a family of measures, the company can be quite specific about what types of improvements will yield bonuses.**

### **Auto Parts Manufacturer**

A simple example of the family of measures approach is provided by a plant that manufactures automotive components. The plan was developed by a joint labor-management design team consisting of an equal number of management people and members of the local union.

The plant had been the first site in the company to implement a formal employee involvement program. As a result of that process, a committee was formed to investigate gain sharing, and ultimately the labor-management design team was formed.

The plan uses four measures: labor cost, scrap, operating supplies, and slug utilization (re-use of leftover steel after components have been cut by punch presses). The specific measures are shown in table 1.

The baseline against which the measures are compared is the average of the three previous years. Gains are shared 50/50 between the company and employees, with bonuses paid quarterly. Bonuses are distributed to employees based on hours worked.



**Table 1 : Auto Parts Manufacturer Gain Sharing Measures**

<b>Labour :</b>	Labor and fringe costs as percentage of throughput (sales minus material cost of sales).
<b>Scrap :</b>	Scrap dollars as percentage of production costs.
<b>Operating Supplies :</b>	Supplies and services as percentage of throughput.
<b>Slug Utilization :</b>	Standard cost of slugs utilized as percentage of standard cost of steel used.

The plan contains an additional feature that is somewhat unusual: any negative inventory adjustments resulting from the annual physical inventory are deducted from the bonus pool.

Deductions are made quarterly, based on the previous year's adjustment; the deduction for the final quarter reconciles the full year deductions to the actual inventory adjustment.

The plan is a straightforward illustration of the family of measures approach. Employee efforts are focused on a small number of specific, controllable variables, and it is likely that most employees are quite clear on what is being rewarded. The plan is considerably broader than one that is limited to labor productivity, yet there is greater line of sight than could probably be obtained through a financial formula.

### **Air Conditioner Manufacturer**

A manufacturer of air conditioning equipment launched a pilot gain sharing plan at one of its plants in 1989.

The plan, which was the product of a joint design effort by management and the union, contained six measures, as summarized in table 2.

The first three measures shown in the table are basic cost measures—labor, materials, and supplies. The labor measure (plant efficiency) uses an approach that involves weighting units of output by a factor that reflects differences in labor content. Both hourly and salaried hours are included in the denominator.

The schedule attainment measure is an excellent example of the use of a family of measures to reinforce important non-cost issues. The measure itself is a creative variation on the usual schedule attainment measure—percentage of scheduled units completed. By multiplying units missed by the number of weeks past due, the past due units carry an ever-increasing penalty to the gain sharing bonus until they are completed.

**Table 2 : Air Conditioner Manufacturer Gain Sharing Measures**

<b>Plant Efficiency :</b>	$\frac{\text{Units produced} \times \text{equivalency factor}}{\text{Total hours worked}}$
<b>Material Utilization :</b>	$\frac{\text{Standard material value of finished goods}}{\text{Material utilized}}$
<b>Supplies Efficiency :</b>	$\frac{\text{Standard cost of goods produced}}{\text{Supply purchases}}$
<b>Schedule Attainment :</b>	$\frac{\text{Actual Scheduled Production} - (\text{Missed units} \times \text{weeks past due})}{\text{Scheduled production}}$
<b>Safety :</b>	OSHA frequency and severity measures
<b>Quality :</b>	$\frac{\text{Total violation points}}{\text{No. of units audited}}$

A common concern expressed by gain sharing designers is how to value, for bonus purposes, gains in non-cost measures such as schedule attainment. One method is to establish an arbitrary value; for example, \$1,000 might be added to the bonus pool for each percentage point improvement in schedule attainment. This arbitrary value must, of course, bear some reasonable semblance to management's judgement of what the improvement in question is worth to the company.

This company takes a different approach to valuing improvements in schedule attainment. The amount contributed to the bonus pool is based on the savings in inventory carrying cost realized through improvements in schedule performance. The company recognizes, however, that the more important gains lie in improved customer satisfaction.

Safety is measured in this system using two readily available indicators: the OSHA frequency (number of accidents multiplied by 1,000,000/total hours worked) and severity (number of days lost multiplied by 1,000,000/total hours worked) indicators.

The final gain sharing variable is quality, as measured through an already existing audit by divisional quality professionals. The outcome of the quality audit is an assessment of violation points based on the type and number of product defects found in the course of the audit process. These violation points are divided by the number of units audited to obtain a quality rating.

The quality indicator is used in a different manner than the other measures. Rather than adding dollars to the bonus pool based on calculated savings, it is used instead as a modifier: the total gains from the other measures are multiplied by the quality modifier to determine the size of



the bonus pool. The value of the modifier is determined by comparing the quality rating to the plant's quality goal; some selected modifier levels are shown in table 3.

**Table 3 : Air Conditioner Manufacturer Quality Modifier**

Quality Rating as % of Plant Goal	Bonus Pool Modifier
78 %	0 %
80	10
85	35
90	60
95	90
98	100
100	110

Using quality as a modifier elevates that variable to a higher level of influence than it would command if it were simply one of several measures that contributed absolute dollars to the bonus pool. As a modifier, it has the power to dramatically reduce, or even eliminate, all of the gains achieved through the other variables. This design feature thus fits well with an organizational emphasis on quality improvement.

This plan contains another feature of interest: if the safety measures exceed the goal, the pool associated with that measure (two hours per month per employee multiplied by the average hourly wage rate) would be paid out regardless of the outcome on all of the other measures. In other words, losses on the other variables, or a poor quality performance, cannot reduce the safety bonus. Management is clearly sending an important message: safety stands alone and will be rewarded as an end in itself.

With the exception of the schedule attainment and quality variables, which are tied to the achievement of targets, the plan uses an eight-quarter rolling baseline (the baseline equals the average of the last eight quarters' performance). Gains are shared 50/50 and paid quarterly.

The complete payout calculation for the plan is summarized in table 4.

**Table 4 : Air Conditioner Manufacturer Payout Calculation**

	Material Utilization Savings
+	Plant Efficiency Savings
+	Supplies Efficiency Savings
+	Schedule Attainment Savings
=	Total Savings
x	Quality Modifier
=	Total Gain
x	50% Employee Share
=	Employee Share of Gains
+	Safety Pool
=	Total Employee Bonus Pool

## Computer Services

A useful example of a family of measures in a service industry is provided by the Business Management Services Division (BMSD) of Control Data Corporation. BMSD provides computerized human resources, payroll, and related services to external customers through a network of 40 sales and service centers.

BMSD management, recognizing the importance of quality and customer service to the success of its business, developed a business strategy to increase the focus on the customer. Gain sharing was viewed as a key element to obtain employee commitment to and involvement in the quality improvement process.

There were virtually no models for gain sharing in the computer services business, and with 40 offices providing essentially identical services, it made sense to pilot a gain sharing program in one office initially. The Southfield, Michigan center was chosen, largely because it was one of the highest performing locations. The program was launched at the beginning of 1990.

The system was developed by an employee design team at the Southfield facility, and is noteworthy for the use of some unusual measures, which are summarized in table 5.

**Table 5 : Control Data Business Management Services Gain Sharing Measures**

Number of credits used
Retention of customers
Cost per processing
Controllable expenses as % of revenues
Number of suggestions submitted

Two of the gain sharing measures—cost per processing and controllable expenses—are straightforward cost measures. Of greater interest are the other measures, which focus on quality and customer satisfaction.

It was imperative that the system incorporate an indicator of quality, and after much consideration, the design team selected the number of credits issued, a measure that is probably unique in the gain sharing arena. The reasoning for this choice was simple: any time a credit has to be issued, someone has made a mistake and the customer is probably unhappy. The customer may not have been provided the full service he was entitled to, or he may have been quoted an incorrect price by the salesperson. Perhaps the invoice simply contained an arithmetic or clerical error of some kind. In any event,



credits represent a broad array of quality problems and thus have no place in a total quality process.

In order to use this indicator, the gain associated with the reduction of credits issued had to be determined. While the intent of this plan was to improve quality and customer satisfaction, the financial gains resulting from improvements in these variables were in-determinable. Accordingly, the design team decided that bonuses should be based on the cost savings that resulted from handling fewer credits. An analysis of the administrative effort required to issue a credit concluded that each credit costs \$80 to process. This amount was thus added to the bonus pool for each unit reduction in the number of credits issued.

Another interesting measure in the Control Data plan is customer retention. Invariably, a certain number of customers are lost each year, some to other vendors, and some because of a decision by the customer to process their payroll in-house. Clearly, retaining customers is important to the growth and success of the business and should be an outcome of higher customer satisfaction. Therefore, the profit effect of retaining a greater percentage of customers than was accomplished in the base period is credited to the gain sharing pool.

The last of the family of measures is an indicator of employee involvement in the improvement process itself. For each suggestion submitted to the company suggestion plan (up to a maximum of ten per quarter), \$100 is added to the bonus pool. The suggestion must be approved for submission by the local suggestion program coordinator, and it must have been developed by a team, rather than by an individual, in order to qualify for gain sharing credit. In addition, if the suggestion is ultimately approved by the corporation (which means there are potential savings in 40 offices), an additional \$100 is added to the bonus pool.

The Control Data plan also has two modifiers—variables that can add to, reduce, or even eliminate the overall bonus pool. One is based on the gross profits of the unit, a fairly common approach. The other modifier is based on a survey of customer satisfaction.

The survey process is called the CARE (Customers Are Really Essential) Program. The surveys are conducted by telephone, and customers are requested to answer a series of questions, with responses ranging from "poor" to "excellent." The percentage of excellent responses is used to modify the gain sharing pool, as shown in table 6.

A customer satisfaction measure would seem to be

**Table 6 : Control Data CARE Program Modifier**

% Excellent Responses	Adjustment to Pool
100 %	+ 15 %
99	+ 12
98	+ 9
97	+ 6
96	+ 3
95	0
94	-3
93	-6
92	-9
91	-12
90	-15

natural for a company that wants to integrate its gain sharing program into a total quality process. However, the imprecision of a survey troubles many managers, particularly those with a bent towards precise quantification of the variables to which pay is to be tied. Nonetheless, the only way to directly gauge customer satisfaction is to ask the customer, and use of survey results as gain sharing measures or modifiers is growing.

The Control Data program, in summary, is of interest for two reasons: it is one of the few examples of a family of measures approach in service business, and it plows some new ground in the creative use of quality measures.

### Goal-Based Systems

Up to this point, all of the gain sharing examples reviewed involved a consistent approach to determining payouts: gains are quantified, and a portion of those gains is paid back to participating employees. While this is indeed the predominant model, there is another way: paying a predetermined amount for the achievement of goals.

In this approach, a goal is established for each of the measures, and a fixed dollar amount (or per cent) is paid to employees for each goal that is achieved.

Goal-based gain sharing systems have some advantages that are worth considering :

- \* They are simpler to design. Design teams are relieved of making decisions around several design components. They don't have to establish a baseline, a task which can require a good deal of analytical work. They don't have to worry about an explicit employee share. And the same rigor is simply not necessary when evaluating and selecting measures to be used in the formula.



- \* They can be tied to existing organizational goals, thus increasing the visibility of and commitment to those goals.
- \* The maximum payout is known in advance. Payouts cannot exceed the amount that would be awarded if all the goals are achieved; this may provide some comfort to management people who are concerned about the possibility of "run-away" payouts. This comfort can be provided in a more conventional gain sharing system by simply capping the payout; however, caps may be undesirable for other reasons.

As with everything else in gain sharing, we must also consider the potential disadvantages of goal-based systems :

- \* The plan may have lower credibility with employees. This is particularly true if the goals established do not appear reasonable to employees. In their view, management may be manipulating them by setting almost unreachable targets and providing only token rewards for achieving them. This particular pitfall can be ameliorated, of course, by involving employees in the development of the goals.
- \* Improvements may be limited. While management limits the potential payout, it may also be limiting the potential improvement. Once the goal has been achieved, there is no motivation to continue to improve beyond that level.
- \* Improvements that fall short of the goal are not rewarded. This event could well result in frustration and dissatisfaction with the program. This problem, as well as the previous one, can be lessened by having multiple goal levels.

A company considering the use of a goal-based gain sharing program should, of course, weigh the risks against the benefits before making a decision.

### Arco Chemical Company

Arco Chemical's Bayport plant in the Houston area launched its gain sharing program in 1985. This initial effort, which was structured around annual goals, did not succeed because business conditions at the time rendered the goals unachievable. The program was modified the following year to incorporate monthly goals as well as annual goals into the system.

The 1989 program included 17 monthly goals and three annual goals, with points awarded for the achieve-

ment of each goal. The 1989 goals, many of which are technical and probably meaningful only to people in the chemical industry, and associated points are detailed in table 7.

Table 7 : Arco Chemical Company 1989 Goals

Monthly Goals	Max Points per Month	Max Points per Year
Propylene yield	6	72
Isobutane yield	6	72
Steam consumption	2	24
Losses to fuel gas	3	36
On-stream time	4	48
Computer loop uptime	1	12
MMS processing	1	12
TBHP quality	1	12
Po Test Tank Samples	2	24
Glycol quality	1	12
PO(E) production	5	60
PO(E) production daily average	5	60
Glycols production	1	12
Customer complaints	2	24
Recordable cases	2	24
Gulf coast waste disposal	2	24
TBA pipeline quality	2	24
Quality charting	2	24
<b>Annual Goals</b>		
Attendance		
(a) First tier		50
(b) Second tier		10
Lost time accidents		24

The maximum number of points that can be earned under Arco Chemical's program is 522, with each point worth .0158 percent of employees' pay. simple arithmetic shows that the maximum bonus potential is thus 8.25 percent. All permanent employees are eligible.

The goal set includes a number of non-cost items, such as safety (recordable cases) and attendance. There are actually two attendance goals: the first tier goal in 1989 was to achieve an absentee rate of 0.95 percent or better, while the second tier goal was to beat the plant's record attendance of 0.67 percent. It should be noted that achievement of the attendance goal would result in the appropriate payout to all employees, regardless of their individual attendance record. This practice, while objectionable to some, is perfectly in keeping with the principle that a group incentive such as gain sharing should not differentiate among individual contributions.

Another interesting and unusual goal is the one for quality charting. In essence, achievement of this goal required that all work areas have meaningful statistical process control or quality charts. Here is another reinforcement for the idea that gain sharing need not be limited to traditional performance measures of productivity cost.



The company has reported as much as \$3 million in annual gains from this program.

### Duke Power Company

A goal-based family of measures plan can also be useful for a company-wide program. In fact, it may be the only realistic alternative to profit sharing for a sizable company that wishes to have all employees covered under a single bonus pool. One of the pioneers with this approach was Duke Power Company, an electric utility headquartered in Charlotte, North Carolina.

Duke Power introduced its Employee Incentive Goals Program in 1981. Each year, corporate management establishes a series of corporate goals; the total can vary, but usually numbers between eight and ten. The goals selected for 1990 are shown in table 8.

Table 8 : Duke Power Company 1990 Gain Sharing Goals

Employee safety—lost time accidents
Employee safety—vehicle accidents
Customer service (outage minutes per customer)
Affirmative action
Electricity sales
Energy management (peak load reductions)
Efficient fossil production (heat rate generated by fossil plants)
Nuclear production (nuclear system capacity)

Due to regulatory considerations, Duke Power chose to pay gain sharing bonuses as matching contributions to the Employee Stock Purchase-Savings Program. Under this program, an employee may contribute up to 10 percent of his salary toward the purchase of company stock. The stock purchased accumulates in the employee's account until retirement.

If four of the eight goals are achieved, the company will make a 24 percent matching contribution. For each goal achieved beyond four, the company contributes another 6 percent. Goal number five carries an additional 2 percent match.

There is also a bonus goal, which can add an addi-

tional 10 percent of the employee contribution. This award is based on controlling costs by staying within budget and is independent of the other eight goals.

It is readily apparent that all of the goals cannot be meaningful to all employees. Certain goals, for examples, apply primarily to power plant employees. In a single plan covering several thousand employees, it is surely unrealistic to expect to construct a family of measures in which all measures are meaningful to all employees.

Duke Power has taken care, however, to ensure that all employees can relate to at least one of the measures. Every employee can presumably focus on improving something that is important to the success of the business.

It should also be noted that all employees receive the bonus for each goal achieved, whether or not they had any direct opportunity to contribute to that result. This feature reinforces the idea that all employees are part of the company team, with their financial well-being tied to the success of the business.

### Summary

The family of measures is of more recent vintage than the other general approaches and offers certain advantages. Because it consists of multiple performance measures, it provides a means to tie bonuses to a variety of performance variables beyond simple productivity. At the same time, it generally fosters greater organizational focus on the key variables, with a greater degree of controllability, than can be achieved with a cost or financial measure. The trade-off for these advantages is a more lengthy and difficult design process.

The family of measures approach also offers great flexibility and opportunity for creativity. Variables such as quality, safety, and customer satisfaction are easily accommodated in this formula approach.

The ultimate choice of a formula category, as well as the specific measures themselves, is dependent on a number of considerations, including management's compensation philosophy, key business needs, and the time and resources available to support the system design.





# Leadership Paradigms, Principles & Processes for Empowering Others

D.H. (Dee) Groberg

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*For most of the managers "Empowerment" means no control; control means no empowerment. Looking at it this way, one feels that by empowering one loses control and by retaining one can't empower. This paper emphasises the fact that this is not an either or situation. There exists a third alternative i.e. of achieving both control and empowerment. This paper examines the tools for accomplishing this alternative.*

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"That's the last straw! This empowerment nonsense doesn't work!" Steven Groves had just received the sales report for the previous month. Sales were down again. Three salesmen hadn't even reported their results. Groves was furious. "If I don't do it myself nothing gets done right." Four of the five sales managers in the room hung their heads. The fifth, David Jensen, spoke up.

"We're not getting enough direction from you, Steve. I'm not sure what you expect from us. You have to tell us what to do." This brought on an icy silence. Groves' voice reflected his frustration.

"The whole idea of empowerment was to let you and your people decide what to do. How can I empower if I'm controlling all the time? Can't you people do anything on your own?"

Bruce Brown looked up. He didn't like being blamed for the poor results. After all, this empowerment thing was Groves' idea. "I've been doing the best I can at empowering my people. I told them that now they're in charge and two of them didn't even turn in their reports. And Jack Jacobs decided he'd lower our prices and stop doing credit checks! Thought it would increase sales."

"Who gave him the authority to do that?" Groves yelled. "This whole thing is out of hand. I'm laying down the law. Bruce, you better whip Jack back in line or I'll find somebody who will. And I want those missing sales reports on my desk first thing in the morning. All of you better get things back under control or some heads are going to roll!"

"But what about empowerment?" Dave asked. Groves answer reflected his impatience. "Forget that nonsense and get the job done. You're empowered enough for that, aren't you?"

As vice president of marketing, Groves had a mixed history. He had done well at first, but as things grew, he began to lose control. His recent history was bad. Several salesmen had left for greener pastures in a company that



had a so-called "better culture." Many others seemed to be disgruntled. Then Groves heard about empowerment. "Release the potential in your people. It'll be more fun for them, less work for you, and you'll get better results." That's the way Groves interpreted it anyway. He could hardly wait to get started.

Now, six months later, things were worse than ever. If this was what empowerment meant, Groves could do without it. He would still "talk" empowerment, but he resolved to get things back under control even if he had to fire the whole sales force and do everything himself.

It hadn't worked, like the Groves, they did the only reasonable thing — they reverted back to control. But the reason it didn't work can be corrected. It's a matter of using correct Paradigms, Principles and Processes.

### Control Vs Empowerment Paradigms

Like Groves, control-style managers are usually disillusioned idealists. At one time they got the idea of empowerment, were excited about it, and tried it. But they didn't get the results they expected. Either people did nothing—because they were so used to being controlled and had lost the initiative to work on their own (like the salesman who didn't turn in their reports)—or they did too much, abusing the new power and influence they assumed they had (like Jack Jacobs dropping prices and credit checks). The disillusioned manager then views empowerment as a license for chaos. It looks like a dichotomy: "Empowerment means no control; control means no empowerment."

**The disillusioned manager then views empowerment as a license for chaos.**

#### Control Vs. Empowerment

Total control  
(No Empowerment)

Total Empowerment  
(No Control)

The problem with this way of looking at control and empowerment is that it makes it seem that by empowering, one loses control, and by retaining control, one can't empower. As a dichotomy, you can have either control or

empowerment, not both. You have to give up one to get the other. And a responsible manager will choose to retain control.

This is not the only way to look at it, however. If we see control as being comprised two parts, an outer control and an inner control, we then have some new options (Fig 1).

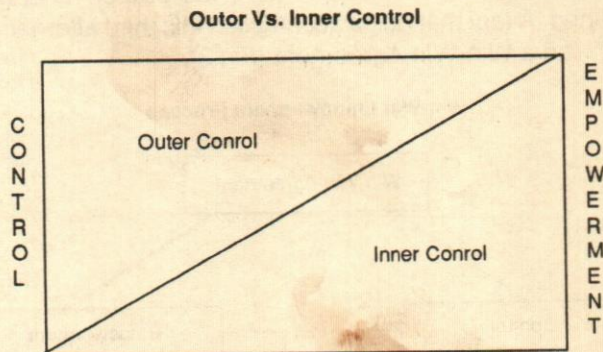


FIG. 1

On the extreme left, all control is imposed from the outside (the manager controls). On the extreme right, all the control is inside the employees (they are empowered). Looking at control and empowerment this way, we find that we can have our cake and eat it too. We can give up control and still retain control. This is because *outer control* by the manager is given up only as it is absorbed as *inner control* by employees. We can have both control and empowerment. It's not an either/or anymore. It's a third alternative. (Fig 2)

For example, a manager might have total control over the financial expenditures in her department. Under that total control every expenditure would have to be approved by her. But she might give an employee inner control over a certain portion of the budget. As the employee demonstrated that he accepted that responsibility and controlled that portion of the budget within the limits set, the manager

#### Control and Empowerment

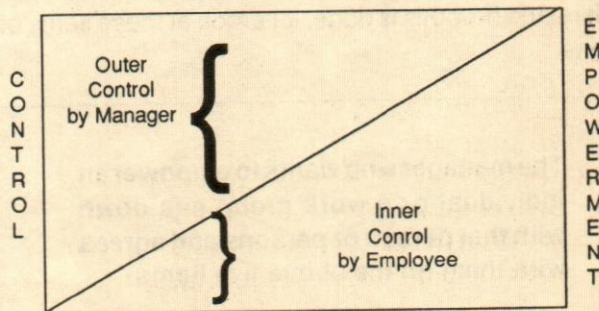


FIG. 2



might then increase the employee's inner control without losing her own overall control—empowering while maintaining control.

By looking for a third alternative—not the either/or perspective of control vs empowerment—we can achieve *both control and empowerment*. This third alternative sounds good theoretically, but the challenge is in actually doing it. In order to actually do it the proper tools are needed. A tool that helps accomplish this third alternative is called a Win-Win Agreement (Fig 3).

Win-Win Empowerment Process

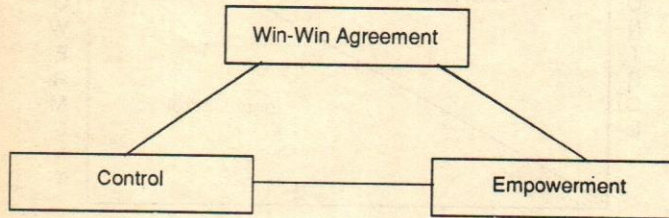


FIG. 3

### A Win-Win Agreement—A Third Alternative

A Win-Win Agreement assures that the external control released by the manager is absorbed internally by the employee. It becomes a statement of mutual understanding. A Win-Win Agreement specifies five things :

- \* Desired Results
- \* Necessary Guidelines
- \* Available Resources
- \* Accountability
- \* Consequences

Establishing a Win-Win Agreement is relatively easy to do. The manager who wants to empower an individual or a work group sits down with that person or persons and agrees with them on the above five items. In order to understand how this is done, let's look at these items one by one.

**The manager who wants to empower an individual or a work group sits down with that person or persons and agrees with them on the above five items.**

### Desired Results

By agreeing on the results that both parties want to achieve, shared visions and missions are established. The employee is thus empowered to figure out the best way to achieve the desired results and can effectively supervise himself. By specifying the desired results, the usual conflicts between manager and subordinate are largely removed. And the need to achieve results along with the mutual commitment insures that action will be taken (Fig 4).

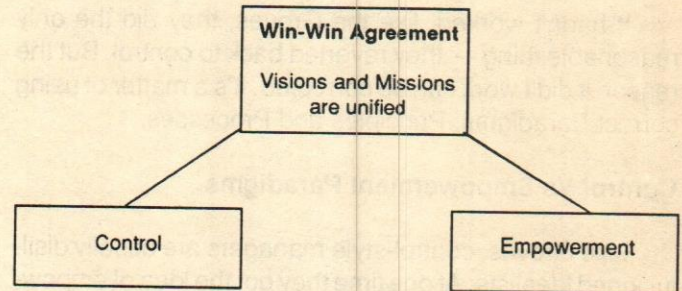


FIG. 4

- Example:
- Personally manage the marketing and sales of corporate In-House Programs.
  - Maintain 45% gross margin.
  - Generate 5 new qualified prospects each month.
  - Achieve the goals specified in the business plan.

### Necessary Guidelines

Empowerment implies letting the employee or work group decide their own way of achieving the results. However, in almost every organization and situation, there are certain guidelines that must be followed. These might be legal requirements, procedural requirements, organizational sacred cows, and so forth. By specifying the guidelines under which the results are to be obtained, sufficient control is retained. It keeps the action within the appropriate boundaries. The person being empowered can then supervise himself in order to achieve the results within the guidelines. (Fig 5)

### Available Resources

Empowerment requires that the people having the responsibility to achieve the results also have access to the resources which will enable them to accomplish the results. This might involve modifying some of the systems or structures in the organization that currently make it



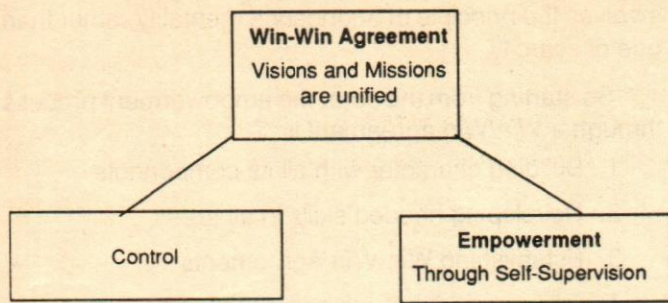


FIG. 5

Example: — Operate with the established policy guidelines. Get all program outlines, presenters, and program directors approved by director before implementing.

difficult for them to operate effectively. Or it might simply mean making the resources available and removing the barriers they might encounter when trying to access them (Fig 6).

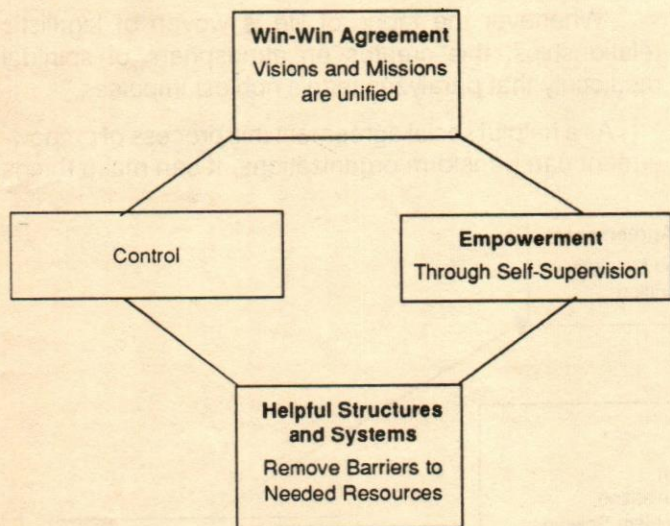


FIG. 6

Example — All existing company resources as identified by the operating plan. (Refer to operating plan for details).

### Accountability

Specifying how and when results will be achieved enables the employee to evaluate himself and make periodic reports on the progress to his manager. The manager thus retains the needed control while continuing to empower. (Fig 7)

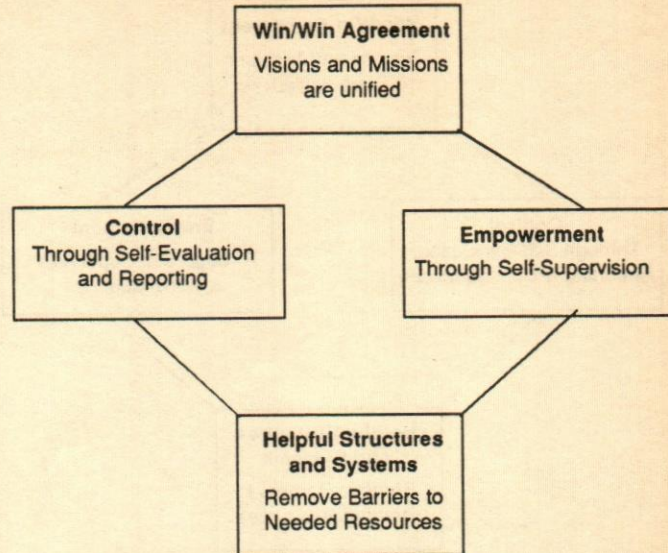


FIG. 7

Example — Provide monthly financial reports as specified in operating plan. Meet with directors on the first and third Thursday of each month to review performance and plan next steps. Meet with V.P. once a month to review progress against the plan and modify the plan accordingly. Submit, in writing, proposed program outlines, program directors, and program presenters to director for approval during these meetings.

### Consequences

By agreeing on the consequences before hand (both positive and negative), incentives are heightened, self-supervision and self-evaluation are sharpened, and the likelihood that the empowerment process will succeed is increased many fold (Fig 8)

### Principles of Empowerment

There are still two items which must come into play before the empowerment process will work. These are the core Principles of the empowerment process. Since they are at the core we put them in the centre of the model. (Fig. 9)

First, basic Skills of communication, planning, and synergistic problem solving are needed. If they are not adequate currently, they must be acquired through training and development.

The whole process, including the skills, must be based on a Character foundation. This involves the principle of integrity on the part of all those entering in on the agreement. It involves the principle of maturity, which is defined as courage balanced with consideration. And finally, it



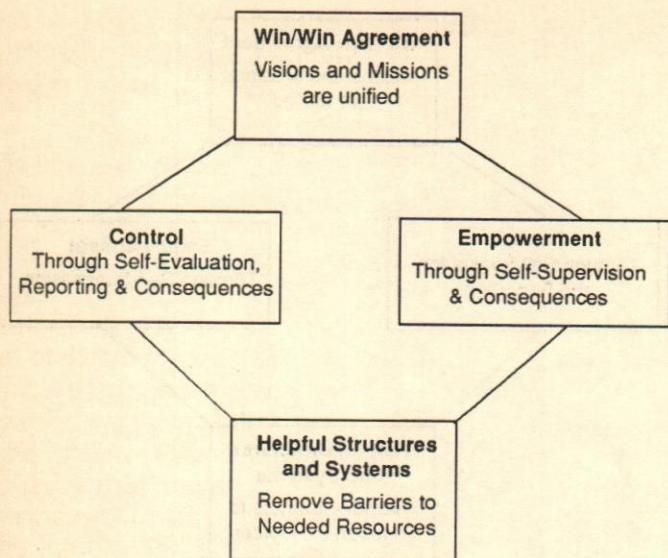


FIG. 8

- Example
- Satisfaction and contribution toward mission
  - Personal improvement and development
  - Raise, as agreed, retroactive to time of agreement
  - Salary as agreed
  - 5 per cent commission
  - 80/20 split on pre-approved projects
  - Regular benefits as specified in company policy
  - Friendship and affirmation

involves the principle of abundance mentality rather than one of scarcity.

So starting from the core, the empowerment process through a Win/Win agreement is:

1. Building character with all its components
2. Developing needed skills in all areas
3. Establishing Win-Win Agreements
4. Empowering through self-supervision and consequences
5. Creating helpful systems and structures to remove barriers to needed resources
6. Controlling through self-evaluation, reporting, and consequences

The process is most effective if it is a social rather than a legal contract. Only then will it be seen as empowering. The words of Alexander Solzhenitsyn are applicable here :

“Whenever the fabric of life is woven of legalistic relationships, this creates an atmosphere of spiritual mediocrity that paralyzes man’s noblest impulses.”

As a helpful social agreement this process of empowerment can transform organizations. It can make things

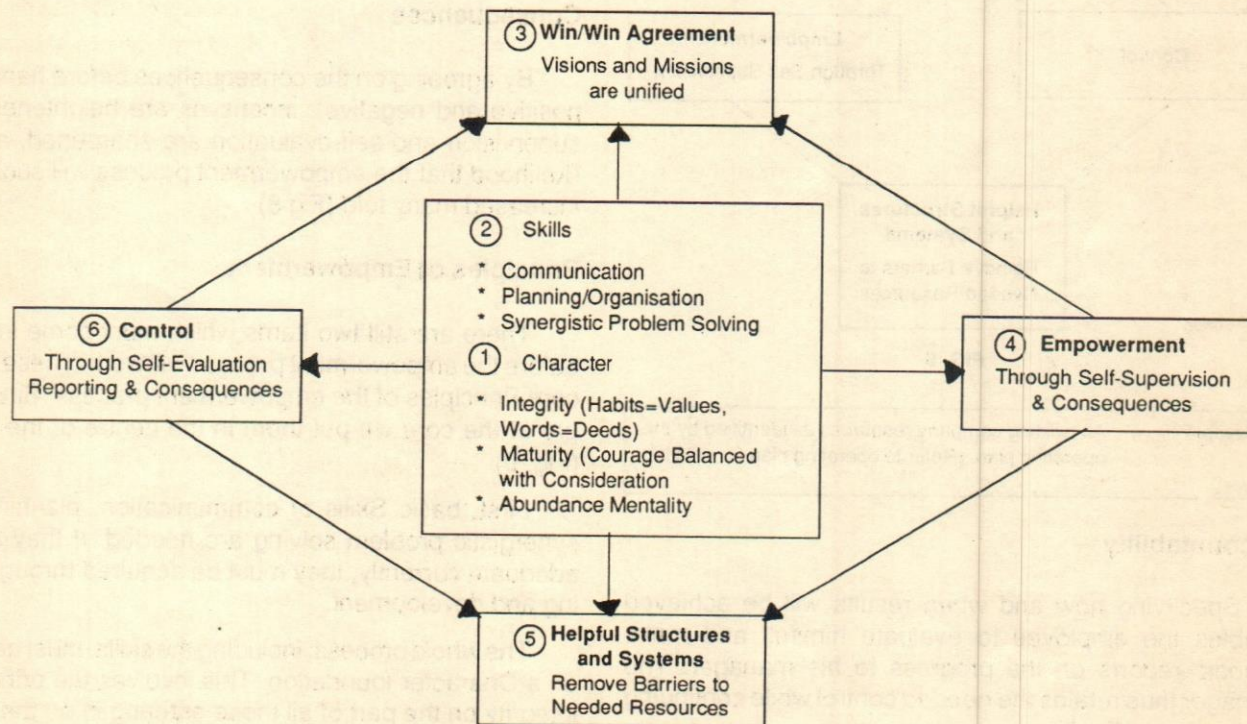


FIG. 9



"more fun for them, less work for you, and you'll produce results." It justifies the optimism of consultant David Alcorn after he completed a massive study of American business trends. He concluded :

"On the whole, corporate America is going to become a more challenging yet better place to work. It's going to become a place where everyone, leaders as well as followers, are treated with greater dignity. And how do I know this? Because those companies who refuse to empower their employees and bring them into greater partnership with the organization will not succeed."

So, Steven Groves, with these paradigms, principles, and processes, give empowerment another try.

### Sample Performance Agreement

- Desired Results*
- Personally manage the marketing and sales of corporate In-House Programs.
  - Maintain 45% gross margin.
  - Generate 5 new qualified prospects each month.
  - Achieve the goals specified in the business plan.

*Guidelines*

Operate with the established policy guidelines. Get all program outlines, presenters, and program directors approved by director before implementing.

### *Available Resources*

All existing company resources as identified by the operating plan. (Refer to operating plan for details).

### *Accountability*

Provide monthly financial reports as specified on operating plan. Meet with directors on the first and third Thursday of each month to review performance and plan next steps. Meet with V.P. once a month to review progress against the plan and modify the plan accordingly. Submit, in writing, proposed program outlines, program directors, and program presenters to director for approval during these meetings.

### *Consequences*

- Satisfaction and contribution toward mission
- Personal improvement and development
- Raise, as agreed, retroactive to time of agreement
- Salary as agreed
- 5 percent commission
- 80/20 split on pre-approved projects
- Regular benefits as specified in company policy
- Friendship and affirmation.



"One uncooperative employee can sabotage an entire organization because bad spirit is more contagious than good spirit."

—Robert Half



# Public Sector Productivity : Employee Participation Schemes

John Man

*Employee participation is only meaningful when management directs and channels the thoughts and energies into areas that account for productivity. These should be in-keeping with the overall goals and objectives of the organisation. Having identified the parameters of participation, employees are provided with the means to bring about meaningful change through the participation schemes— This paper discusses in detail various employee participation schemes which are the vital management tools for achieving organisational goals.*

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Organisations exist to serve lives. This implies that organisations employ people who help it to fulfill organisations' goals and objectives. In other words, organisational goals and objectives are fulfilled through the effort of people who work for the organisations. On the other hand, when people are employed by the organisations, their lives are also served through employment, when their individual needs can be satisfied. Hence, we can see a symbiotic relationship between organisations and people : the organisation's life is sustained by people through employing them and people's lives are sustained through employment in the organisations. Fig 1 illustrates how people's needs and organisational goals are met :

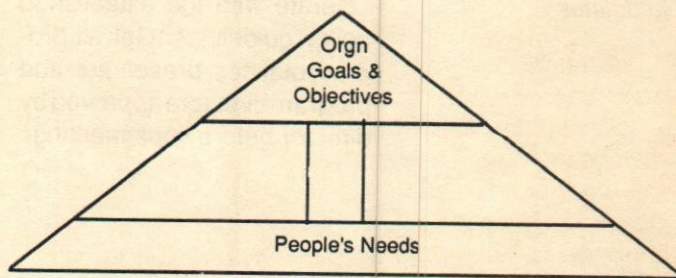


FIG. 1

Excellent organisations will seek to bridge the gap between having to fulfill organisational goals and satisfy people's needs. They will bridge this gap by defining areas that will enable them to ensure that a job is done in the best possible manner. These areas include :

- a. Training and Education
- b. Welfare
- c. Astute use of Resources
- d. Staffing
- e. Employee Participation Schemes
- f. Problem-solving



Areas (a) to (d) are issues which management controls directly. As such, they constitute management controllable areas. When management provides the necessary training, care and infrastructure, it is creating a basis to enable people to do the job.

Areas (e) and (f) are issues where people who are employed by the organisation participate in. People, as operators, execute the policies of management. As a result, they are in control of the work situation and can directly influence it. In other words, they manage operator-controllable problems.

## Employee Participation

Employees, in view of their proximity to work situations, are important agents of change. It is vital that management carefully considers the two areas: Management-controllable areas and Operator-controllable areas in order for excellence to be achieved. Fig 2 illustrates the relationship between these two areas :

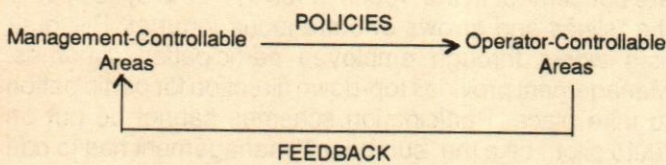


FIG. 2

Employee participation is a crucial factor in helping organisations attain their goals and objectives. Management cannot expect participation to come about by itself or just through exhortation. It must be managed. Hence, management has to determine and formalise the scope and the parameters for participation. Participation involves giving feedback through ideas and problem-solving that occur in the work environment. Employees' efforts should be directed at areas that are of concern to management. By providing a focus and direction, employees are able to work hand-in-hand with management. Innovative ideas and better ways of doing a job can now surface.

In Singapore, the public sector organisations take the lead in formalising employee participation schemes. Participation rate in the staff suggestion scheme and WITs has increased since it was launched in 1981. Statistics indicate the overwhelming success of the public sector in these schemes. It is difficult to seek out parallels in other countries. By and large, employee participation schemes are evident in private sector organisations where the bottom line (in terms of production quota, profits, etc.) is evident.

Employee participation schemes are not "auto pilot" programmes. They exist because management recognises the need for formalising them. The schemes are a means for validating management policies and directions. Participation schemes are "bottom-up" in approach but not without "top-down" guidance and support. Why have them? Because management concedes that it does not know all that takes place at the "grassroots" level. Public sector organisations are generally large and often widespread. Decentralisation is inevitable because it enables officials to be flexible and responsive to the demands of the public sector. Employee participation schemes thus help management obtain feedback on the effectiveness of its policies and directions.

**Participation schemes are "bottom-up" in approach but not without "top-down" guidance and support.**

Management's attention is focused on strategic issues. Management is concerned about implementing decisions based on specific plans. In implementation, management constantly reflects on the goals and objectives of the plan. Are such plans that provide meaning to actions confidential and known only to management? Knowledge of the objectives and goals is crucial to direct efforts towards achieving specific goals. Employees face the brunt of management decision-making. But they are not passive followers. They are in touch with reality. They work in an environment in which policies appear not just in words. They discern the policies in practical terms. Juran explains: employees express the "language of things" while management speaks the "language of money." (Fig. 3).

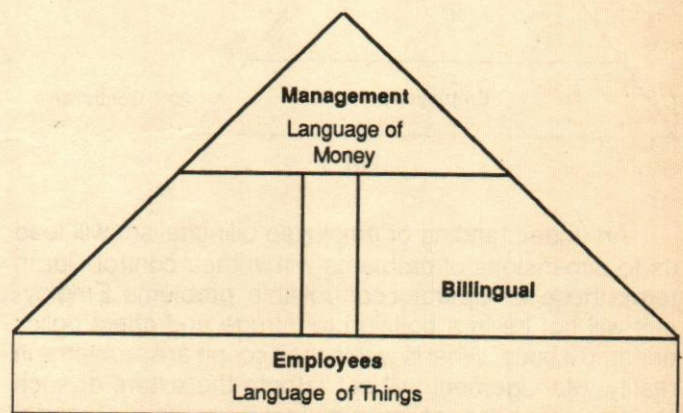


FIG. 3



**Employees express the "language of things" while management speaks the "language of money."**

Management and employees must effectively be bilingual. Therein lies the means to achieve organisational goals and fulfill individual needs. Participation schemes are efforts in achieving bilingualism, that is, the language of things is translated into the language of money and vice versa.

When management shares its vision with employees, it is making an effort in bilingualism. In all strategy planning, visions are defined through mission statements, objectives and operational plans. These cannot be confidential because they affect work. Work, as we know, is done by employees. An enlightened management puts into effect plans that work. A good plan is developed through research and past experience. But the best plan is one which has been validated. Most organisations use feedback mechanisms to validate its policies and decisions. Feedback will be meaningful to the degree management strives towards being bilingual. Management prefers to take credit for all that takes place in an organisation. Rightfully so, but it is not limited to all that is well. It is also accountable and responsible for all that goes bad. It is not wonder Juran explains: 80% of the problems in an organisation are management controllable.

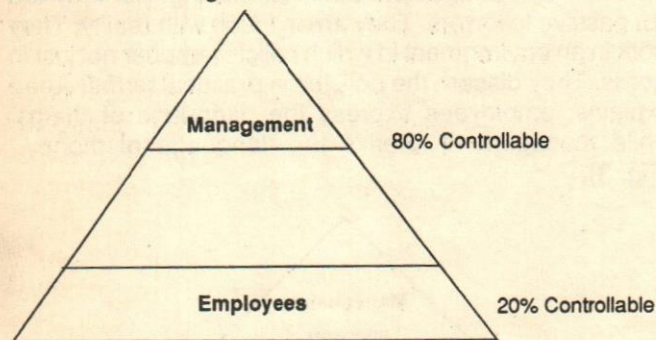


FIG. 4

An understanding of employee bilingualism will lead us to dimensions of problems within their control. Juran terms these as "Operator controllable" problems. Employees will not be in a position to intrude and affect policy oriented issues. What is within their scope are problems in reality. Management will not fathom the extent of such reality issues because, put simply, it is not there. Management By Wandering Around (MBWA) is an effort towards

reaching out to reality. Employees are indispensable in this aspect to share the reality with management.

**It is not wonder Juran explains: 80% of the problems in an organisation are management controllable**

Bilingualism is crucial at this point. Employees' feedback on the reality may be hampered by a lack of understanding of management tools, fear and apprehension. It has been said that when employees share their innermost thoughts with management, they bear the risk of being "stripped bare of their dignity." Employees work in the realm of reality, that is, the realm of interpersonal exchanges, cultural underpinnings, group think, politics, etc. While management has the means to seek redress from such situations, it is a "dead end" so far as the employees are concerned. In the "realm of reality," employees suffer the "slings and arrows of outrageous fortune!" Bilingualism works through employee participation schemes. Management provides top-down direction for participation to take place. Participation schemes cannot be put on "auto pilot." Like the "surf board" management has to ride on the "ridge of the waves" and bring the organisation through its ultimate glory.

**In the "realm of reality," employees suffer the "slings and arrows of outrageous fortune!"**

Management must set the criteria for participation. When employees participate actively in the organisation, organisational goals are achieved. That is only one end of the exchange relationship. Employees' needs are fulfilled simultaneously when reality issues are overcome and through them achieve a sense of achievement and belonging. Participation schemes, more than just addressing reality issues, are people-building.

### The Challenge

Do employee participation schemes exist because organisations want to be referred to as enlightened? Perhaps it is in vogue to have participating management practices. Does management exhort that the door is always open for employees' ideas, only to find that hidden nearby is a gun that points to the head? Employee



**Participation schemes, more than just addressing reality issues, are people-building.**

participation schemes are powerful means which only work when implemented in its finest form. There can be no half-way measures. Anything less than the actual thing is deadly.

### **Ministry of Defence (Singapore) Case Study**

Singapore is a small nation devoid of any natural resources. Singapore can only depend on its people for its growth and development - THE HUMAN RESOURCE FACTOR. Since people are a high asset, the Ministry of Defence (MINDEF) recognises that being a citizen army, it shares the country's valued manpower resources. MINDEF thus believes :

- a. In utilising fully the talents of its regulars, national service men, reservists and volunteers.
- b. In developing its people to their fullest potential through training and providing opportunities for self-improvement.
- c. In fostering a strong sense of commitment among its people towards their role in the military defence system.
- d. In motivating its people to give off their best in fulfilling their assigned responsibilities within the organisation.
- e. In instilling pride in military people.
- f. In providing an environment conducive to the social integration of its people as each contributes towards national defence and security.

### **Personnel Management Philosophy**

MINDEF therefore adopts a Personnel Management approach :

- a. That is in line with national human resource development goals.
- b. That is adaptive and continually sensitive to the changing profile of its people.
- c. That is people-oriented and participative in style while upholding the essentials of discipline and authority.

- d. That emphasizes both horizontal and vertical communication exchanges.
- e. That is greatly concerned with the well-being of its people and its families.
- f. That rewards its people based on performance and advances them according to demonstrated potential.

The MINDEF PRODUCTIVITY MOVEMENT (MPM) was launched in mid 1981. It adopted the acronym "PRIDE" - Productivity In Daily Effort" to add meaning to what we do. It means doing the right thing right and always looking for a better way to do it in our daily life. The Daily PRIDE checklist is :

- a. Know what I want to achieve.
- b. Look for a better way to do the job.
- c. Improve my skills and knowledge.
- d. Suggest one improvement a week.
- e. Help my soldiers to improve their skills and knowledge.
- f. Care for my soldiers.
- g. Educate my men to take pride in themselves and in their work.
- h. Train my soldiers as a team.

### **Guiding Principles**

Based on this definition, the MPM laid down the following guiding principles :

- a. A more satisfying and rewarding work environment can be achieved from improved productivity. To attain this, the organisation has to take measures to gain commitment to productivity improvement.
- b. Everyone should be prepared to accept job changes or job enlargement and the necessary retraining which come with measures to improve productivity.
- c. Everyone should co-operate to discuss, study, deliberate and develop measures to increase productivity.
- d. The fruits of improved productivity should be distributed fairly.

### **Objectives**

It is governed by the following objectives :

- a. To foster a climate responsive to change.



- b. To introduce, develop, and disseminate tools and techniques for management.
- c. To develop and promote the concept of organisation being responsible for the welfare of its people as part of its overall social responsibility.
- d. To promote two-way communication and to achieve common goals through greater participation and co-operation by everyone.
- e. To promote close relations and co-operation based on mutual trusts, confidence and understanding.

### Defining Productivity

Productivity is an attitude of mind that strives for and achieves the habit for improvements, as well as the systems and the set of practices that translate this attitude into action :

- a. In and by ourselves through constantly upgrading our knowledge, skill and disciplines, individual efforts and teamwork.
- b. In our work through better management and work methods, cost reduction, better systems and better technology so as to achieve high quality work and service.

Productivity is a mentality of progress, of the constant improvement of that which exists. It is the certainty of being able to do better today than yesterday, and less than tomorrow. It is the will to improve on the present situation, no matter how good it may seem, no matter how good it may really be. It is the constant adaptation of economic and social life to changing conditions. It is the continual effort to apply new techniques and new methods. It is the faith in human progress.

### The Practice of PRIDE in MINDEF

How can we encourage PRIDE in our service men in MINDEF? A simple illustration is to get people to ask two basic questions :

Am I doing the best I can do?

Am I being the best I can be?

Therefore, the slogan for the Productivity Movement is : "LIVING PRIDE - THE SAFE WAY TO EXCELLENCE"

Commanders consciously or unconsciously practice PRIDE daily. This can be seen in the way they perform their tasks and management of servicemen under their command. If the following tasks are undertaken diligently, then productivity can be achieved daily.

### a. Looking after the welfare of servicemen

Commanders in the units ensure that the soldier's welfare is well looked after. The serviceman is aware of the various channels and avenues, and welfare programmes available to him when he requires assistance and guidance. When a soldier knows that MINDEF cares for him and his family, and that the commander is interested in his welfare, then he will give of his best.

### b. Leading by example

Commanders always set the example for their men to follow. This can be leading the front platoon for a route march, carrying full combat loads as the servicemen during an exercise, etc. By the commander taking the lead, the soldiers below him will feel motivated to undertake tasks with PRIDE.

### c. Upgrading of skills

Commanders whenever possible and necessary, upgrade the standard and training of the men under their charge. The soldiers are sent for appropriate basic and upgrading courses so that they can contribute more effectively to the SAF.

### d. Promotion of productivity through suggestions and work improvement teams

Commanders take the initiative to join Work Improvement Team (QCCs) and impress upon their men the benefits to be gained from such participation. Commanders can also encourage their men to constantly seek different ways to improve their work environment and submit their ideas through suggestions.

### Personnel Participation That Works

The Unit Suggestions Management System (USMS) and Unit WITS Managements System (UWMS) are based upon the simple concept that nearly all people will take PRIDE and INTEREST in their work if they are allowed to make meaningful contributions which influence decisions made about their work. Productivity is an attitude of mind, ONE THAT IS WILLING TO IMPROVE. Thus, to achieve productivity servicemen must be encouraged to improve their work environment - an area where they spend most of their time. They should be treated as people with ideas and should therefore be given the opportunities to voice their opinions and ideas.



## 1. Objectives of USMS and UWMS

The Suggestions and WITS Systems provide the means for :

- a. Inspiring a high degree of teamwork
- b. Promoting job involvement
- c. Creating a problem solving capability
- d. Instilling quality consciousness
- e. Encouraging self management
- f. Improving mgt-servicemen relations
- g. Enhancing the quality of service
- h. Developing leadership and personal qualities

- i. Creating a harmonious work environment

## 2. Role Of Commanders

Commanders must :

- a. directly motivate and educate their men to always look out for how things may be improved
- b. Help their men to develop, experiment and present their ideas for improvement
- c. Respond quickly to ideas
- d. Implement good ideas promptly
- e. Monitor the participation level closely.

## ESSAYS INVITED UNDER 1992 ANNUAL APO ESSAY CONTEST

—Cooperation and Productivity for Growth—

The APO, as part of its extensive programmes to promote productivity in Asia and the Pacific region, is soliciting entries for its annual APO Essay Contest. The theme for the 1992 APO Essay Contest is "Cooperation and Productivity for Growth". The Contest carries a first prize of US\$3,000, three second prizes of US\$2,000 each, and six third prizes of US\$1,000 each.

The Contest aims at promoting the productivity movement in the industrial, service, agriculture, and agro-industry sectors through the collection and dissemination of outstanding essays prepared by individuals in APO member countries.

The essay should be an original contribution and should not have been published or printed before anywhere, and should be written in English. Essays written in other languages should be accompanied by an English translation and meet other conditions. The length of the essay should not be longer than 30 type-written pages in double space on A4 paper, excluding graphs, illustrations, diagrams and reference. An abstract of less than 200 words summarizing the contents and conclusions of the essay should accompany the essay.

It is suggested that the essay should be written in an understandable and interesting style starting with conceptualization of the theme, giving a logical sequence of facts and analysis, innovative ideas and proposals, and ending with sound conclusions and findings. The approach should be practical rather than academic.

A Screening Committee of well-known experts on productivity and development will undertake the screening and the selection of outstanding essays.

Two copies of the essay must be submitted to the APO Secretariat not later than 31st July 1992. For further details, please contact the APO or the National Productivity Organizations in APO member countries.

The APO Essay Contest, it may be mentioned, replaces the APO Oshikawa Essay Contest, and to extend its coverage for the development of overall industry, agriculture, agro-industry, and trade and service sectors.



# Application of Japanese Manufacturing Management Techniques in India

T.S. Raghunathan & Subba Rao

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*Japanese management techniques have demonstrated to produce products of higher quality at lower cost. Attempts have been made to introduce these techniques in developing nations. This paper specifically focuses on the applicability of these techniques in Indian conditions. A conceptual model of implementation of these techniques in India has been developed based on extensive interviews with CEO's of three different organizations.*

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After the successful emergence of Japan as a leading low cost, quality producer of manufactured goods and as a formidable competitor to the western industrialized nations, a lot of research effort has been devoted to study the causative factors underlying their success. Many organizations are trying to incorporate Japanese management techniques to achieve better quality at reduced cost and gain competitive advantage. The contribution of the Japanese management methods has been to demonstrate that higher quality of the products can be obtained without increasing costs. Though there is a general agreement as to these techniques/concepts like Just-in-time (JIT), total-quality-system (TQS) and multi-functional worker there is still a debate as to the applicability and implementation of these techniques in other countries [Ebrahimpour, 1984, Lee, 1984]. There have been studies which have attempted to identify the differences in the sociocultural heritage, political climate, socioeconomic and legal environments in various countries and their effect on management practices [Negandhi, 1984, and 1985, Monkiewicz 1986; Jain 1987]. Studies have also been conducted on the differences in the management practices of Japanese parent organizations and their subsidiaries in other developing and developed nations [Negandhi, 1985; Hayashi 1986]. However, the question as to the extent of the knowledge of, and implications of implementing Japanese manufacturing management techniques in organizations in the developing countries has not been fully answered. This article is an attempt to study the applicability of Japanese manufacturing management techniques in Indian conditions.

Two developments in the international and Indian industrial climates motivated this study. As the standard of living in Japan rose in the last two decades leading to increased labour costs, countries like Korea, Taiwan and Singapore, the tigers of Pacific basin, have entered the field and are giving competition to Japan. It is a matter of time before history repeats itself in these countries too—improved standard of living and increased labour costs.



Countries like India offer opportunities for the next wave of entrants to international competition because the labour costs are still low and there exist opportunities for wide margins of productivity gains to be achieved.

The second development is in the changes of the industrial policies of India. "In many ways, India is an ideal subject for an examination of the transferability of managerial know-how from Japan. One of the (Indian) government's main objective is to industrialize and modernize the Indian economy, and to achieve this, Indian firms have been encouraged to enter collaborative agreements/joint ventures with firms in other advanced countries" [Jain 1987]. Following independence, India was a centrally planned economy with its doors closed for, or suspicious against, any free market influence. Though India still follows a centrally planned system its doors are now more open to foreign know-how and collaborations and free market systems. The government is pushing to industrialize and modernize its economy. Many incentives are given to export oriented industries. There is liberalization of foreign collaborations, import of know-how and loosening of controls on selected consumer oriented industries. In this changing environment it is important that Indian managers learn from Japanese manufacturing management techniques and adapt them to suit Indian conditions to compete in the international markets based on quality, cost and delivery.

**Countries like India offer opportunities for the next wave of entrants to international competition because the labour costs are still low and there exist opportunities for wide margins of productivity gains to be achieved.**

### Indian Manufacturing Environment

During the better part of the 80's there have been a large number of joint ventures with Japanese, starting with Suzuki and Honda in 1984. Though limited in capital resources, India is rich in raw materials and has a competent labour force. Culturally oriental and similar to Japan, India, in its industrial practices, is more akin to western industrialized nations, particularly, the United Kingdom due to historical reasons. It also has a large pool of scientific and technical personnel. India has a diversity of cultures which gets reflected in the attitudes of the labour force which changes from one part to another of the country. Labour union movement is strong with the unions

having affiliations to political parties. As a result, during labour-management negotiations the particular organization's and its labour's interest may not be guiding factors, in fact they get subjugated to the political party's interest. This is in marked contrast to Japanese situation where the unions are not usually affiliated to political parties, but on the contrary they are loyal to the organizations and therefore during negotiations the labour's interest is of foremost importance. While job security as practiced in Japanese industries has acted as an incentive to greater involvement and higher productivity of workers, under Indian conditions where job security, assured most of the time by law, in conjunction with the nature of labour union practices has resulted in a complacent and under productive work-force.

**This is in marked contrast to Japanese situation where the unions are not usually affiliated to political parties, but on the contrary they are loyal to the organizations and therefore during negotiations the labour's interest is of foremost importance.**

Indian consumers by and large are not fully aware of their rights and, given the scarcity economy in many sectors, do not demand quality and service. In the Indian market, price is the prime consideration for the manufacturer rather than quality and service. The large domestic market, not insisting on quality, creates a dilemma for the Indian manager on the quality dimension : A manufacturer of a product making it for export markets as well as the domestic market has to meet high quality standards for the international market while for the large domestic market quality is of secondary importance. The dilemma of the Indian manager will be to find ways of running two parallel set ups, one for the domestic market and the other for export. This is in sharp contrast to the Japanese situation where their domestic market demanded higher quality products [Alden, 1987] and hence it was easy for the Japanese manufacturers to make products for the local market whose quality was as good as, if not better, than that required to compete in the international markets. In the international arena concept of marketable quality is being replaced by total quality systems and quality assurance. Quality consciousness is something which has to be ingrained as an objective of an organization and all levels of labour and management have to be educated and should strive to achieve total quality.

A second concern to the Indian Manager is cost. Given the conventional wisdom that higher quality will cost more,



the average Indian manager is usually not very enthusiastic to improve quality. However, increasing quality need not necessarily increase cost and in fact may reduce cost by bringing down rejections and reworks. This should encourage the manager to concentrate on quality and produce quality products. There is also a need for the manager to educate his suppliers and customers in this regard.

There are other issues facing the Indian manager which have serious implications for employing the JIT approach. The Indian economy is controlled by quotas and licenses. Inflation is not very much under control. Quality materials are in short supply. For imported materials there are many restrictions and one has to plan much in advance. Imported materials obtain a premium in the domestic market. Because of short supply of goods, inventories for some will appreciate in value. In these conditions Indian manager will question the applicability of JIT concepts particularly for those materials.

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However, regarding reduction of inventory, organizations can easily control in-process inventory. They may not have very much control on the raw material side except to educate the vendors and forecast their requirement and within the forecasted requirement get the material as they are available. They should be in a position to identify scarce material and those which are freely available. Organizations should try to control and implement JIT concepts with respect to the materials which are freely available.

### **Purpose & Scope of the Study**

The authors undertook a limited field research to examine the applicability and adaptability of the Japanese manufacturing techniques and concepts in the Indian environment. The scope of the study was limited to interviews with executives in three Indian organizations in South India. The interviews were held with top and middle level managers. The fact that India is a vast sub-continent, and labour attitudes and labour-management relations differ from one part of the country to another, shall also be borne in mind in drawing conclusions from this limited

study. Of the three organizations, one was an automobile parts manufacturer, the second a hydraulic equipment manufacturer, while the third one manufactured electrical equipment and also traded in Japanese products.

### **Views of Indian Managers**

The automobile parts manufacturing organization is well reputed for their products. The organization is professionally managed and has had a track record of good labour-management relations. They are well aware of Japanese manufacturing management techniques since one of their sister companies has a collaboration agreement with a Japanese manufacturer. In the view of the executive interviewed, who is also the CEO of the organization, Japanese manufacturing techniques are applicable in Indian conditions. He felt that they will be helpful in improving both quality and productivity. Two main requirements for implementation are top management support by way of their time and resources, and good labour-management relations. In his organization, he has converted successfully one cell to follow JIT. Within the cell the organization was such that there was minimal WIP which was achieved by storing the required materials outside the cell area and bringing them in at the required time. According to the CEO, this created a situation of near zero inventory and a sense of orderliness within the cell producing productivity improvements. The success of this cell has encouraged them to plan for converting all other cells to JIT. The organization was able to achieve success mainly due to the cooperation of the labour which resulted from the good labour-management relations. The organization has a policy of sharing a part of the profits with the labor. Labour respect management's promises and consider management to be fair in negotiations and implementation of settlements. The CEO feels that the arrangement of sharing profits with the labour makes the labour to appreciate, understand and work towards the concept of JIT.

The executive who was in-charge of implementation of the JIT system was also interviewed. This interview reinforced the views of the CEO. This executive felt that

**Two main requirements for implementation are top management support by way of their time and resources, and good labour-management relations.**



the labour satisfaction is high and they were able to achieve the targeted quality and production much earlier than their expectations. Another salient point mentioned was that the management no longer insisted on the conventional rate of return for justification of allocation of resources. It was enough for the executives and the labour to agree on the need for equipments to achieve the targeted efficiency in the process, and management would allocate necessary resources. He mentioned that they are applying Japanese management techniques towards achieving the following objectives :

- a. To improve the return on capital employed,
- b. To improve profit before interest and tax on sales,
- c. To increase value added per employee,
- d. To increase stock turnover,
- e. To increase work in process (WIP) turnover,
- f. To improve the ratio of direct to indirect labor,
- g. To improve delivery performance, and
- h. Reduction in levels of management.

Their past performance and their present achievement towards their objectives are shown in table 1. In implementing JIT to achieve the above goals the organization had :

**Table 1: Past and Present Performance**

Objective	Past	Present
Return on capital employed (%)	8	14
Work-in-process turnover	15	100
Stock turn-over	4	14
Number of levels of management	9	3
Planning horizon (months)	2	.5
Rolling plan (months)	1	.25
Delivery performance (%)	—	95

- (a) Created an *integration task force* to reduce the number of suppliers and also to educate the suppliers towards quality and timely delivery of parts.
- (b) Transferred the responsibility for most of the functions like material planning and production, procurement, manufacturing, quality, maintenance, personnel, industrial engineering and costing to the cell.
- (c) Designed the layout of the assembly line to suit the process.
- (d) Educated all the workers regarding the benefits of this new assembly line and trained them to work in this new setup.

The second organization was a hydraulic equipment manufacturing organization. This organization has technical collaboration with a Japanese multinational. Their major consumers are original equipment manufacturers (OEM) and quality is an essential requirement for the organization's survival. Though managers were aware of the Japanese management techniques, these were not applied to the manufacturing process. The organization strives to achieve quality by 100% inspection of critical components and finished products. This definitely increases their cost of manufacturing. The authors feel that this organization is able to absorb the increased cost since the profit margin is high. The impression of one of the authors, who interviewed the executive is that while the management understands the concepts of Japanese management techniques, there is a lack of full appreciation of its benefits. Their relation with labour, which is not cordial, is likely to be a second factor impeding the application of these techniques.

**While the management understands the concepts of Japanese management techniques, there is a lack of full appreciation of its benefits**

The third organization was in electrical equipment manufacturing business. They import heavy transformers and generator sets from Japan. The CEO of this company had extensively toured Japan and had visited many Japanese manufacturing plants. He felt that commitment by both the employer and employees is essential for successful implementation of any new management approaches. In his opinion, though Japanese management techniques have been applied in some Indian organizations they are not wide-spread because of basic cultural differences. He felt that under present Indian conditions there are no incentives to cut down on inventory because usually inventory appreciates more than the carrying cost, and there are no incentives to improve quality because the market does not insist on quality. Cost reduction is not a necessity at present because the profit is high due to scarcity conditions. However, he felt that the Indian market is slowly getting saturated and consumers may start demanding higher quality. He felt that though top management is aware and wants to introduce efficient management techniques the appreciation and need had not permeated down the line to middle and operational management levels to force successful implementation. This reinforces the view of the manager of the first organization



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who felt that organization-wide commitment is an important factor for successful implementation of these techniques.

in India. This conceptual model is shown in Figure 1. The environmental factors like global markets and increased

## Focus

# Sharing Gains of Productivity & Motivation

Subratesh Ghosh

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*This paper points out the fact that solution to work may be created and strengthened by both monetary and non-monetary rewards, depending on the work environment, the nature of the work process and the management skill with which these are introduced and operated.*

*Subratesh Ghosh is a professor at the Indian Institute of Management, Calcutta.*

Controversy on the relative merits and scope of monetary and non-monetary approaches to motivation has been considerable for many decades, and particularly since the late fifties, when a group of researchers led by Herzberg tried to show that monetary rewards did not act as motivators, but might be treated as hygiene factors affecting performance and productivity (Herzberg, Mausner and Snyderman, 1959; Herzberg, 1966, 1968). This was followed by strong denials by several scholars, who had shown weaknesses in the arguments of Herzberg and his supporters and also pointed to the empirical evidences based on different research findings emphasising the role of money as a motivator (Vroom, 1964; Opshal and Dunnette, 1970; Lawler, 1971, 1973).

The motivation to work may be created and strengthened by both monetary and non-monetary rewards, depending on the work environment, the nature of the work-process and the managerial skill with which these are introduced and operated. Successes have been reported in regard to the use of individual and group wage-incentives schemes as well as the overall productivity linked monetary incentive schemes in the western and third world countries (I.L.O., 1984, Belcher 1962; Lawler, 1973; Graham-Moore and Ross 1990; National Productivity Council, 1973; Dolke, 1974; Ghosh, 1986-C, 1989; Suri, 1973; Haggalund, 1989). On the other hand encouraging results have also been reported in regard to the organisational effectiveness and other facets of performance from the use of non-monetary motivational programmes, e.g., participative work redesign, quality circles, job rotation and various programmes relating to job enrichment and employee participation (De, 1984; Jacob, 1975; Rogers, 1982; Rice, 1958; Maccoby and Carmichael, 1984; Inagami, 1983; Kanwati, 1984; Takezawa, 1983; Mankidy, 1989). In fact on the basis of the records of success and failures of both the types of motivational schemes and keeping in view the undisputable fact that man has various needs, some of which can be well met by money and some others by other types of stimuli, there appears to be a very strong case for such motivational



programmes which combine monetary as well as non-monetary rewards for better performance at the workplace.

**There appears to be a very strong case for such motivational programmes which combine monetary as well as non-monetary rewards for better performance at the workplace.**

### Gainsharing Plans and the Motivational Bases

The gainsharing plans refer to various types of monetary incentive schemes which seek to reward the employees for their contributions to enhance the overall performance of some unit of an organisation (or the organisation as a whole) usually measured on the basis of reduction of costs (at times by increase in profit or value added etc.). As Lawler (1987) puts it, the idea in all these plans is to relate pay to the overall performance of a business unit—typically a plant or a major department,—by using a formula to decide the size of the gainsharing bonus payable to the employees. Typically bonuses are paid when the formula indicates a decrease in such costs as labour, materials or supplies. Another U.S. expert has stated that gainsharing systems are designed to encourage workers, unions and management to work together to enhance profitability of an organisation (Haggalund, 1989). He particularly emphasised the feature of these plans on which teamwork and communication systems are relied upon with a view to “cut costs by taking advantage of ideas coming from the grassroots of the organisation”.

Among the gainsharing plans, possibly the oldest and the most well-known scheme is the Scanlon Plan. This was first devised around the late twenties by J. Scanlon,—a steelworker, who later achieved distinction as a trade union think-tank and earned a position in the faculty of the prestigious Massachusetts Institute of Technology. The first use of Scanlon Plan is reported as far back as 1927. Several studies on Scanlon Plan's working had been undertaken at M.I.T. and several U.S. universities and research institutes. A 1956 study reported 60 Scanlon Plans in operation in various organisations (Belcher, 1962). They continued to be popular and prevailed in many organisations due to their successful implementation even in the eighties and early nineties (Delaney et al, 1990; Graham-Moore & Ross, 1990). Under these plans, each working unit (plants, sections or departments etc.) in the organisation has a joint committee consisting of the

employee-representatives and supervisors. They engage into joint problem-solving in the areas of cost-reduction and productivity and examine the ways and means for savings in labour costs (usually measured by labour cost : sales-value ratio). If the agreed solutions and suggestions are accepted and successfully implemented, the gains resulting from cost-saving/productivity improvement are shared between the organisation and the employees according to a mutually agreed formula. It has been reported that about 80% of the suggestions emerging out of Scanlon Schemes prove practical and are adopted (Decenzo & Robbins, 1988).

Rucker Plan is another Gainsharing Plan in which the gains to be shared are measured by the reduction of the labour costs : value added ratio. Here also joint labour—management committees play a crucial role in obtaining and appraising suggestions from the grass roots levels for improvements in production and reduction of costs. However, the degree of employee-participation in the Rucker Plan is less than that under the Scanlon Plan (Balkin & Gomez-Mejia, 1987). The size of the bonus or the share for the workers under this plan depends mainly on the estimated per cent of labour-cost : value added ratio that may be attributed to the employees' contribution. As this estimate is likely to be mainly based on industrial engineering studies and as the labour representatives are less conversant with the industrial engineering than the management, the scope of labour's say in decision making, in the matter, is likely to be less than that under the Scanlon Plan.

In the USSR, a scheme first developed by a collective of builders led by N. Zlobin used an integrative approach similar to the Gainsharing Plans described above. Under this approach a collective of workers, described as “work-brigade” signs a contract with the organisation for the whole job. If the brigade completes the work on or ahead of the schedule (or exceeds the output targets), the brigade receives a “bonus” based on the time-saving or the extra output (Prokopenko, 1987). It has been reported authoritatively that the scheme has spread to other industries due to its initial success (Garvilov, 1989).

A more recent addition to the list of Gainsharing Plans is the Improshare. Under this scheme, first suggested and implemented in U.S.A., the bonus element is based on the saving of time measured by the reduction of the ratio of actual hours worked by the group to the total standard time fixed for the job to be performed by the same group. This gain is distributed between the employees and the organisation on the basis of a mutually agreed formula. However, as the standard time for the group is fixed by

of output or productivity is more difficult, although not impossible.

However, since cost-effective gainsharing plans have wider applicability in different sectors than their counterparts and as cost-effectiveness should now receive a much higher priority in our economic policy decisions than in the past due to the greater competition at the micro-level and also due to the urgency of containment of inflation, a comparison between these plans and the overall performance linked incentive (OPI) schemes in terms of their motivational effectiveness should be appropriate. If they are found to be more or at least equally satisfactory in terms of motivation as compared to the overall productivity-linked schemes the economic policy makers in the public sector, private sector as well in the Government should more carefully assess the ways and means of introducing the cost-saving gainsharing plans in the Indian organisations.

Starting from Lawler's triple conditions of motivational effectiveness as presented above, the first two conditions, i.e., the tie-up between performance and pay and the perceived relation between the two within a timeframe are met by the cost-saving gainsharing plans as well as the variants of OPI schemes prevalent in Indian organisa-

on productivity bargaining (Randeria, 1978; Ghosh, 1986-B, Pande, 1989; Nayak, 1989).

Comparing the expected impact of the two alternatives on the mutual trust building and credibility, the productivity gainsharing, through participative joint-committees of the ground-level employees and the management representatives, appears to be more effective being based on joint problem-solving and the objective of cooperation within a win-win framework. On the otherhand, the OPI schemes, introduced through traditional collective agreements or productivity agreements based on union-management bargaining, being basically dependent on a framework of confrontation and own-gain maximising strategy at the cost of opposite side, are likely to be less effective from the point of view of trust building. Although having been signed by the union and the management representatives they carry some reassurance to employees (at least to the supporters and members of the signatory union) in regard to their interests, however, the element of distrust involved in the collective bargaining process is likely to make the resulting productivity gainsharing arrangement less trustworthy to employees compared to the gainsharing introduced through the direct involvement of the ground-level employees-representatives (or the employees themselves) in the respective shops/sections or departments.



industrial engineers of the company and as there is hardly any emphasis on employee participation in this respect, the participative features of improshare scheme are essentially weak.

### Impact of Gainsharing Plans

With some exceptions, the Gainsharing Plans have often been found as successful in raising the level of effectiveness of organisations which introduced them. This explains the spurt of interest in Gainsharing Plans and other performance linked monetary reward schemes in the U.S. in recent years. According to a survey conducted by the Personnel Policies Form in 1984, 69% of the productivity improvement programmes in the U.S. were based on financial incentives (Haggalund, 1989).

Compared to the traditional individual/group incentive schemes based on the excess output over a standard (task-bonus type) or time-saving compared to the standard time (individual or small-group time bonus type), the main attraction of most of the Gainsharing Plans (with the exception of Improshare) lies in the combination of the financial motivation with the

**Organisations must not only tie rewards to performance, but that must be done in a manner that leads the employees to perceive the relationship**

and unambiguous. The third condition relating to the trust element is also amply fulfilled by Scanlon, Rucker or Zlobin types of plans through employees participation in determining the bonus share and also the methods of achieving the improvement in time-saving or target exceeding through joint-committees in Scanlon and Rucker and the collective contracts (similar to memorandum of understandings) between the work-brigade and the enterprise under the Zlobin-type method. However, Improshare involves the workers to much less extent in Gainsharing decisions (Newman, 1987). Accordingly, although the traditional U.S. Gainsharing Plans (Scanlon, Rucker etc.) and their Russian counterpart amply meet all three motivational criteria for monetary rewards for performance, the Improshare variety developed more recently

### References

- Balcher, D.W.**, Wage and Salary Administration, Prentice-Hall, Englewood Cliffs, 1962.
- De, Nitish R.**, Alternative Designs of Human Organisation, Sage Publications, New Delhi, 1984.
- Decenzo, D.A. and Robbins, S.P.**, Personnel/Human Resource Management, Prentice Hall of India, New Delhi, 1989.
- Delaney, J.T. et al.** Human Resource Policies and Practices in American Firms, Part II, American Labor News Supplement, Vol. 17(5), May 1990.
- Delaney, J.T. et al.**, Human Resource Policies and Practices in American Firms, Part III, American Labour News Supplement, Vol 17(6), June, 1990.
- Dolke, A.M.**, Factors in Job Satisfaction of Indian Workers, in *Roy, S.K. and Menon, A.S. (eds.) Motivation and Organisation Effectiveness*, Shri Ram Centre for Industrial Relations, New Delhi, 1974.
- Garvilov, B.**, Incentive Schemes to Raise Labour Productivity in U.S.S.R. in Suri, G.K. and Monga, R.C. (eds.) *Linking Wages with Productivity*, National Productivity Council, New Delhi, 1989.
- Ghosh, Subrathesh.**, Approaches to Raising Labour Productivity in the Public Sector: An Appraisal of the Indian Experience, Labour and Society, Journal of International Institute of Labour Studies, Vol. 11(2), May 1986. A.
- \_\_\_\_\_, *Productivity Agreements in India*, Personnel Today, Vol. 7(2), July-September, 1986-B.
- \_\_\_\_\_, *Productivity and Monetary Incentives*, Economic and Political Weekly, Vol. 21(35), August 30, 1986-C.
- \_\_\_\_\_, *Linking Wages with Productivity in Public Sector of India: Achievement, Possibilities and Problems*, in Suri G.K. and Monga, R.C., (eds.) Op. cit., 1989.
- Graham-Moore, M.S. & Ross. (eds.)**, Gainsharing: Plans for Improving performance, Bureau of National Affairs, New York, 1990.
- Haogalund, G.**, Alternative Reward Systems: A Means to Raise productivity? in Suri, G.K. and Monga, R.C., op. cit., 1989.
- Herzberg F., Mausker, B and Soyderman B.**, Motivation to work, Wiley, New York, 1959.
- Herzberg F.**, Work and the Nature of Man, World Publishing, Cleveland, 1966.
- \_\_\_\_\_, *One more Time: How Do you Motivate Employees?*, Harvard Business Review, January-February, 1968.
- Inagami, T.**, Labour-Management Communication at the Workshop Level, Japan Institute of Labour, Tokyo, 1983.
- International Labour Organization.**, Payment by Results, Geneva, 1984.
- Jacob, D.**, Job Enrichment of Field Technical Representatives: Xerox Corporation, in Davis L.E. & Cherns A.B., *Quality of Working Life*, Vol. II, Free Press, New York, 1975.
- Kanwati, G. (ed.)**, Managing and Developing New Forms of Work Organizations, I.L.O. Geneva, 1984.
- Lawler, E.E.**, Pay and Organizational Effectiveness, McGraw Hill, New York, 1971.
- \_\_\_\_\_, *Motivation in Work Organization*, Brooks/Cole Publishing Co., Monterey, 1973.
- \_\_\_\_\_, *Reward Systems*, in Hackman, J.R. and Shuttle, J.L. (eds.), *Improving Life at work*, Goodyear, Santa Monica, 1977.
- \_\_\_\_\_, *Paying for performance*, in Balkin, D and Gomez-Mejia (eds.), *New Perspectives in Compensation*, Prentice-Hall, Englewood cliffs, 1987.
- Maccoby, M & Carmicael, D.**, Issue of Participation and Ownership in Productivity and Development, American Labour News Supplement, Vol. XI(1), January, 1984.
- Mankidy, Jacob**, Quality Circles, Himalaya Publishing, 1989.
- National Productivity Council**, Incentives in Indian Industries, Part III, N.P.C. New Delhi, 1973.
- Nayak J.P.**, L&T's Experiment at Bangalore, in Suri, G.K. & Monga, R.C. (eds.), op cit., 1989.
- Newman, J.M.**, Selecting Incentive Plans to complement organizational Strategy in Balkin, D and Gomez-Mezia, L. (eds.) op. cit, 1987.
- Opsahl, R.L. & Dunnette, M.V.**, Role of Financial Contribution in Vroom V and Deci, E.L., (eds), *Management and Motivation* Penguin, Harmandsworth, 1970.
- Pande, S.N.**, Human Side of Tata Steel, Tata-McGraw Hill, Bombay, 1989.
- Prokopenko, J**, Management of Productivity, Geneva, I.L.O., 1989.
- Randeria, K.N.**, Productivity Bonus Scheme in I.T.C., in Suri, G.K. (eds.) *Wage Incentives: Theory and Practice*, Shri Ram Centre for Industrial Relations, New Delhi, 1978.
- Rice. A.K.**, Productivity and Social Organization: The Ahmedabad Experiment, Tavistock, London, 1986.
- Suri, G.K.**, Wage Incentives and Productivity, in Suri, G.K. (ed.) op. cit., 1978.
- Takezawa, S. et. al.**, Improvement of Quality of Working Life in Three Japanese Industries, I.L.O., Geneva, 1983.
- Vroom V.**, Work and Motivation, Wiley, New York, 1964.



# Productivity 2000 : Singapore's Initiative

Koh Juan Kiat

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*This paper looks at the progress made by the Singapore Productivity Movement in galvanising the workforce and companies to pursue productivity as a vital force for economic growth; and highlights the initiatives that have been taken in key areas to improve Singapore's productivity and competitiveness in the 1990s: positive work attitudes, skills upgrading, labour-management cooperation, progressive management practices and better use of manpower*

*Koh Juan Kiat is the Executive Director at National Productivity Board, Singapore*

The decade of the 1990s has been described in this year's World Competitiveness Report as potentially "the greatest period of change and converging forces in history". Unprecedented change also means more opportunities but only for those who are ready. The international market will become an increasingly tougher place to do business. In its 1991 World Development Report, the World Bank projected, based on an optimistic scenario, an average annual gross domestic product (GDP) growth of 2.9 per cent for the high-income OECD countries in the 1990s compared to 3.1 per cent in the 1980s. The East Asian economies, i.e. Japan ASEAN countries, Korea, Taiwan, People's Republic of China and Hong Kong, are expected to grow at an average annual rate of 6.7 per cent, compared to 7.2 per cent during the period 1965-89. Furthermore, as more economies liberalise and adopt outward-oriented policies, the jostling for greater market shares will inevitably intensify.

These sweeping changes would pose a fundamental question for Singapore: How can it continue to make economic progress and have a place in the world economy? The country does not have a large economy with buffers to absorb sudden changes in externalities. It has neither the luxury of a large labour force nor an abundance of natural resources. The only way for Singapore to progress is to be competitive internationally.

Professor Michael Porter of Harvard University has said that the only meaningful concept of competitiveness at the national level is productivity. He states: "The principal goal of a nation is to produce a higher and rising standard of living for its citizens. The ability to do so depends on the productivity with which a nation's labour and capital are employed. The productivity of human resources determines employee wages; the productivity with which capital is employed determines the return it earns for its holders. A nation's standard of living depends on the capacity of its companies to achieve higher levels of productivity—and to increase productivity over time."



## Contribution of Productivity to Singapore's Economic Growth

From 1981 to 1990, Singapore's productivity increased by one-and-a-half times, reaching S\$40,000 (US\$22,070) per worker—higher than the levels attained by Korea and Taiwan and on par with Hong Kong's. This increase in productivity accounted for two-thirds of economic growth during the period. If productivity has stagnated since 1981, Singapore's GDP today would only be S\$36 billion (US\$20 billion)—36 per cent below the actual level attained. Its present per capita GDP would be S\$14,000 (US\$7,720), about the level achieved in 1983.

**This increase in productivity accounted for two-thirds of economic growth during the period.**

This dependence on productivity will become more crucial for Singapore in the future. Hence, the national target is to sustain an average annual productivity growth of 4 per cent in the 1990s. Achieving this target will be a major challenge for various reasons. First, Singapore companies will be facing keener competition in the world markets. Second, as the growth rate of the labour force slows down further, the labour market will tighten and the proportion of mature workers (i.e. those aged 40 years and above) will increase. Third, the workplace will become more automated and computerised, and workforce expectations will continue to increase. All these will have an impact on the Productivity Movement in Singapore.

**The national target is to sustain an average annual productivity growth of 4 per cent in the 1990s.**

## The Singapore Productivity Movement

The Singapore Productivity Movement was launched in September 1981 to galvanise companies and the workforce to pursue productivity as a vital force for economic progress. Spearheading the Movement is the National Productivity Council (NPC), a tripartite policy-making body with

representation from the government, employer groups and unions. The National Productivity Board (NPB) serves as the Council's secretariat and executing agency.

In the initial phase of the Productivity Movement from 1981 to 1985, the focus was on raising productivity awareness at the national level, making Singaporeans understand what productivity is. Since then, the Movement has progressed from awareness to action at the workplace, and to individual ownership of productivity. It has also adopted a total approach to productivity, which encompasses both the human and technological aspects of productivity.

The progress made by the productivity Movement can be seen from the following :

- (a) A 1990 Productivity Survey showed that almost the entire workforce understood the meaning of productivity, and nearly 9 out of 10 employees had taken actions to improve productivity at their workplace.
- (b) Today, there are about 90,000 workers involved in quality control circles (QCCs), compared to just 2,700 workers in 1982. This represents 6 per cent of the workforce, which compares favourably with Japan's 4 per cent. Such a positive participative trait has enabled Singapore to consistently receive a perfect rating of three points for Workforce Participation in Corporate Decision Making, one of the criteria in the Quality of Workforce Index developed by the U.S.-based Business Environment Risk Intelligence (BERI).
- (c) In 1990, companies expended an average of 2.3 per cent of payroll on training, compared to 1.5 per cent in 1986. Between FY 1981 and FY 1990, the annual number of worker training places increased by more than 12 times, from 32,600 to 405,600. This means that 1 in 3 Singapore workers is trained every year. BERI gave Singapore a perfect score for company support of education and training in its Quality of Workforce Index, ahead of developed countries like Germany, Japan, United States and Switzerland.

## Productivity 2000

By the year 2000, the primary source of Singapore's productivity growth will not come from more investments but rather from improvements in total factor productivity or



TFP—the economist's jargon for the qualitative aspects of productivity improvement. Between 1981 and 1990, TFP growth accounted for 14 per cent of Singapore's productivity growth. This is still low compared to the 60 to 70 per cent in the developed countries. The conclusion is that the contribution of TFP to productivity growth can be expected to become even more important as the Singapore economy develops further.

As higher TEP growth originates from qualitative improvements, it requires changes in the ways in which companies and the workforce operate. Companies will have to adopt new ways of managing their manpower, organising their work and managing technology. Employees will have to develop new ways of working and acquire skills and be more flexible and adaptable.

To achieve such a transformation, the NPB launched the Productivity 2000 project (P2000 in short) in 1989. Four tripartite committees, comprising mainly private sector representatives, were formed to study the key issues that would have an impact on the Productivity Movement in the 1990s. Their report was endorsed by the major employer groups, the government and the National Trades Union Congress (NTUC)—a tripartite support that would ensure the successful implementation of the various productivity initiatives recommended.

The P2000 report covered five key areas that would improve Singapore's productivity and competitiveness: positive work attitudes, skills upgrading, labour-management cooperation, progressive management practices and better use of manpower.

### **Positive Work Attitudes**

Singapore needs to achieve a fundamental shift in its people's understanding of productivity. Traditionally, productivity is perceived as maximising output from given resources, i.e. productivity is synonymous with efficiency. This perception should now give way to a much wider perception of productivity as an attitude of mind that strives for and achieves the habit for improvements.

For the 1990s, NPB has repositioned the Movement to focus on quality promotion. This emphasis follows through from the last ten years of promoting various inputs to productivity—ranging from teamwork to pride in work, training, and being the best we can be. All these values must now be translated into 100% right quality, which satisfies the customers. This emphasis on 100% right quality provides the platform for the next phase of the Movement, which will focus on quality.

**“Productivity” has a wide meaning but people have difficulty in understanding how they can improve productivity themselves. “Quality”, on the other hand, is more readily understood and connotes certain standards.**

The rationale for this transition is that “productivity” has a wide meaning but people have difficulty in understanding how they can improve productivity themselves. “Quality”, on the other hand, is more readily understood and connotes certain standards. Coupled with continuous improvement, it can encourage workers to do even better. Quality and Productivity are, in fact, two sides of the same coin—not separate concepts. While Productivity will still be retained for the quantitative evaluation of progress and competitiveness, it is Quality which will form the content of the education for the Singapore Workforce.

### **Skills Upgrading**

The Productivity Movement aims to upgrade the skills of the Workforce through continuous training. The NPB manages the Skills Development Fund (SDF), which provides financial incentives to organisations for training and which is used to develop the training infrastructure in Singapore. All companies in Singapore with a staff strength above 50 have received financial assistance for worker training from the SDF compared to only 69 per cent in FY 1984. For companies with staff strength of 50 and below, 20 per cent have benefited from SDF grants compared to only 4 per cent in FY 1984.

Companies are encouraged to increase their training investment from the present average of 2.3 per cent of payroll to 4 per cent - the amount spent by the better corporations worldwide. In addition, the national infrastructure of trainers, training delivery system, training contents, and instructional technology has to be upgraded, so that training is cost-effective for employers and accessible to the Workforce. Companies must be committed to train and workers must be willing to undergo training—using the best and most-effective technology or delivery system available.

To support these objectives, the SDF will sustain its annual training grant commitments for companies at S\$ 100 million (US\$55 million) annually. This will be supported by various initiatives centred on the following areas:



## Increasing Training Intensity and Opportunities

The NPB will increase its efforts to encourage companies, particularly the small and medium sized enterprises, to train. New initiatives will continue to be introduced to further boost the training infrastructure in Singapore. This would involve developing new national training programmes, exploiting the latest technology for training effectiveness and upgrading training resources and expertise. To make available tried and tested training resources of industry winners to others, the NPB has teamed up with reputable organisations to develop productivity training programmes. So far, 11 partnerships have been established. These initiatives have helped to make training more cost-effective for employers and more accessible to employees.

In June 1990, the NPB launched FAST FORWARD, a new national televideo learning system, designed to reach mature workers, shift workers and those who have had little access to conventional skills upgrading due to lack of time and motivation. To date, over 500 companies have enrolled more than 10,000 workers for the first five courses launched—Successful Supervision, Successful Selling, WorkPerfect, Easy English and Easy Maths. New courses are being developed to enhance the scope of training under the system.

## Improving the Quality of Skills and Craftsmanship

The thrust over the next five years will be to move towards excellence in training and to improve the quality of skills and craftsmanship of the workforce. The NPB will do this by bringing in the best trainers in the world, developing new training syllabuses and resources to impart new skills, and raising the standard of skills upgrading. The ultimate aim is to produce a world class quality workforce.

**The ultimate aim is to produce a world class quality workforce.**

## Labour-Management Cooperation

The prerequisite for productivity improvement in a country is harmonious labour-management relations (LMR). Fortunately, the LMR climate in Singapore is stable and

harmonious. Singapore's union leaders have accepted productivity as being mutually beneficial to management and workers. The active involvement of grassroots union leaders and the example they set, have encouraged workers to respond likewise. The task is to build on this foundation, to strengthen tripartism, and to upgrade the professionalism of personnel practitioners and union leaders. The objective is to catalyse management and union leaders to forge active partnerships to jointly tackle issues facing companies and workers in the 1990s.

The Singapore Institute of Personnel Management (SIPM) has upgraded its curriculum, so that personnel practitioners would be more effectively trained in human resource management practices to play a productive role in companies. The NTUC has also set up a Singapore Institute of Labour Studies to educate and train unionists on industrial relations issues to diploma, and eventually to, degree level. To strengthen tripartism at the grassroots level, an industrial Relations Society was formed in January 1991. The Society aims to bring together practitioners from the private sector, unions, government and academia, so that they can exchange views and be kept informed of any new developments in industrial relations. The Society will also draw up a Code of Practice on Industrial Relations to help keep alive the spirit of tripartism, and to guide industrial relations practices in Singapore in the 1990s.

**Singapore's union leaders have accepted productivity as being mutually beneficial to management and workers.**

## Progressive Management Practices

Singapore companies can learn to compete more effectively by adopting progressive management practices based on basic principles like cost effectiveness, high quality products/services, customer satisfaction, and information technology management. What is appropriate for a company would depend on its stage of growth, i.e., whether it is a start-up company, an established company, or a company ready to go global. To facilitate the learning of progressive management practices, training institutions are encouraged to develop programmes for each of these three groups of companies. In addition, selected companies will be assisted to progress to the next stage of development, so that they can serve as models for others.



The P2000 report has also recommended that a culture of cooperation be built up among Singapore companies, so that they can compete on productivity performance. Through linkages such as multi-company collaborations, chain-store alliances and collaborations among companies in different industries, local companies can grow and become a vibrant part of the economy.

### **Effective Use of Manpower**

With a scarce supply of human resources in Singapore, the effective use of manpower is of major concern. Two major target groups are the mature workers (those aged 40 and above) and those with "A" level qualification and below. These workers will have to be trained in new skills. Selected companies are now being assisted to train these workers in areas such as communication skills and industrial automation. The NPB has succeeded in focusing national attention on the training of mature workers, who are expected to comprise 43 per cent of the labour force in 2000 as compared to 28 per cent in 1990. From a low 8,500 in 1987, the number of mature workers trained annually increased to 29,000 in 1990.

The effective use of manpower also concerns the health of the workforce. A healthy workforce makes the effective use of manpower possible, improves morale and is a competitive edge for companies. The NPB will promote the need for companies to invest in healthcare programmes to ensure a healthy workforce.

Another area of focus is the promotion of pride in service, as services continue to be the largest sector in the Singapore economy, contributing more than 70 per cent to

GDP. To push for quality in the service sector, the NPB has teamed up with Singapore Airlines to set up a Service Quality Centre to train up chief executive officers, managers and workers on how to deliver quality service. The Centre aims to train 10,000 employees over two years. The NPB has also worked with the Vocational & Industrial Training Board to develop and certify skills standards for several service occupations.

### **Productivity—A Marathon with no End**

Improving productivity is like running the marathon. It is a long-haul effort. One needs to judge the terrain and vary the pace in order to keep in the race. The late Mr Kohei Goshi, former Chairman and President of the Japan Productivity Center, summed this up very well :

"All world class marathons are designed to test the athlete's endurance and will to win. Flat courses are inevitably followed by 'Heartbreak Hills' and any good athlete knows that you cannot maintain the same pace throughout the entire marathon if you expect to win."

The P2000 report provides Singapore with a map of the terrain that will hopefully enable it to take the right roads. Most of the ideas and innovations in the report came from, and are for, the private sector. It would require companies to take the whole package of solutions and persevere with its implementation. The government and unions are moving in tandem with companies to help them achieve the competitive edge that they are seeking in a much tougher world environment. Unlike the usual marathon, the productivity marathon is a race without a finish line.





# Innovative & Non-innovative Small Firms in Kerala

Sridhar Seetharaman

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*This study examines the small manufacturing firms with the dual purpose of identifying the essential characteristics of the innovative and non-innovative firms and developing a typology with predictive potential that would arrange these firms into fairly distinctive groups. The study reveals a significant positive correlation between scanning and innovation.*

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The importance of small firms in job creation, technological innovation and economic rejuvenation is accepted by most economists, management theorists and policy makers. In spite of the concept of small business incubators becoming popular, it is ultimately innovation that determines the distinction between run-of-the-mill small business and a high potential venture. One of the early contributors to the literature on innovation, Schumpeter (1939) outlined two types of innovation from a micro-economic perspective (i) entrepreneurial innovation; and (ii) managed innovation. A variable associated with individual success in business is the need for achievement or n-Ach (McClelland, 1961). While there is ample evidence that n-Ach is a core motivating factor in entrepreneurs, the causal relationship between it and entrepreneurial success has not been established. Miller and Toulouse's (1986) results show that n-Ach is not correlated with innovation in small firms. It is for this reason n-Ach is not considered.

Chief Executive Officers (CEOs) with an Internal Locus of Control (Rotter, 1966) are more likely to display entrepreneurial qualities (Shapiro, 1975) and to favour strategies of product market innovation (Miller and Toulouse, 1986). Therefore, we would expect the most innovative firms to be headed by internals.

Some innovative ideas stem from sensitivity to the environment, we can hypothesize that extensive use of methods to gather information about the firms' environment (Scanning) should be a feature of the innovative firm. Moreover, contact with other technical professionals (Hage and Aiken, 1970) is a source of ideas. As the small firm is strongly influenced by the CEO (Miller and Toulouse; 1986), we can expect that the CEO heading an innovative firm is likely to engage in technical interchanges through professional meetings and journals.

Formalisation and centralisation are considered to vary inversely with innovation (Hage and Aiken, 1970). The argument goes that decentralisation grants lower level individuals greater participation in decision making and thereby a proprietary interest in the outcome. It also



facilitates information transfer and a free exchange of ideas. All these encourage innovations. However, Normann (1961) and Hage and Dewar (1973) posit the view that centralisation will promote innovation.

## Methodology

This study examines the small manufacturing firms with the dual purpose of identifying the essential characteristics of the innovative and non-innovative firms and developing a typology with predictive potential that would arrange these firms into fairly distinct groups.

## Sample Firms And Respondents

The sample of small firms in Kerala embraced a diverse product group such as Metal Fabrication, Non-electrical Machinery, Electrical and Electronic Machinery, Transportation Equipment and Instrumentation. The criteria for choosing the firms was that it must have less than 500 employees. Units that were subdivisions of large firms were excluded as it was found difficult to establish their autonomy. The respondents of the firms were Chief Executive Officers or Managing Directors.

In all, the questionnaire was mailed to 200 firms. One hundred and eight responses were received, of which 8 had to be discarded because of substantial data gaps. This ultimately resulted in a success rate of 50 per cent. The present analysis that follows is based upon a discussion of 100 firms. The division between innovative and non-innovative firms being subjective, trial and error method was used to determine the innovation variable value that generated the most distinctive grouping in the cluster analysis. Values higher than 3.50 represented the innovative firms and *vice versa*.

### A. Innovative Group

For purposes of study, the innovative firms were clustered into 2 groups. The first group consisting of 30 firms exhibited a high degree of pro-activeness, risk taking, product differentiation and research expenditure. These firms were significantly younger than average, and had the courage to attempt market leadership and support their strategy with research expenditure. For all these reasons, they are labelled 'Young Turks'.

In the second group, there are 18 firms. These firms score highly in employing scanning methods for integrated decision-making, control and analysis. The CEOs were new to the firms, had better than average educational background and remained updated by participating in professional meetings and subscriptions to professional jour-

**The CEOs of these category of firms worked substantially higher than average working hours. These firms were well endowed in advanced management techniques and executive quality and hence are dubbed 'Blue Chips'.**

nals. The CEOs of these category of firms worked substantially higher than average working hours. These firms were well endowed in advanced management techniques and executive quality and hence are dubbed 'Blue Chips'.

### B. Non-innovative Firms

The cluster analysis yielded three groups of firms. The first group exhibited poor controls, poor planning, analysis, integration and explicitness of strategy. The CEOs of these firms had been at the firms for substantially longer than average and worked fewer hours. Adding these reasons to the fact that these firms continue to survive, one can surmise that their products and marketing strategies were engineered in the past and continue to serve them well. These firms were therefore called 'Silver Spoons' and were 26 in number.

The second group consists of 14 firms, which were similar to Blue Chips in strategic and functional variables except that the CEO had been at the helm of affairs for significantly longer than average period. This group registered significantly positive values for controls, planning, analysis and integrated decision making. The executives took an active role in innovation particularly in technical development. These firms, as their name indicates, appear to try hard, but without any success at innovation, and are therefore called the 'Striving Stoics'.

In the third group, there were 12 firms. In this classification a majority of variables have significantly low scores with the notable exception of the number of journals read by these executives. The Locus of Control was significantly positive (more external) for these executives. An external locus of control implies belief in Fate/Karma and a clear lack of mastery over the environment. The CEOs were heavily dependent on fate or luck and hence these firms were nicknamed 'Belief In Karma'.

## The Questionnaire

The questionnaire employed was used previously by Kim (1980). Locus of Control was measured by using Rotter's (1966) Internal-External Scale. The questionnaire



method was employed to generate information on 42 variables which represented the responses.

The innovation variable is a composite of three items dealing with product/service innovation. Each requires the CEOs to mark their firms position on a 1 - 7 spectrum. The first item places 'emphasis on true and tried products/services on the low end of the scale and 'emphasis on technological leadership' at the high end; the second is a measure of quantity with no new product lines/services at one end and 'many' on the other; and, the third considers type of innovation with the spectrum spanning minor (incremental) to drastic (radical).

Correlation Analysis and Ward's Hierarchical Clustering Method (1963) were used to analyse the data.

## Results

The Pearson correlations of products/service innovation and locus of control with study variables are reported in table 1. In addition, tables 2 and 3 represent the groupings of innovative and non-innovative firms obtained by cluster analysis. The study revealed that the data mean is 3.27 and the median is 3.42 (scale 1-7).

The age of the firm was found to be negatively correlated (-0.19) with product differentiation. This is consistent with Schumpeter's (1939) assertion that differentiation lessens as industry and markets mature. This relationship is not very significant (18.88% level), but then, the data taken together subsume older products and markets to the older firms. These results are partly confirmed in the cluster analysis (table 2) where Group I among the innovative firms consists of significantly (10% level) younger firms and they demonstrate significantly (10% level) greater product differentiation than the average.

The locus of control scores measured by the Rotter (1966) questionnaire had a mean of 5.19 with a standard deviation of 2.59. This reflected the view that our respondents were clearly internals. It is also comparable with Shapero's (1975) average response of 6.58 from 135 entrepreneurs. There is almost no correlation between innovation and locus of control (table 1). It appears, then, that small firms are more likely to be run by internals and hence, locus of control does not serve as a cogent innovation discriminator within them. Simultaneously, the variables of controls, scanning and strategic planning have significant negative correlations, where the negative sign indicates a correlation with internal locus of control. This tends to conform to the view that internal executives, believing that they control the destiny of their firms, are likely to favour an environment in which that is possible.

Table 1: Pearson Correlations

	Product Service Innovation	Significance level (%)	Locus of Control	Significance level (%)
<b>ENTREPRENEURIAL</b>				
Proactive	0.78	0.01	0.01	92.62
Risk Takers	0.62	0.01	-0.19	19.33
Product/Service Innovation	1.00	0.000	0.02	87.51
<b>STRATEGIC</b>				
Planning	0.24	9.46	-0.11	46.51
Analysis	0.31	2.78	-0.25	8.60
Integration	0.37	0.79	0.11	46.04
Explicitness	0.21	14.99	0.02	87.77
<b>STRUCTURAL</b>				
Centralised	-0.27	6.11	0.20	16.46
Formalised	-0.04	80.19	0.15	32.53
Technocracy	0.22	13.26	-0.17	25.56
<b>FUNCTIONAL</b>				
Controls	0.27	5.88	-0.25	8.65
Communication	0.02	88.82	0.14	35.57
Integrated Decision Making	0.49	0.03	-0.20	18.31
Scanning	0.28	0.08	0.19	19.84
	0.46	0.08	0.19	19.84
<b>PRODUCT DIFFERENTIATION FIRM</b>				
Resources	0.13	38.56	0.05	72.01
Age	-0.30	3.74	-0.04	76.56
Percentage of R & D to CGS	0.23	12.33	-0.16	28.76
<b>ENVIRONMENT</b>				
Dynamism	0.47	0.06	-0.06	68.30
Heterogeneity	0.37	0.76	-0.02	87.79
Hostility	-0.22	12.80	-0.13	37.64
<b>RESPONDING EXECUTIVE</b>				
Age	0.15	31.15	-0.30	3.56
Years at Firm	-0.39	0.52	-0.29	4.37
Education	0.11	45.72	-0.01	96.97
Professional Meetings	0.18	22.41	0.18	22.41
Professional Journals	0.22	11.67	-0.06	69.35
Hours Worked (Office)	0.19	20.17	0.02	88.69
Hours Worked (Home)	0.13	38.52	0.10	48.24
<b>ROLE IN INNOVATION</b>				
Initiation	0.09	52.03	0.07	62.66
Technological Development	-0.37	0.82	-0.21	15.55
Marketing Research	-0.18	20.47	-0.005	97.36

In the cluster analysis, locus of control is not a significant factor for the innovative firms (table 2). Among the non-innovative firms (table 3), the locus of control is significant at 5% level for Striving Stoics and *Karma Dependent* firms. Locus of control for the Striving Stoic managers is considerably more internal ( $t = -3.46$ ) than our overall sample. While this might appear paradoxical for non-innovative group, it also turns out that these managers have been with their firms much longer than average time ( $t = 2.57$ ), which might explain the current diminished creativity. Managers of firms who are dependent on *Karma* lean towards an external locus of control ( $t = 3.34$ ) which is consistent with lower innovative tendencies.

Environmental dynamism revealed a correlation of 0.47 with product innovation at a highly significant 0.06%



**Table 2: Innovative Firms**

	Group I "The Young Turks"		Group II "The Blue Chips"	
	n	t-value	n	t-value
<b>ENTREPRENEURIAL</b>				
Proactive	30	3.96(4)*	18	3.26(2)
Risk Takers	30	1.96(1)	18	2.91(2)
Product/Service Innovation	30	8.70(7)	18	5.40(5)
<b>STRATEGIC</b>				
Planning	30	1.21	18	0.65
Analysis	30	1.08	18	2.31(2)
Integration	30	0.94	18	1.86(1)
Explicitness	30	-0.05	18	1.39
<b>STRUCTURAL</b>				
Centralised	30	-0.62	18	-0.71
Formalised	30	0.21	18	0.18
Technocracy	30	0.83	18	0.60
<b>FUNCTIONAL</b>				
Controls	30	-0.17	18	2.04(1)
Communication	30	0.22	18	0.56
Integrated Decision Making	30	-0.81	18	2.54(2)
Scanning	30	-0.88	18	5.04(5)
<b>PRODUCT DIFFERENTIATION FIRM</b>				
Resources	30	2.00(1)	18	0.19
Age	30	1.01	18	-1.21
Age	30	-2.04(1)	18	0.21
% R and D to CGS	28	2.57(2)	14	-3.39(2)
<b>ENVIRONMENT</b>				
Dynamism	30	1.61	18	2.90(2)
Heterogeneity	30	0.49	18	2.50(2)
Hostility	30	0.05	18	-2.00(1)
<b>RESPONDING EXECUTIVE</b>				
Locus of control	28	-1.05	16	0.95
Age	30	-1.36	18	-0.18
Year at Firm	30	1.26	18	-5.39(5)
Education	30	-0.43	18	2.71(2)
Professional Meetings	30	-1.62	18	3.56(3)
Professional Journals	30	-0.35	18	3.67(3)
Hours worked (Office)	28	-0.57	18	4.79(4)
Hours worked (Home)	30	-0.07	18	1.53
Initiation	30	0.46	16	-2.07(1)
Technological Development	30	-0.50	16	-2.53(2)
Marketing Research	30	-0.34	16	0.98

\* The numbers in parenthesis represent as follows :-  
 (1) 0.05 < p ≤ 0.10;                      (2) 0.01 < p ≤ 0.05;  
 (3) 0.005 < p ≤ 0.01;                    (4) 0.001 < p ≤ 0.005;  
 (5) 0.0005 < p ≤ 0.001;               (6) 0.0001 < p ≤ 0.0005;  
 (7) p ≤ 0.0001

level (table 1). It confirms our hypothesis that a firm facing a dynamic environment has to be innovative to survive. Moreover, the significant correlation of heterogeneity (0.37;  $\alpha = 0.76\%$ ) with innovation is also to be expected because the firm is forced to respond to the diversity. The correlation of environmental hostility with innovation is minus 0.22 at 12.80% level. While this figure is not high, the implication is a possible tendency for a small firm faced with environmental hostility to 'pull in its horns' to be safe. We had also hypothesised that scanning which indicates sensitivity to

the environment should be positively correlated with innovation. Table 1 confirms this within a 5% level of significance.

**'Blue Chips' firms are significantly sensitive to all the environment variables and show significant and extensive use of scanning**

The cluster analysis (table 2) revealed that the established innovative firms of the 'Blue Chips' group repeat the correlation findings. These firms are significantly sensitive to all the environment variables and show significant and extensive use of scanning ( $t = 5.04, \alpha = 0.05\%$ ). In contrast, the 'Young Turks' are less concerned with external environmental factors and display a sharper product focus. All the non-innovative groups (table 3) show an absence of positive significance in these variables. Further, the 'Striving Stoics' have a significant negative t-value for heterogeneity. For them, operating in a homogeneous environment reduces the need for innovation. The 'Karma Dependents' have a significant negative t-value for dynamism signifying a stable environment which is a likely contributing factor for their survival.

Among the variables measuring technical interaction with other professionals, the most significant correlation with other innovations (table 1) is for the 'number of professional journals read regularly ( $t = 0.22, \alpha = 11.67\%$ ). Of the innovative firms, the 'Blue Chips' (table 2) show significantly greater than average values for both professional meetings and journals. But the 'Young Turks' at this juncture focus their attention on internal development as evidenced by significantly higher than average research expenditure.

The noninnovative firms indicated highly ambiguous results. The 'Silver Spoons' showed significantly less than average values for the journals variables which is expected, but the firms which are 'dependent on Karma' are the exact opposite. As the latter are noninnovative, it would be safe to conclude that any beneficial effects of such technical interactions are not realised because of external locus of control. Therefore, technical interaction cannot be considered a core factor with respect to innovation (table 3).

The correlation between innovation and research and development expenditure as a percentage of cost of goods sold (% R and D to CGS) was found to be 0.23 at the level



**Table 3: Non-Innovative Firms**

	Group I		Group II		Group III	
	The Silver Spoons		The Striving Stoics		Karma Dependent	
	n	t-Value	n	t-Value	n	t-Value
<b>ENTREPRENEURIAL</b>						
Proactive	26	-4.50(5)*	14	-0.74	12	-0.91
Risk Takers	26	-2.09(1)	14	-0.41	12	-1.07
Product/Service	26	-6.49(7)	14	-2.59(2)	12	-2.19(1)
<b>STRATEGIC</b>						
Planning	26	-4.86(6)	14	3.56(2)	12	1.24
Analysis	26	-4.52(5)	14	4.63(4)	12	-1.67
Integration	26	-2.18(2)	14	0.01	12	-0.03
Explicitness	26	-5.11(6)	14	1.94	12	0.54
<b>STRUCTURAL</b>						
Centralised	26	0.93	14	-0.50	12	2.58(2)
Formalised	26	-2.74(2)	14	0.37	12	1.20
Technocracy	26	-2.45(2)	14	0.98	12	-0.17
<b>FUNCTIONAL</b>						
Controls	26	-2.57(2)	14	4.85(4)	12	-0.32
Communication	26	-1.29	14	2.07(1)	12	1.11
Integrated Decision						
Making	26	-3.03(2)	14	2.27(1)	12	-1.77
Scanning	26	-1.78	14	-1.96(1)	12	-0.29
<b>FIRM</b>						
Resources	26	-0.68	14	-0.05	12	0.96
Age	26	3.63(4)	14	0.45	12	-0.08
% R & D to CGS	24	-2.45(2)	14	-3.95(3)	12	-0.14
<b>ENVIRONMENT</b>						
Dynamism	26	-0.81	14	-0.96	12	-2.11(1)
Heterogeneity	26	0.60	14	-2.42(1)	12	-1.93
Hostility	26	0.76	14	-0.21	12	0.05
<b>RESPONDING EXECUTIVE</b>						
Locus of Control	26	-0.21	14	-3.46(2)	12	3.34(2)
Age	26	1.10	14	1.16	12	-0.53
Years at Firm	26	5.38(6)	14	2.57(2)	12	-2.31(1)
Education	26	-1.27	14	0.45	12	1.36
Professional Meetings	26	-1.27	14	0.45	12	1.36
Professional Journals	26	-4.23(4)	14	**	12	5.85(4)
Hours worked (Office)	26	-2.52(2)	14	0.00	12	1.11
Hours worked (Home)	26	-1.13	14	-0.79	12	1.52
Role in Innovation	26	0.88	14	3.12(2)	12	-1.60
Initiation	26	1.21	14	0.85	12	-1.30
Technological Development	26	2.43(2)	14	2.18(1)	12	-1.23
Marketing Research	26	-0.96	14	0.63	12	-1.90

\* The numbers in parentheses represent as follows :-

- |                         |                          |
|-------------------------|--------------------------|
| (1) 0.05 < p ≤ 0.10;    | (2) 0.01 < p ≤ 0.05;     |
| (3) 0.005 < p ≤ 0.01;   | (4) 0.001 < p ≤ 0.005;   |
| (5) 0.0005 < p ≤ 0.001; | (6) 0.0001 < p ≤ 0.0005; |
| (7) p ≤ 0.0001          |                          |

\*\* Zero variance.

of 12.33%. The weak significance of the relationship is consistent with the ambiguous results in the cluster analysis, where among the innovative firms, the 'Young Turks' have significantly greater than average R and D percentage and the 'Blue Chips' are the reverse. For the noninnovative firms, the 'Silver Spoons' and the 'Striving Stoics' maintain a significantly less than average R and D percent-

age, while the variable is not significant in the firms which are 'Karma Dependent'.

There is a strong relationship between innovation and proactiveness (table 1) with a correlation of 0.78 at the 0.01% level. Highly significant, greater than average proactiveness in both innovative groups (table 2) provides confirming evidence. In contrast, all noninnovative groups (table 3) are less proactive than average, with a high significance level in the case of 'Silver Spoons'. Our hypothesis also holds for risk taking where the relationship with innovation is similar to that of proactiveness though attenuated.

The abundance of resources available to a firm is not found to correspond with successful innovation: the variable has a correlation of 0.13 ( $\alpha = 38.56\%$ ) in table 1 and also not significant in the separate groups identified by cluster analysis (tables 2 and 3). At the same time, the abundance of resources available does have some effect on proactiveness. The correlation between the two variables is 0.38 and is highly significant ( $\alpha = 0.67\%$ ). The finding is logically consistent in that, a resource rich firm is more likely to attempt market leadership.

### Conclusions

1. There was a weak confirmation that differentiation lessens as industry and markets mature. Locus of control scores signified that the respondents were clearly internals.
2. Scanning was positively correlated with innovation and so were challenges to the firm in the form of environmental dynamism or heterogeneity.
3. Environmental hostility had a negative effect inducing the firm to "pull in its horns".
4. Abundance of resources encouraged proactive market leadership.



5. Finally, although prior research (Seetharaman, 1988) has shown that centralisation in small firm management structure correlates with entrepreneurship, yet our findings could not extend the relationship to innovation. The strong leader in a centralised small firm is entrepreneurial but the resulting environment can be less supportive of innovation.

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### References

Hage, J., & M. Aiken, *Social change in Complex Organizations*, Random House, New York, U.S.A., 1970.

Hage, J., & R.Dewar, (1973) "Elite Values Versus Organizational Structures in Predicting Innovations", *Administrative Science Quarterly*, Vol. 18.

Kim, L., (1980) "Organizational Innovation and Structure", *Journal of Business Research* 8.

Mc Clelland, D.C., "The Achieving Society" van Nostrand, Princeton, New Jersey, U.S.A., 1961.

Miller, D., and J.M.Toulouse, (1986) "Chief Executive Personality and Corporate Strategy and Structure in Small Firms" *Management Science* Vol. 32.

Normann, R., (1971) "Organizational Innovativeness: Product Variation and Reorientation," *Administrative Science Quarterly*, Vol. 16.

Rotter, J.B., (1966) "Generalized Expectations for Internal Versus External Control of Reinforcement" *Psychological Monographs: General and Applied* Vol. 80 (1).

Schumpeter, J.A., "Business Cycles" Mc Graw Hill, New York, U.S.A., 1939.

Seetharaman, Sridhar (1988) "Entrepreneurial Correlated in Three Types of Firms in Kerala" *Productivity*, Vol.29 (2), July-September.

Shapiro, A., (1975) "The Displaced, Uncomfortable Entrepreneur", *Psychology Today*, 9, 6.

Ward, J.H., (1963) "Hierarchical Grouping to Optimize an Objective Function" *Journal of the American Statistical Association*, Vol. 58.



## The Balance of Power?

Employees hold the balance of power in today's organizations. Since the "front line" far outnumbers management, employees hold sway. They decide whether the hundreds of tiny "moments of truth" with customers will be positive or negative, pluses or minuses for the company. Employees decide whether to let a defective product slip through. Employees choose whether or not to take the initiative to deal with small problems—or do nothing and let them become bigger problems. Employees usually make the difference. Management provides the tools and material, but employees are the ones who use them. The people who get development opportunities beyond technical areas are usually "rising stars" in the management staff. Seldom is the secretary, the shipper, the machine operator, or the assistant given leadership development. That approach could be tragic. As Tom Peters asserts: "Highly trained and thus more flexible workers . . . are a must for constant adaptation to customer needs and constant innovations."



# Identification of Characteristics & Measuring Entrepreneurship Potentiality

S. Chatterji, Manjula Mukerji & Anjali Ghosh

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*The study identifies the characteristics of Entrepreneurs in the Indian context. Achievement motivation (n.Ach) along with risk taking, independence, initiative, etc. are the important characteristics of an entrepreneur. But, this paper observes that in the Indian condition family background, social contact, financial support, etc. are equally important. A paucity of proper standardised tools for identifying potential entrepreneurs underlines the importance of a properly designed training programme.*

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During the past several decades the concept of entrepreneurship has assumed considerable importance to research workers of developing countries, because of its dominant role in economic growth and its contribution in multiplying employment opportunities. Identification and measurement of personal characteristics of successful entrepreneurs yield valuable information to the government as well as to the lending organizations like banks and financial institutions. In the developing countries attempts are being made to inculcate the spirit of entrepreneurship among young men and women who are likely to turn into manufacturers. Colleges of business administration can make significant contribution in entrepreneurial education if the nature of entrepreneurship is known to them.

Arthen H. Cole as early as in 1942, brought into focus the need for definite research into the general question of entrepreneur. He, in 1948, established the Research Centre of Entrepreneurial History at Harvard which was unfortunately discontinued in 1958. At present, Harvard as well as Michigan State University are the centres of research related to the nature of an entrepreneur. At Michigan State University, W. Floyed Warner and Collins carried out their studies on entrepreneurship when at Harvard, David C McClelland was the leader of the main research programme in this area. His book 'The Achieving Society' (1961) had been highly recommended throughout the world.

Until 1950, the characteristics of a successful entrepreneur as presented by researchers were as follows : (a) stamina, (b) ambition, (c) willingness to make sacrifices, (d) risk taking attitude. But, McClelland & Winter (1969) found out that achievement motivation (n-Ach) should be considered the primary characteristic of an entrepreneur. They were so sure about the role of n-Ach that they had stated "We've spent twenty years studying just this (why one businessman succeeds and another fails), twenty years in the laboratory doing very careful research, and we've isolated the specific thing. We know the exact type of motivation that makes a better entrepreneur". He de



defined achievement motivation as a desire to do well, not so much for the sake of social recognition or prestige but to attain an inner feeling of personal accomplishment. Similarly, studies conducted in Michigan State University indicated that power motivation (i.e., motivation to gain power) and discomfort in a dependency situation were of major importance. Schrage (1965) however observed that accurate awareness of the environment was more important than either achievement need or power motivation.

**Objective methods of assessment could be successfully utilised to differentiate the successful entrepreneurs from the "men in general"**

Hornaday and Bunker (1970, 1971) carried on a systematic empirical study to identify the characteristics of successful entrepreneurs. The subjects of his study consisted of sixty successful entrepreneurs. A successful entrepreneur was defined as an individual who had started a business, building it where no previous business had been functioning, and continuing for a period of at least five years to the present profit-making structure. The group was made up of both manufacturing concerns and service business and included only organizations with 15 or more employees. Although many other indices might be used as criteria of success, continuity in business was considered as the all-pervasive quality.

The following tests or inventories were used upon the sixty chosen entrepreneurs :

- (A) The Standardised Interview Schedule;
- (B) Kuder Occupational Interest Survey (OIS);
- (C) The Gorden Survey of Interpersonal values (SIV);
- (D) Edward's Personal Preference Schedule (EPPS);
- (E) A five-point scale of personal self-estimates called The Self-evaluation Scale.

The results obtained may be summarised as follows :

- (a) The EPPS "*Autonomy Scale*" yielded no significant t-value when the average of successful entrepreneurs was compared with that of the "men in general" though interest in "independence" was a special characteristic of successful entrepreneurs.
- (b) SIV Independence Scale was found to be highly significant.

- (c) Compared to "men in general", entrepreneurs were significantly higher on scales reflecting "need for achievement", "independence", and "effectiveness of their leadership" and were low on scales reflecting emphasis on "need for support".
- (d) On the whole, the Kuder Occupational Interest Survey was not effective in selecting entrepreneurs.
- (e) Self-evaluation Scale was highly subjective. However, the entrepreneurs rated themselves significantly above average on "need for achievement", "self-reliance", "competitiveness", "initiative", "confidence", "versatility", "perseverance", "resilience", "innovation" and "physical health".

The study proved that objective methods of assessment could be successfully utilised to differentiate the successful entrepreneurs from the "men in general", and the authors felt that there was no need of utilising projective technique for this purpose which is often recommended, though it is usually expensive.

As mentioned earlier McClelland put maximum stress on n-achievement as the necessary characteristic of a successful entrepreneur. The most reasonable interpretation of his opinion seems to be that high n-Ach predisposes a young man to seek out an entrepreneurial position in which he can, normally attain more of achievement satisfactions he seeks than in other types of positions. Ordinarily business provides more scope for entrepreneurial behaviour.

### The Indian Context

In India, many Government agencies and Financial institutions are involved in promoting entrepreneurship. Most of these agencies are guided by the results of foreign research and have taken for granted that entrepreneurs should have high achievement motivation, moderate risk taking attitude, orientation to learn from feedback and to take personal responsibility. But, whether the results obtained or applied in developed countries may be taken as applicable in our country, have yet to be verified.

McClelland assumes universal applicability for his theory on the causal relationship between a socio-psychological variable which he calls the achievement motive and entrepreneurship. He feels that the single most important causative factor in the rise of entrepreneurship, which in turn leads to the economic development of a country, is the prevalence among people of this socio psychological drive.



This theory has been used to account for differential levels of economic growth, presumably due to entrepreneurial activities among various countries. Javillonar and Peters (1973) tried to find out the application of n-Ach theory to explain the paucity of entrepreneurial activities in contemporary developing countries. They feel that the proposition that high n-Ach is positively related to entrepreneurship is premised on an open social structure where there is relative freedom of occupational choice, and individual efforts may directly affect success or failure. An open social structure allows equal access to opportunity across society and distributes rewards and sanctions on the basis of role performance. The utility of n-Ach theory in understanding entrepreneurship becomes questionable where occupational choice among individuals is restricted, and where bases for success are other than one's efforts and performance.

In India, a person is assigned a role and acquires a status in society on the basis of his birth, or family status. Achievement motivations and values which are derived from an open social structure, thus seem to have a lesser relevance to role assumption in the developing countries like India, than in highly industrialised Western societies. It is likely that a society which allocates rewards on the basis of ascription rather than achievement is less likely to produce individuals with the psychological need to excel, than a society where rewards are distributed more on the basis of achievement.

Javillonar and Peters (1973) also noted the difference in the family structure prevailing in India as compared to Western countries. The nuclear family which is the predominant social unit in Western societies is conducive to and perhaps necessary for early development of the feeling of independence and self reliance in planing their careers, and living independently. In India, the extended family is the basic unit for individual identification and orientation. It is the unit which determines and around which revolve most of the individual's activities throughout his life. It may be true that an individual who depends upon the extended family for help is unlikely to possess initiative for self-advancement. On the other hand an individual coming from a business family may work hard for the benefit of the family with which he identifies himself. So, in a family oriented society like India it is probably more meaningful to view entrepreneurship as a family rather than as an individual phenomenon. To verify this concept empirically Javillonar & Peters adapted two approaches : (a) viewing Indian entrepreneurship as a function of n-achievement, and (b) treating it as an extended family phenomenon. The subjects included entrepreneurs com-

**In a family oriented society like India it is probably more meaningful to view entrepreneurship as a family rather than as an individual phenomenon.**

ing from two occupational backgrounds - 12 business and 15 non-business occupations.

Indian adaptation of the Thematic Apperception Test (TAT) and a Sentence Completion Test of achievement motivation were employed as a measure of n-achievement. TAT could not yield any results as the responses of the entrepreneurs to the pictures were meagre. Only the responses given to the sentence completion test could be utilised. Besides these, from the occupational histories of the entrepreneurs, evidences of entrepreneurial behaviours viz., (1) risk taking, (2) novel or energetic instrumental activity, and (3) individual responsibility were obtained.

The subjects were dichotomised on each of the variables. The results of the analysis show that :

- (a) Level of n-Achievement failed to discriminate between entrepreneurs with business and those with non-business backgrounds.
- (b) Level of n-achievement did not differentiate initiators of business from non-initiators.
- (c) Level of n-achievement was consistently found to be unrelated to either entrepreneurial role assumption or performance.

These findings suggest that n-achievement theory of McClelland may not be relevant to the understanding or explaining the nature of Indian entrepreneurship. The result of the study indicates that entrepreneurship among the Indian small-scale manufacturers studied may be more meaningfully viewed as a situational phenomenon tied to the type of ownership of the business enterprise than as an individual phenomenon i.e., related to an individual's need for achievement. It may be noted that the family structure prevailing in India helps a person to start his own business by providing :

- (1) the financial resources necessary in establishing a factory;
- (2) the technical training necessary to run a factory independently.

The importance of non-psychological variables such as opportunity structure, financial support, etc. play a more



important role than n-Achievement in achieving success in business. Hence, simply identifying the individuals with the entrepreneurial qualities will not be sufficient under Indian conditions. The family background, social contact, etc. are equally important, if not more, as the n-Achievement or other psychological variables like risk-taking abilities, initiative. These points are to be given proper attention while carrying on any research in India.

Akhouri and Bhattacharjee (1979) analysed the Indian situation and suggested the following characteristics to develop the profile of entrepreneurs. They divided the characteristics into three categories and under each of their suggested several sub-categories as follows :

(A) *Psychological*

- (a) High need for achievement; (b) High need for power; (c) Independence; (d) Propensity to take risk;

(B) *Economic*

- (a) Personal modernity; (b) Sense of efficacy; (c) Support; (d) Business experience; (e) Leadership;

(C) *Social*

- (a) Symbolic or actual rejection of father (b) Lack of social mobility drives.

They reported that most of the entrepreneurs were found to be orphans or half orphans i.e., with parents psychologically away or in forced separation which means symbolic or actual rejection of father. The findings of the study suggests that entrepreneurship has to be examined by three groups viz., Sociologist, Psychologist and Economists. Sociologists may analyse the characteristics of entrepreneurs in terms of caste, family, social status. Psychologists should attempt to isolate them from the general population on various personality traits such as need achievement and economists highlight the situational characteristics such as occupational background, access to capital & business and technological experiences. Hence, all the three dimensions are to be analysed while identifying a potential entrepreneur. An attempt to describe an entrepreneur on the basis of one of the three dimensions will definitely lead to a partial analysis of the situation.

Once the variables related to entrepreneurial activities are determined the question of selecting the potential entrepreneurs comes up. The Small Industry Extension Training Institute (SIET), Hyderabad developed an elaborate selection procedure as a part of the SIET Integrated Model for entrepreneurial development. The procedure for selection comprises written test and personal interview.

The following weightages to different items were decided by the officer trainees from different status at the time of formulating an Action Plan for entrepreneurial development in their respective states.

**Scoring Schedule**

Written test and background data	Model I	Model II
	Based on J.K; Assam; Marathwada data	Based on Karnataka data
1. Psychological		
a) Need for achievement	10	5
b) Risk taking	5	5
c) Personal efficacy	5	5
2. Family background	5	5
3. Social participation & leadership skill	5	5
4. Educational background	5	10
5. Past experience	20	20
6. Knowledge, skill & attitude towards business	25	25
7. Efforts made so far towards starting the enterprise	20	20
	100	100

**Personal Interview Items :**

1. Eagerness for self employment :	5
2. His state in the enterprise :	8
3. Logic & rationality :	8
4. Knowledge of proposed enterprise :	5
5. Immediate possibilities of starting the enterprise :	5
6. Present activities :	4
7. Reaction in case of failure :	10
8. Physique & general personality :	5
	50

As presented above there were two scoring schedules for two groups. It shows that there is no universal system of scoring and weights assigned to different variables vary with the group. However, same weights were used for variables to be assessed through interview. The procedure suggested may not be applicable in different situations and it proves that for standardisation of the selection procedure more research has to be carried on.

**Tools to Measure the Psychological Qualities**

Different researchers used different tools to assess the psychological variables needed for an entrepreneur. For measuring n-Achievement the most commonly used tool is Thematic Apperception Test. Here, some 5/6 pictures are presented to the subjects and they are requested to narrate a story based on each picture. By analysing the content of the picture, assessment of certain psychologi-



cal variable of the story writer is made of which n-Achievement is one. But, this analysis and assessment cannot be done by any layman mechanically. Only professionally trained persons are fit to interpret the responses and assess the psychological variables that come out of the responses given. The method is time consuming and expensive but is widely used because of its indirect approach which is supposed to be of help in eliminating faking.

The other tools which are also used along TAT are :

- (A) Kuder Occupational Interest Survey - If the respondent expresses his desire to take up business as their occupation or any other occupations that require independent effort for success, then that is taken an indication of entrepreneurship.
- (B) Edwards Personal Preference Schedule - Need for achievement, need for autonomy and need for aggression scales of EPPS are used for measuring Entrepreneurship. Entrepreneurs are supposed to be significantly higher than "men in general" in these areas.
- (C) Gorden Survey of Interpersonal Values - Significantly high scores on Independence and Leadership scales and low Benevolence scores are taken as indication of entrepreneurship.

Sharma (1978) has constructed a scale titled as "A comprehensive scale of Entrepreneurship" (CES). He, in the manual claims "For identifying the entrepreneurs during their educational career, there is no scientific tool by which they could be objectively screened. With a view to meet this need, this scale of entrepreneurship has been developed. It aims at identifying objectively the entrepreneurs from non-entrepreneurs who could prove themselves to be better self-employed personnel. No such scale has been prepared by any one at least in India and therefore the scale would be not only novel in its character but also extremely useful for industrialists, businessmen, enterprises and such government agencies as SISI etc."

It has six components as follows :

- (A) A scale of self-perception of Entrepreneurship - 45 traits
- (B) A scale of organizational ability and managerial skill - 4 sections with 45 traits.
- (C) A scale of personality maturity - 18 statements with 6 alternatives.
- (D) A scale of executive reaction pattern - 20 statements with 5 alternatives.
- (E) A scale of human relation - 25 statements with 5 alternatives.

(F) A scale of human Engineering - 21 questions.

Organisers of Entrepreneurship Development Programme Scheme of Government of India had recommended the introduction of these characteristics to identify potential entrepreneurs. Reliability of the scale was estimated by Test-Retest as well as Split-half method and these were found to be high. The validity study of the questionnaire was not based on a very sound procedure. Correlations between the assessment made at the end of the training programme and the scores on six scales were presented as estimates of validity coefficient. The values are quite high but in the absence of the size of the sample nothing can be said against or for the values thus obtained. The other set of correlations based on responses of the Executive Heads of the small scale industries on an opinion questionnaire is equally uninterpretable because it does neither explain the nature of the response nor gives the number of cases.

### Programme for Development of Entrepreneurs

Creation of n-Achievement directly through training programmes involves the theoretical question whether an adult personality can be transformed at all. The Psychologist would say no, but the answer would be positive from the socio psychological perspective. McClelland & Winter (1969) tried to justify the possibility of developing n-Achievement at the adult stage. With theoretical connection he initiated action programmes on an experimental basis to examine the effects of the action programmes on the n-achievement level and performance of entrepreneur.

One of his important programmes was launched for motivating the entrepreneurs in Kakinada and Vellore in South India. He observed that n-Achievement scores of the trainees were much higher just after their training as compared to the scores before training. But, after one or two year a great fall in n-Achievement scores was observed for the same group of trainees, and their scores were not significantly higher than those of non-trainees. It means, the impact of training programme was not permanent. He commented that the motivational training was not sufficiently strong to cause the participants to break loose from their position in the social structure and find opportunities. The failure of the training programme in generating motivation may be substantiated with another fact that none of the trainees of the Small Industries Service Institute who hailed from non-business or non-industrial families, could be motivated to assume the role of entrepreneur. Only those trainees who already had a business background could ultimately take to manufacturing.

There are multiple determinants of entrepreneurial



growth. But, of these, three are most important :

1. Ethico-social background of entrepreneurs;
2. Need for achievement;
3. Politico-industrial milieu.

On the basis of their relationship with entrepreneurship, many entrepreneurship promotion programmes have been devised. These three sets of factors are interdependent. For instance achievement and the politico-industrial milieu as well. The effect of these factors on entrepreneurship is to be determined. It is presumed that all of them are important but the degree of their effectiveness varied at different stages of entrepreneurial growth.

Sharma and Singh (1980) conducted a detailed study about Entrepreneurial Growth and Development Programmes in Northern India. They divided the entrepreneurial growth into four stages as follows :

- (A) Entry into manufacturing;
- (B) Expansion of business;
- (C) Perception of business stability;
- (D) Commitment to expand the unit after perception of stability.

The effects of different political, social and psychological factors on these stages were empirically studied. It was observed that in India, family and caste background of the people were more effective than any other factor such as need for achievement motivation and assistance.

Deivasenapathy (1988) tried to identify the important characteristics and skills associated with each stage of entrepreneurial growth. He divided the enterprise building process into different stages and tried to find out the important characteristics required for each of these stages.

He asked 20 trainers of Entrepreneurship Development Programme to rate the characteristics required for the following stages of entrepreneurial growth :

(A) Realisation of opportunity; (B) Resource awareness; (C) Creation of venture; (D) Survival; (E) Growth and expansion.

The following characteristics are obtained with their order of importance for these 5 stages :

- (A) Risk taking (I), Initiative (II), Need for achievement (III), Scanning of environment (IV), Decision making (V).
- (B) Problem solving (I), Planning (II), Information seeking (III), Achievement motivation (III), Perseverance (IV).
- (C) Problem solving (I), Decision making (I), Coping ability (II), Co-ordinating ability (II), Interpersonal skills (III).
- (D) Problem solving (I), Coping ability (II), To work under stress (II), Decision making (III), Managerial

skills (IV).

- (E) Scanning of environment (I), Need for power (II), Creativity (II), Risk-taking (III), Need for achievement (III).

It shows that at different stages of entrepreneurial growth different factors become important and their relative importance also vary. Taking these points into account the entrepreneurial development programmes are to be framed. Whether such a development programme is able to generate positive attitude among the participants has to be assessed through proper follow up studies. Past studies conducted in India indicate much effective outcome of such entrepreneurial development programmes. It may be necessary to modify the programmes so that result turns to be more encouraging.

## Conclusion

Everyone is not an entrepreneur and at the same time it is not possible to turn everyone into an entrepreneur through training. Hence, identification of potential entrepreneur and their proper development through training programmes are important issues specially in a country like ours where in each year the number of unemployed young men and women is expanding very rapidly. Action research is to be carried on to develop proper machinery to achieve this goal.

## References

- Akhouri, M.M.P. & Bhattacharya, S.K. - Policy Implications of Identification and Selection Strategy. In T.V. Rao & T.K. Moulik (Eds.) "Identification & Selection of Small Scale Entrepreneurs", Indian Institute of Management, Ahmedabad, 1979.
- Deivasenapathy, P. - "Characteristics of Entrepreneurs as perceived by Trainers". Indian Journal of Applied Psychology, 1988, Vol. 25(2).
- Hornaday, J.A. & Bunker, C.S. - "The Nature of Entrepreneur." Personnel Psychology, 1970, 23.
- Hornaday, J.A. & Aboud, J. - "Characteristics of Successful Entrepreneurs." Personnel Psychology, 1971, 24.
- Javillonar, G.V. & Peters, G.R. - "Sociological and Social Psychological Aspects of Indian Entrepreneurship". British Journal of Sociology, 1973, 24, 3.
- McClelland, D.C. - The Achieving Society, 1961, Princeton, N.J.: D. Van Nostrand and Co.
- McClelland, D.C. - "N. Achievement & Entrepreneurship - A Longitudinal Study." Journal of Personality and Social Psychology, 1965, 1, 4.
- McClelland, D.C. & Winter, D.C. - "Motivating Economic Achievement." 1969, New York : The Free Press.
- Schrage, Harry - "The R and D Entrepreneur : Profile of Success". Harvard Business Review, 43, (November-December, 1965), 56.
- Sharma, V.P. - "Manual for a Comprehensive Scale of Entrepreneurship". 1978, National Psychological Corporation, Agra.
- Sharma, K.L. & Singil, H. - "Entrepreneurial Growth and Development Programmes in Northern India," 1980, Abhinav Publications, New Delhi.
- Singh, N.P. - "n/Ach among agricultural and Business Entrepreneurs of Delhi." The Journal of Social Psychology, 1970, 81.



# Two Heuristic Techniques for Locating Service Facilities

Shams-ur Rahman

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*A service system is generally considered to be more efficient, if the service is more accessible to its users. Location-allocation models can play an important role in making the services more accessible. This paper compares the efficiency of two heuristic techniques for selecting specified number of facility locations when the location problem is considered as a maximal covering location problem. As these heuristics were designed for  $p$ -median problem, the distance matrix is modified to solve the maximal covering location problem. The results indicate that both the heuristics perform equally good where the performance is measured in terms of accuracy of solutions.*

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A location-allocation model is a method for finding optimal sites for facility locations. The method involves simultaneously selecting a set of locations for facilities and assigning spatially distributed set of demands to these facilities to optimise some specified measurable criteria. Location theory was first formally introduced by Weber (1909 who considered the problem of locating a single warehouse to minimise the total travel distance between the warehouse and a set of spatially distributed customers. Since then researchers have developed models for a wide variety of location problems. Examples include, models for locating warehouse/production centres (Maranzana, 1964; Efraymson and Ray, 1966; Eilon et al., 1971), emergency service facilities (Toregas et al., 1971; Plane & Hendrick, 1977; Eaton et al., 1985), obnoxious facilities (Church & Garfinkel, 1978), bank accounts (Cornuejols et al., 1977; Hopmans, 1986); health centres (Dokmeci, 1977; Patel, 1979). These problems can be broadly classified into private sector and public sector location problems (ReVelle, et al., 1970). In the broad sense, both type of problems are similar in that they share the objective of maximising some measure of utility to the owners. In the narrow sense, however, they differ in the way that the objectives and constraints are formulated. For instance, private sector facilities are often located to fulfill precisely stated objectives, such as to minimise cost or maximise profit. In contrast, the goals of the public facility location are more difficult to identify. Thus, different interpretations of the goal of maximum public welfare lead to a number of possible problem statements in the sphere of public facility location. For instance, if the problem is to locate emergency ambulance services, a possible criterion would be to minimise the average distance or time an ambulance must travel in order to reach a random incident or the patient must travel to reach the closest emergency medical service station. Another appropriate criterion could be to minimise the maximum distance that the ambulance must travel to reach an incident.



Public facilities can again be classified into three types (Hodgart, 1978) :

1. *Central facilities* to which people must travel to receive the service. It is regarded that closer the facilities to the communities, better the access. Therefore, they are also called desirable facilities. Examples include : health centres, parks, schools.
2. *Semi-desirable facilities*. Local football stadium is an example of a semi-desirable facility. Local residents may prefer the stadium to be located further away; and local teenagers and football fans may regard as a valuable amenity.
3. *Obnoxious facilities*. Plan to construct the facilities, such as the nuclear power plants, are generally opposed by local groups because of potential danger.

This paper is concerned with location models and solution procedures for locating the central facilities.

### Location Models and Their Relationships

One of the popular approaches to public facility location planning given discrete demands from  $n$  points is to locate a given number of facilities ( $p < n$ ) with the objective that the total travel distance (or time) between facilities and demand points is minimised. The problem is known as the *p*-median problem (PMP). On a network it seems to have been first studied in depth by Hakimi (1964). He showed that for any value of  $p$  there is at least one optimal  $p$ -median solution set which consists entirely of nodes of the network.

ReVelle and Swain (1970) formulated the PMP as an integer linear programming problem with facilities restricted to nodes of the network which can be stated as follows :

P1: minimise

$$\sum_{i=1}^n \sum_{j=1}^n a_i d_{ij} x_{ij}$$

subject to:

$$\sum_{j=1}^n x_{ij} = 1, \quad i = 1, 2, \dots, n. \quad (1)$$

$$\sum_{i=1}^n x_{ij} = p \quad (2)$$

$$x_{ij} \leq x_{jj} \quad \forall i, j; \text{ where } i \neq j \quad (3)$$

$$x_{ij} \in \{0, 1\} \quad (4)$$

where

$$x_{ij} = \begin{cases} 1, & \text{if demand } i \text{ assigned to a facility } j; \\ 0 & \text{otherwise.} \end{cases}$$

$n$  = number of demand points;

$a_i$  = population of demand  $i$

$d_{ij}$  = shortest distance from demand  $i$  to facility  $j$

$p$  = number of facilities to be located.

The constraint (1) ensures that the demand from demand point  $i$  is met in full. The constraint (2) ensures that exactly  $p$  facilities are located and constraint (3) ensures that no demand is met from  $j$  if no facility exists there.

The PMP is attractive, since the smaller the total weighted or average travel distance (time), the more convenient for one to get to the nearest facility. It is assumed that all users of the facility choose to travel to the closest one. However, the PMP does not take the 'worst case' situations into account and so it may result in solutions which are not acceptable from a service point of view. This means that usage of service facilities may decline rapidly when the travel time exceeds some critical value. The concept of a critical distance (beyond which the usage of service facilities may decline rapidly) between a facility and a demand point could be much stronger than that of average distance which according to Toregas and ReVelle (1972; 133) 'has no real everyday meaning to an individual or community'. This is a typical situation with the use of rural health facilities in developing countries (Rahman et al., 1982; Stock, 1983). Therefore, it is quite reasonable to consider maximum service distance or time constraints in formulating a location problem. This leads to the formulation of the *Location Set Covering Problem* (LSCP).

In the PMP the total weighted travel distance (time) is minimised subject to a financing constraint expressed in terms of number of facilities. Conversely, consideration may be given to a problem in which financing costs (in terms of number of facility) are to be minimised given a maximal service distance constraint. This problem is called *Location Set Covering Problem* (LSCP). A statement of the problem is : find the minimum number of facilities ( $p$ ) and their location such that each demand point ( $n$ ) has a facility within a given maximal service distance ( $S$ ).

The LSCP identifies the minimum number of facilities such that each and every demand point is covered by at least one facility. In many cases the resources required (in terms of number of facilities) for complete coverage (for a desired maximum travel distance) are greater than what is available. Hence, it is perhaps reasonable to relax the requirement of complete coverage and focus attention on just what can be covered by a fixed number of facilities in



the most efficient way. Church & ReVelle (1974) proposed a model to address the problem of determining the largest possible coverage within a given maximal service distance (time) using a fixed number of facilities. This problem is known as the *Maximal Covering location Problem* (MCLP). Church and ReVelle formulated the problem in the following way :

P2: minimise

$$\sum_{i=1}^n a_i y_i$$

subject to :

$$\sum_{j \in N_i} x_j + y_i \geq 1, \quad i = 1, 2, \dots, n. \quad (5)$$

$$\sum_{j=1}^n x_j = p \quad (6)$$

$$x_j \in \{0, 1\} \quad j = 1, 2, \dots, n. \quad (7)$$

$$y_i \in \{0, 1\} \quad j = 1, 2, \dots, n. \quad (8)$$

where

$$x_j = \begin{cases} 1, & \text{if a facility is located at } j; \\ 0, & \text{otherwise.} \end{cases}$$

$$y_j = \begin{cases} 1, & \text{if demand } i \text{ is not covered by a facility;} \\ 0, & \text{otherwise.} \end{cases}$$

$N_i = \{j | d_{ij} \leq S\}$  — set of facility eligible to provide cover to demand  $i$ ;

$d_{ij}$  = shortest distance between demand  $i$  and facility  $j$ ;

$S$  = maximum service distance;

$a_i$  = population at demand point  $i$ ;

$p$  = number of facilities to be located;

$n$  = number of demand points.

The objective function of problem P2 is stated in terms of minimising the number of population that is not covered. Church and ReVelle showed that this objective is equivalent to maximising the number of population that is covered. The constraint (5) is used to determine whether a demand point is covered or not. The constraint (6) is required to ensure that the number of facilities are equal to  $p$ . Constraint (7) and constraint (8) state the integer requirements.

The MCLP can be used to determine not just what can be covered by a given number of facilities but also to determine the marginal coverage associated with an additional facility. Church & ReVelle (1974) have demonstrated that an analysis of marginal coverage values may

lead a decision maker to consider locating fewer facilities than originally planned because of the decreasing marginal coverage as the number of facilities increases.

In many respects the PMP and the MCLP are similar. Both the problems locate a specified number of facilities, and both admit the importance of population and distance in the solution of location problems. Church & ReVelle (1976) have shown that the MCLP can be formulated as a PMP, with simple transformation of the distance matrix ( $d_{ij}$ ) in the following manner :

$$d'_{ij} = \begin{cases} 1, & \text{if } d_{ij} > S_i; \\ 1, & \text{if } d_{ij} \leq S_i; \end{cases}$$

where

$d_{ij}$  = shortest distance from demand  $i$  to facility  $j$ ;

$d'_{ij}$  = modified distance from demand  $i$  to facility  $j$ ;

$S_i$  = maximum service distance.

When a PMP is structured with the modified distance ( $d'_{ij}$ ), the objective of the problem modifies to minimising the number of population not served within the maximum service distance. Thus the modified distances of the PMP is fully equivalent to an associated MCLP. This means the methods that can solve the PMP can also be employed to solve the MCLP. Hence, a study using several different definitions of accessibility would essentially require only one computer code to find the optimal facility locations. In this paper we compared the performance of two heuristic methods for the MCLP which were originally designed for the PMP.

### Heuristic Solution Techniques

Since the introduction of PMP, several exact solution procedures have been proposed to solve it. Example include. ReVelle & Swain (1970), Garfinkel et al.(1974), Cornuejols et al.(1977), Narula et al. (1977) and Galvao (1980). However, these procedures generally require a great deal of computer time even to solve a small problem and very often fail to find the optimum for realistic large problems. As a result, a number of heuristics have been suggested for this problem: Maranzana (1964), Teitz & Bart(1968), Khumawala (1972), and Eilon & Galvao (1978).

Recently, Ardalan (1988) proposed an efficient heuristic for the PMP which is simple, easy to understand and apply. He compared the accuracy and efficiency of this heuristic with another simple heuristic suggested by Khumawala (1972). The results showed that the Ardalan method performed better than the other and the solutions



are at most 9% larger than the optimal. However, another widely used heuristic for the PMP is that proposed by Teitz & Bart (1968) which is relatively simple and computationally straightforward. This heuristic has been used to compare the efficiency and accuracy of other exact procedures and heuristics (Narula, et al., 1977; Rosing et al., 1979; Rahman & Smith, 1991) and has been applied widely to real world problems (Banerji & Fisher, 1974; Fisher & Rushton, 1979). Here an attempt has been made to compare the accuracy of the Ardalan heuristic with that of Teitz and Bart for the MCLP.

Both the heuristics consider that the population at the communities and the distance between facilities and communities are given. Then, the objective is to locate a number of facilities to serve all communities at minimum total travel cost.

### The Ardalan Method

1. Calculate the total travel cost to each community from all communities.
2. Identify the community with the lowest total travel cost and locate a facility in that community.
3. If the desired number of facilities has been located and the communities are assigned to these facilities, stop. Otherwise, continue.
4. For each community, compare the current lowest travel cost with the travel cost to all other communities that have not been selected as facilities yet. If the travel cost is less than the current lowest travel cost, do not change the travel cost; otherwise, set the travel cost equal to the current lowest travel cost.
5. Calculate the total travel cost to each community, not been selected as facility, from all other communities. Go to 2.

### The Teitz & Bart Method

1. Locate (randomly) a desired number of facilities amongst the communities and calculate the total travel cost from all communities to the facilities.
2. Choose (arbitrarily) a community which is currently not a facility and substitute it for each of the facilities.
3. Calculate the total travel costs from communities to the facilities at each substitution.

4. Remove that facility from the facility set which, upon replacement by the chosen non-facility community produces the largest decrease in the total travel cost.
5. Choose a next non-facility community for successive substitution and calculate the total travel costs in each case. If, upon replacement of a facility by a chosen non-facility community, does not yield a decrease in the total travel cost stop. Otherwise go to 4.

It is important to note the following observations about the Ardalan and the Teitz and Bart heuristic :

- (1) In the Ardalan method, once a community is chosen as a facility, it remains in the solution set until the procedure terminates. There is no built-in mechanism to replace one existing facility by a potential facility which by being in the solution set might produce better objective value. It is essentially a constructive type of heuristic. On the other hand, the Teitz & Bart heuristic tries to find a better solution by successive substitution of a facility by a non-facility community. The Teitz and Bart method is an improvement type of heuristic.
- (2) The Ardalan heuristic does not guarantee optimality at termination. It has been argued that 'successive node substitution' of the Teitz and Bart method is completely analogous to the 'vector substitution' of the simplex method and therefore should produce an optimal solution (ReVelle et al., 1970). However, analysis showed that it does not produce optimal results in all cases (Rosing et al., 1979).

### Data Sets and Computational Results

Two sets of data were considered for analysis by us. The first set consists of data on 35 localities for Devon, England. The 1981 census data on population of these communities was used. The second set consists of data for 48 towns for England, Wales and Scotland. The population data for these communities has been taken from *Automobile Association Handbook* 1986/87. These sets of data were utilized by other authors (Rahman & Smith, 1991), however, for the PMP and PMP with maximum distance constraints.

The Ardalan and the Teitz & Bart heuristics were coded in Pascal and run on a Sun 3/260 system. In all 30 problems were solved using these heuristics, 15 problems for each data set. In the case of the Teitz & Bart heuristic, the initial solutions of the problems were generated



randomly. The algorithm was run 10 times for each value of  $p$ . In solving the MCLP using both data sets, six values of  $S$  were used. The different values of  $S$  were arbitrarily chosen. The analysis was done taking one data set at a time. Out of 300 runs only in 23 cases Teitz & Bart's worst solution different from the best solution.

The results of the analysis are presented in Tables 1 and 2. Using data on 35 communities, 15 problems were solved. In two cases ( $p=3, S=15$  and  $p=5, S=15$ ) the Teitz & Bart heuristic performed better. In these cases Ardalan's solutions were found to be larger than Teitz & Bart by 4.1% and 43.8% respectively. In one case ( $p=7, S=10$ ) the Ardalan method performed better, where the Teitz & Bart's

Table 1: Results of Problems for Data on 35 Communities

Demand (n)	Facility (p)	Maximum service distance (s)	Ardalan solution (AR)	Teitz & Bart solution (TB)	% excess of solution (AR over TB)
35	2	5	331	331	-
		10	274	274	-
		15	169	169	-
	3	5	235	235	-
		10	142	142	-
		15	89	78	14.1
	5	5	178	178	-
		10	72	72	-
		15	23	16	43.8
	7	5	137	137	-
		10	40	44	-10.0
		15	6	6	-
10	5	90	90	-	
	10	18	18	-	
	15	0	0	-	

Table 2: Results of Problems for Data on 48 Communities

Demand (n)	Facility (p)	Maximum service distance (s)	Ardalan solution (AR)	Teitz & Bart solution (TB)	% excess of solution (AR over TB)
48	2	15	7314	7314	-
		25	7314	7314	-
		35	7135	7135	-
	3	15	6552	6552	-
		25	6552	6552	-
		35	6109	6109	-
	5	15	5565	5565	-
		25	5493	5493	-
		35	4423	4423	-
	7	15	4667	4667	-
		25	4567	4567	-
		35	3475	3475	-
	10	15	3571	3571	-
		25	3471	3471	-
		35	2570	2570	-

solution was found to be 10% larger than the Ardalan. In rest of the cases both methods found identical solutions. Similarly, using data on 48 localities, 15 problems were solved. The results indicate that both the techniques produce identical solutions in all the cases.

## Conclusion

In a recent study Rahman & Smith (1991) have shown that the Teitz & Bart heuristic is a superior solution technique than the Ardalan for the PMP and the PMP with maximum distance constraints. This study shows that generally both Ardalan, and Teitz & Bart heuristic performs equally good for the MCLP. Based on two experiments, it can be seen that only in 6.7% (2 out of 30) of the problems the Teitz & Bart method found better solutions, and in 3.3% (1 out of 30) of the problems the Ardalan found better solutions. In rest of the problems both found identical solutions. Therefore, based on these results one can recommend either of the heuristics for the solution of MCLP.

## References

- Ardalan, A (1988) 'A comparison of heuristic methods for service facility locations', *International Journal of Operations & Production Management*, 8,
- Automobile Association Handbook, 1986/87 Automobile Association, Basinstoke, UK.
- Banerji, S & Fisher, H B (1974) 'Hierarchical location analysis for integrated area planing in rural India', *Papers of the Regional Science Association*, 33,
- Church, R & Garfinkel, R S (1978) 'Locating an obnoxious facility on a network', *Transportation Science*, 12,
- Church, R & ReVelle, C (1974) 'The maximal covering location problem', *Papers, Regional Science Association*, 32,
- Church, R L & ReVelle, C S (1976) 'Theoretical and computational links between the p-median, location set covering and maximal covering location problems', *Geographical Analysis*, 8,
- Cornuejols G M, Fisher, M L & Nemhauser, G L (1977) 'Location of bank accounts to optimize float : an analysis study of exact and approximate algorithms', *Management Science*, 23, 789-810.
- Dokmeci, V F (1977) 'A quantitative model to plan regional health facility systems', *Management Science*, 24,
- Eaton, D J, Daskin, M S, Simmons, D, Bullock, B & Jansma, G (1985) 'Determining emergency medical service vehicle deployment in Austin, Texas', *Interfaces*, 15,
- Efroymsom M A & Ray, T L (1966) 'A branch-bound algorithm for plant location', *Operations Research*, 14,
- Eilon, S, Watson-Gandy, C D T & Christofides, N (1971) *Distribution Management: Mathematical Modelling and Practical Analyses*, Griffin Publishing, London.
- Eilon, S & Galvao, R D (1978) 'Single and double vertex substitution in



- heuristic procedures for the p-median problem', *Management Science*, 24,
- Fisher, H B & Rushton, G** (1979) 'Spatial efficiency of service locations and the regional development process', *Papers of the Regional Science Association*, 42,
- Galvao, R D** (1980) 'A dual-bounded algorithm for the p-median problem', *Operations Research*, 28,
- Garfinkel, R S, Neebe, A W & Rao, M R** (1974) 'An algorithm for the m-median plant location problem', *Transportation Science*, 8,
- Hakimi, S** (1964) 'Optimum location of switching centers and the absolute centers and medians of a graph', *Operations Research*, 12,
- Hodgart, R L** (1978) 'Optimizing access to public services: a review of problems, models and methods of locating central facilities', *Progress in Human Geography*, 2,
- Hopmans, A C M** (1986) 'A spatial interaction model for branch bank accounts', *European Journal of Operational Research*, 27,
- Khumawala, B M** (1972) 'An efficient algorithm for central facilities location', Paper No. 357, Krannet School of Industrial Administration, Perdue University, USA.
- Maranzana, F** (1964) 'On the location of supply points to minimise transport costs', *Operational Research Quarterly*, 15,
- Narula, S C, Ogbu, U I & Samuelsson, H M** (1977) 'An algorithm for the p-median problem', *Operations Research*, 25,
- Patel, N R** (1979) 'Locating rural service centers in India', *Management Science*, 25,
- Plane, D R & Hendrick, T E** (1977) 'Mathematical programming and the location of fire companies for the Denver Fire Department', *Operations Research*, 25,
- Rahman, M M, Aziz, K M S, Munshi, H M, Patwari, Y & Rahman, M** (1982) 'A diarrhoea clinic in rural Bangladesh: influence of Distance, age and sex on attendance and diarrhoeal mortality', *American Journal of Public Health*, 72,
- Rahman, S & Smith, D K** (1991) 'A comparison of two heuristic methods for the p-median problem with and without maximum distance constraints', *International Journal Operations & Production Management*, 11,
- ReVelle, C, Marks, D & Liebman, J C** (1970) 'An analysis of private and public sector location models', *Management Science*, 16,
- ReVelle, C & Swain, R** (1970) 'Central facilities location', *Geographical Analysis*, 2,
- Rosing, K E, Hillsman, E L & Vogelaar, H R** (1979) 'The robustness of two common heuristics for p-median problem', *Environment and Planning A*, 11,
- Stock, R** (1983) 'Distance and utilization of health facilities in rural Nigeria', *Social Science & Medicine*, 17,
- Teitz, M and Bart, P** (1968) 'Heuristic methods for estimating the vertex median of a weighted graph's', *Operations Research*, 16.,
- Toregas, C & ReVelle, C** (1972) 'Optimal location under time or distance constraints', *Papers, Regional Science Association*, 28,
- Toregas, C, Swain, R, ReVelle, C & Bergman, L** (1971) 'The location of emergency service facilities', *Operations Research*, 19,
- Weber, A** *Uberden Standort der Industrien*, 1909; translated as *Alfred Weber's Theory of the Location of Industries*, University of Chicago, 1929.

### How to Defuse Effects of Stress

- \* Stressed to kill. Work-based psychological stress is potentially fatal. But there are ways to protect yourself.
- \* Manage your time. Avoid unnecessary meetings and excessive paperwork, don't procrastinate, and delegate more
- \* Say "no" to time demands you feel you can't handle
- \* take more frequent, shorter holidays
- \* improve your diet. Cut down on coffee, alcohol and smoking. Eat regular meals
- \* Relax totally for at least 10 to 15 minutes each day. Try breathing exercises, yoga, meditation, massage, and/or relaxation tapes
- \* Exercise three or more times a week for atleast half an hour each time. Brisk walks provide good aerobic exercise
- \* Don't react to events beyond your control. For example, don't become angry in traffic jams
- \* Develop outside interests
- \* Understand yourself. Take advantage of your strengths and forgive your weaknesses
- \* Share your feelings with those close to you. A harmonious home life is a refuge from stress at work
- \* Seek counselling if you feel the need. Stress is not a sign of weakness or madness
- \* smile

—Works Management Feb. 1992



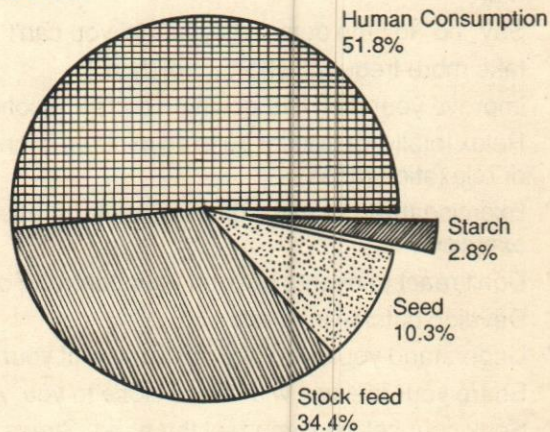
# Waste Potatoes – A Source for Starch

S.D. Kulkarni & K.C. Joshi

*The enormous amount of waste potatoes available, if used for starch production, would not only result in value added products, but also generate employment and save foreign exchange. This paper examines the possibility of producing starch from waste potatoes by taking into account the techno-economic aspects. The authors also identify areas where such units can be established.*

India has shown tremendous increase in potato production in the last two decades. This achievement is due to the development of high yielding, disease resistant varieties as well as the increase in the area under this crop. Although potato ranks the fourth major food in the world, the benefits of high production have not reflected on the per capita consumption in our country, because it confines mostly as a vegetable in our diet. The recent development in the area of potato processing for chips though is a welcome step, involves high cost imported machinery. The benefits from this industry therefore did not percolate to the growers.

Potato is a starch rich material. In India no steps have been initiated to produce starch from the potatoes. However, the pattern of world potato utilization indicates over 2.8 per cent potato is used for starch extraction (Fig 1). The small percentage may be due to non-use of potatoes for starch by many potato growing countries like India. In our country maize and tapioca are the chief sources of starch. In south India, particularly in Kerala and Tamil Nadu a number of small scale units are engaged in tapioca starch production. Similar kind of small scale units can be initiated in the major potato growing areas for potato starch production.



Alcohol : 0.7% (Source : Verma, 1983)

FIG. 1. WORLD POTATO UTILIZATION

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The annual production of potatoes in India is to the tune of 14 million tonnes (Anon 1990) (Fig 2). About 18-20 percent of the total produce goes as waste (Upadhyay, 1986) owing to their unsuitability for seed or table purpose. This portion usually consisting of over size, under size,

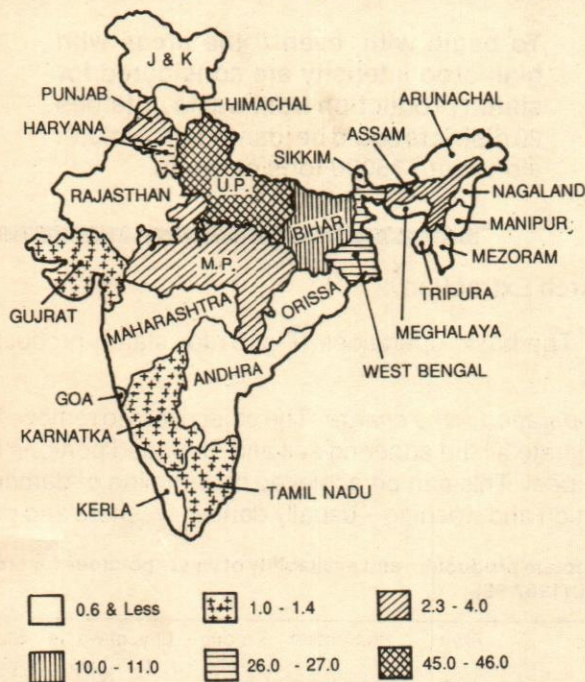


FIG. 2. PERCENT OF TOTAL PRODUCTION IN DIFFERENT POTATO GROWING REGIONS (TOTAL PRODUCTION 14.1 M.T.)

cull, cut and damaged potatoes, amounts to 2.1 million tonnes and can be easily utilized for starch production. This production can benefit the nation in saving foreign exchange, used for importing potato starch from European Common Market countries and Japan.

Potatoes contain about 16-20% starch and perhaps for this reason are regarded as an uneconomical starch source. On the other hand tapioca though similar to potatoes is used as a source for starch in our country. Both being tuber/root crops, the technology of tapioca & potato starch production is similar, but unlike potatoes the tapioca tubers owing to their poor shelf life can not be stored for a long duration. The tapioca is to be transported, as quickly

Potato may become the third chief source of starch production in the country

as possible, to the extraction plant. Making it necessary for these plants to be close to the site of tapioca cultivation. If not the chips are to be made after blanching. In case of maize starch the germ, which contains fats/oil has to be removed. Potato may become the third chief source of starch production in the country provided special efforts to breed high starch containing varieties are undertaken coupled with the best agronomical practices. Research of CPRI showed that the areas of Gangetic plains and Deccan parts are ideal for increasing starch content of existing potato varieties.

The areas of Gangetic plains and Deccan parts are ideal for increasing starch content of existing potato varieties

### Prediction of Starch Content

It is not advisable to conduct small scale extractions to determine the starch content for each lot. Verma, et al (1975) developed the following relationship between specific gravity of potato and starch content for 12 varieties grown at Jallander.

$$Y = -181.4600 + 181.7187(\text{specific gravity})$$

(g starch/100g fresh tuber) (r = + 0.875)

Specific gravity can be easily determined by a hydrometer and subsequently the starch content can be calculated. Since the above equation is location specific and may not be useful for those who do not have the facility for determination of specific gravity of potatoes, the data of Joshi (1971) was analysed for 15 varieties grown in Punjab (Jallander), Bihar (Patna) and Uttar Pradesh (Babugarh) and the following relationship between dry matter and starch content has been developed based on 35 observations.

$$Y = -9.149 + 1.197(\text{Dry matter})$$

(g starch/100 g fresh tuber) (g/100 g fresh tuber)  
(r = + 0.899)

This approach would be useful in estimating the starch yield from the lot before processing. Also, the relationships between specific gravity and dry matter content of potato are available for different locations (Verma et al, 1972).

### Starch from Waste Potatoes

It has been indicated (Potty, 1986) that cost of starch production from potatoes would be very high depending on the price of the raw material unless it is based on use of by-



product. He further stated that it is doubtful if the potato starch can compete with tapioca or maize starch owing to their lower cost. This can be true when sound potatoes, which have high price, are considered as raw material for starch. However, the situation would be different in case of utilization of waste potatoes, which are available at throw-away prices and some times free of cost. Joshi & Kulkarni (1991) reported that the waste potatoes (damaged, cut, green etc.) can be used as source of starch extraction, even if on a small basis. They reported the starch recovery of 51.2 per cent from such tubers as compared to 65-67 per cent from sound tubers. The potato growers of the main potato growing area like UP, West Bengal, Bihar, Punjab, and some parts of Deccan can start starch production from waste potatoes individually or on co-operative basis, with an advantage from potato growing seasons i.e.—Spring & Autumn. In the Himalayan hill region comprising HP and UP (Kumaon) two crops - the April - July and Sept, Oct - Jan, Feb can be taken. The starch from potatoes would not only make available the starch to the industry at a reasonable cost, but can also add substantially to the profits of the potato growers who are at present not getting anything from waste potatoes. The residue after starch extraction can be dried, pulverised and used in bakery products, porridge and as a thickener.

### Waste Potatoes Availability Potential

About 15-17% of the total produce goes as waste due to damage, cut, green, over under size tubers (Joshi & Kulkarni, 1991). The potato production has increased ten times (Fig. 5) and productivity has risen from 6.6 t/ha to 16.2 t/ha since 1949-50 (Verma, 1983). The availability of waste potatoes for 1987-88 has been estimated @ 15 per cent wastage to 2118, 800 tons which is more than total potato production for 1949-50 (Fig 5) with a potential of 133490 tons of starch extraction (table 1). Uttar Pradesh alone contributes to over 45% of India's potato production followed by West Bengal 26.81 percent and Bihar 10.85 percent totaling to over 83 percent (table 1). Thus, 83 percent of waste potatoes available in the country can be obtained primarily from these three states.

To begin with, even if the areas with high crop intensity are considered for starch production from waste potatoes 20 districts could be identified from U.P. alone with 15000 tons or more (100 times more the annual processing capacity of small unit) availability of waste potatoes in each district (table 2) covering over 33 percent of total waste potatoes available in country. Other states however contribute mar-

ginally with cut off point of 15000 tonnes of waste potatoes which is considered safe for initial take-up of the activity. Thus, the most convenient state appears to be Uttar Pradesh for starch extraction from waste potatoes.

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### Starch Extraction

The basic operations (Fig. 3) for starch production are :

*Preparation of the charge* : The objective is to remove and separate all the adhering soil and damaged portions and the peel. This can be achieved by trimming of damaged portion and washing—usually done in washers and peel-

**Table 1: Statewise potato production and availability of waste potatoes for starch production. (1987-88).**

S.No.	State	Area (1000 ha)	Production (1000 T)	Productivity (T/ha)	Qty. of waste potatoes (1000 T)	Starch potential (1000 T)
1	Uttar Pradesh	332.11	6419.37	19.33	962.91	60.66
2	West Bengal	179.93	3787.02	21.05	568.05	35.79
3	Bihar	143.89	1532.51	10.65	229.88	14.48
4	Punjab	28.10	540.90	19.25	81.10	5.11
5	Assam	54.01	328.80	6.09	49.32	3.11
6	Madhya Pradesh	28.95	326.92	11.29	49.04	3.09
7	Gujarat	9.40	197.90	21.05	29.69	1.87
8	Karnataka	17.81	194.95	10.95	29.24	1.70
9	Tamil Nadu	8.32	184.02	22.12	27.60	1.74
10	Haryana	9.90	154.50	15.61	23.18	1.46
11	Meghalaya	18.70	145.40	7.78	21.81	1.37
12	Orissa	8.72	78.74	9.03	11.81	0.74
13	Maharashtra	11.68	59.76	5.12	8.97	0.57
14	Tripura	2.77	46.81	16.90	7.02	0.44
15	Sikkim	5.00	26.40	5.28	3.96	0.25
16	Himachal Pradesh	13.81	24.95	1.81	3.74	0.24
17	Manipur	2.50	20.90	8.36	3.14	0.20
18	Arunachal Pradesh	3.00	20.70	6.90	3.11	0.19
19	Rajasthan	1.99	17.13	8.61	2.57	0.16
20	Andhra Pradesh	0.73	6.81	9.33	1.02	0.06
21	Jammu & Kashmir	1.72	5.99	3.48	0.90	0.06
22	Nagaland	0.93	2.50	2.69	0.38	0.02
23	Delhi	0.18	1.34	7.44	0.20	0.01
24	Mizoram	0.23	0.98	4.26	0.15	0.01
ALL INDIA		874.38	14125.29	16.16	2118.79	133.49

Source : 1. Anon (1990) for Area & Production.  
2. Waste potatoes & starch potential estimates are based on 15% wastage and 51% starch recovery 12.3% starch content of waste potatoes, (Joshi & Kulkarni, 1991).



**Table 2. Potential districts for establishment of 100 units / district for processing of 150 Tonnes / yr (4 months/yr) waste potatoes for starch production.**

District	Waste potatoes available (100 T)	Starch potential (100 T)	Product value (Rs. Crores)	Possible No. of starch units	Manpower employment potential (1000 No.)
<b>Uttar Pradesh</b>	9629.1	606.6	174.4	6420	64.2
Agra	247.6	15.6	4.5	165	1.7
Allahabad	389.6	24.6	7.1	260	2.6
Badaun	307.5	19.4	5.6	205	2.1
Barabanki	308.0	19.4	5.6	205	2.1
Basti	155.5	9.8	2.8	104	1.0
Bulandshahar	281.8	17.8	5.1	188	1.9
Etah	242.8	15.3	4.4	162	1.6
Etawah	275.0	17.3	5.0	183	1.8
Faizabad	324.6	20.5	5.9	216	2.2
Farrukhabad	1965.0	123.8	35.6	1310	13.1
Ghaziabad	207.5	13.1	3.8	138	1.4
Ghazipur	265.6	16.7	4.8	177	1.8
Gorakhpur	155.8	9.8	2.8	104	1.0
Hardoi	204.8	12.9	3.7	137	1.4
Jaunpur	254.0	16.0	4.6	169	1.7
Kanpur	270.8	17.1	4.9	181	1.8
Lucknow	202.7	12.8	3.7	135	1.4
Mainpuri	514.1	32.4	9.3	343	3.4
Meerut	252.1	15.9	4.6	168	1.7
Moradabad	257.3	16.2	4.7	172	1.7
<b>West Bengal</b>	5680.5	357.9	102.9	3787	37.9
Hooghly	162.5	10.2	2.9	108	1.1
<b>Bihar</b>	2298.8	144.8	41.6	1533	15.3
Hazaribagh	150.9	9.5	2.7	101	1.0
Nalanda	184.1	11.6	3.3	123	1.2
<b>Punjab</b>	811.4	51.1	14.7	541	5.4
Hoshiarpur	213.8	13.5	3.9	143	1.4
Jalandhar	285.0	17.9	5.2	190	1.9
<b>Tamil Nadu</b>	276.0	17.4	5.0	184	1.9
The Niligiris	186.0	11.7	3.4	124	1.2
U.P. Only	7082.1	446.2	128.4	4722	47.4
<b>Total</b>	8264.4	520.7	149.8	5511	55.2

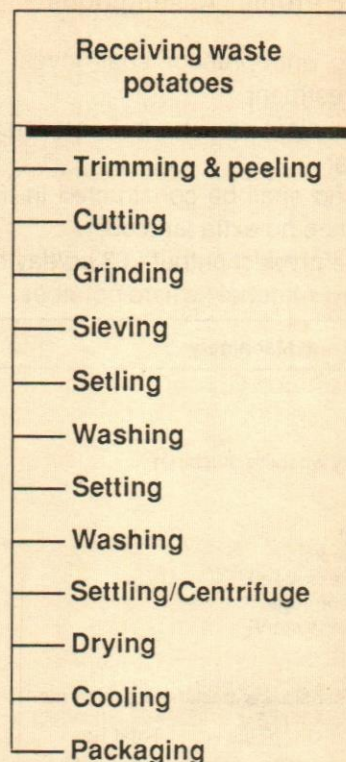
Note: Product value @ Rs 28750/t of starch. One starch unit/150 t waste potatoes, Manpower : 10 No./unit.

ing—usually done with the help of peelers. The potatoes are ready for grinding immediately after washing.

**Communication** : Main objective is to disintegrate the cellular structure of potatoes in order to release the starch. It can be achieved by tearing, abrasion and disintegration by impact.

**Screening** : It is done to separate the comminuted pulp into two fractions viz; waste fibrous material and starch. Most of the screens designed aim at retaining the fibrous waste on a screen through which starch suspension can pass.

**Starch dewatering or settling** : This is to separate starch granules from the suspension in water and can be achieved by gravitational sedimentation and mechanical dewatering. The quality of starch produced depends upon, to a great extent, the proper performance of this operation. Gravitational sedimentation can be carried out either in



**FIG. 3. STEPS IN POTATO STARCH EXTRACTION**

settling tanks or separating channels of about 50 m in length and 30 cm deep with small inclination, which is costlier.

**Mechanical dewatering** : It can use either vacuum filters or centrifuges. Vacuum filters operate continuously and consist of hollow, slowly rotating horizontal cylinders which are perforated and covered with a cloth. The cylinder is partly submerged into the trough containing starch suspension. When vacuum is applied, water is sucked through the cloth screen leaving starch to adhere to cloth. Centrifuges used in starch industry generally fall into two groups. The first is composed of high speed machines (3500 rpm) and the second with comparatively large diameter rotors (400 mm to 2500 mm).

**Drying** : Usually the starch is dried in ovens at temperatures in the range of 40-50°C to keep the native starch intact. On a cottage level basis, it can be dried using solar driers or in the open sun, but for the problem of dust contamination during open sundrying, the former is recommended.

**Machinery** : Various machines are available for performing the basic operations during the process of starch production. Many firms in India manufacture these machines. (Addresses of some manufactures are given in table 4).



## Economic Profile : Assumptions

- The entrepreneur shall invest 25% of the total investment.
- The plant shall be in operation for 120 days in a year.
- Shed shall be constructed in the farm itself and hence no extra land cost.
- The product output : 63 kg/day of 8 hours.
- Raw material : waste potatoes.

### Equipment and Machinery

Item	Cost in Rupees
Washer, (Rotary washing machine)	11,000
Peeler	14,000
Slicer	14,000
Pulveriser	16,500
Settling tanks (Stainless steel)	13,000
Bucket centrifuge (Stainless steel)	12,500
Dryer	31,000
Misc. (Racks, balance, packing machine etc.)	8,000

Total Rs. 1,20,000

### Shed

(60 m <sup>2</sup> , @ Rs 500/m <sup>2</sup> (Semipakka 60 m <sup>2</sup> ) with asbestos sheet roof top (Fig 4)	Total Rs.	30,000
		30,000

### Daily requirement of raw material

		Rs.
Potatoes (Waste) (Net : 10 q). (20% extra for removing damaged parts) (@ Rs. 0.50/kg)	1200 kg	600
Chemical (Potassium meta bisulfite)	1 kg	100
Packing material	1 kg	60
Misc.		40

Total Rs. 800

### The staff pattern

	No.	Monthly total salary
1. Skilled workers	1	1,500
2. Unskilled workers	10	6,000
	Total Rs.	7,500

### Working capital requirement (30 working days)

1. Raw material (30 days)	18,000
2. Salary of staff and labour	7,500
3. Electricity charges	1,500
4. Water charges	100
5. Chemicals	30
6. Other charges	500

Total Rs. 30,600

### Financial break-up

a. Fixed Capital	
i. Cost of machinery and equipment	1,20,000

ii. Installation and commissioning charges @ 5%.	6,000
iii. Cost of shed (60 m <sup>2</sup> )	30,000

Total Rs. 1,56,000

b. Working capital for 30 working days	30,600
c. Total capital investment (a+b)	1,86,600
d. Capital to be taken on loan (75% of total capital)	1,47,450
e. Capital share of entrepreneur	49,150

### Profitability assessment

A. Annual fixed cost (Rs/kg 4/28)	Rs. 51,400
i. Depreciation @ 10% of equipment cost	12,000
ii. Depreciation @ 2% of shed cost	600
iii. Insurance @ Rs. 5/1000 of shed & equipment cost	750
iv. Interest @ 16% on total capital investment	31,456
v. Maintenance @ 5% of equipment cost and 2% of shed cost.	6,600

Total 51,406

Say 51,400

B. Variable cost (Rs/yr basis) Rs. 1,65,600

(Rs/kg 13.80)

i. Raw material cost for 120 days @ Rs. 800/day	96,000
ii. Staff salary for six months @ Rs. 7500/month	45,000
iii. Electrical charges	9,000
iv. Water charges	600
v. Other charges	3,000
vi. Publicity/marketing cost @ Re 1/kg of product.	12,000

Total 1,65,600

C. Total cost (A+B) Rs. 2,17,000

D. Cost of the product 28.71

Rs/kg (7560 kg/yr) Say 28.75

E. Analysis of returns with 20 & 40% profit margin.

	40% profit	20% profit
i. Ex-factory price of product (Rs/kg)	40.25	34.50
ii. Total sales revenue (Rs/yr)	3,04,290.00	2,60,820.00
iii. Gross profit (Rs/yr (E-ii-C))	87,290.00	43,820.00
iv. Net profit (income tax N : L)	87,290.00	43,820.00
v. Return an investment, % (undiscounted)	44.40	22.30
vi. Payback period, years	1.83	3.06
vii. Break Even point (BEP) in terms of : Production, (kg/yr)	1,944.00	2,483.00
No. of days of production/yr	31	40
Sales revenue at BEP (Rs)	78,246.00	85,664.00



## The Starch Potential Product

Joshi & Kulkarni (1991) reported that the starch content in green damaged potatoes is 12.3 percent and 51.2 percent starch recovery from such potatoes is possible. Therefore the starch extraction per 100 kg of fresh damaged/green potatoes comes to about 6.3 kg. The starch potential on all India basis is therefore 1.34 lakh tonnes (Fig 5) and that of Uttar Pradesh and West Bengal is 0.61 and 0.36 lakh tonnes respectively (table 3). Value added product of the starch if produced from the waste potatoes can worth Rs 384 crores (table 3) and help in reduced imports of starch for use by industry in India thereby saving considerable amount of foreign exchange. Out of Rs. 384 crores, U.P. and West Bengal can produce starch worth Rs. 275 crores from waste potatoes (table 3). The entrepreneurs from this area should be encouraged to take-up the production of starch from waste potatoes by providing marketing facilities.

### Employment & Income Generation

On all India basis, the starch producing units can employ about 1.5 lakh persons and UP alone can employ over 64000 workers (table 3). Even if only high crop intensity districts (table 2) are taken into account, about 50,000 workers can be employed in U.P. alone in 4700 starch producing units of 1.2 t/day processing capacity. Establishment of such units can also provide indirect employment to many due to transportation of waste potatoes from field to processing unit. Besides, this, the potato growing farmers can get additional income owing to good price of the waste potatoes which some times cause a disposal problem. Though, India can have over 14000 units of 1.2 t/day processing capacity for processing entire quantity of waste potatoes (table 3) U.P. can have over 6400 units and districts like Farrukhabad alone have the potential (table 2) of establishing over 1300 units—20 percent of the capacity of U.P. and 10 percent of national potential for giving employment to 13000 persons. For potato starch production Farrukhabad can become Salem of North. Salem district in Tamil Nadu has about 600 tapioca starch producing units. More over, any capacity machinery is available indigenously (table 4).

Table 3: Major potato growing states, their employment and income generation potential through waste potato utilization for starch production.

State	Waste potatoes (1000 T)	Starch potential (1000 T)	Employment potential (1000 Men)	Product value (Rs. Cr.)	Possible starch units (Nos.)
Utter Pradesh	962.9	60.7	64.2	174.4	6420
West Bengal	568.1	35.8	37.9	102.9	3787
Bihar	229.9	14.5	15.3	41.6	1532
Punjab	81.0	5.1	5.4	14.7	540
All India	2118.8	133.5	141.3	383.9	14125

Note: Product value @ Rs. 28750/T. Employment 10 persons/unit. One starch unit/150 T waste potatoes available/season.

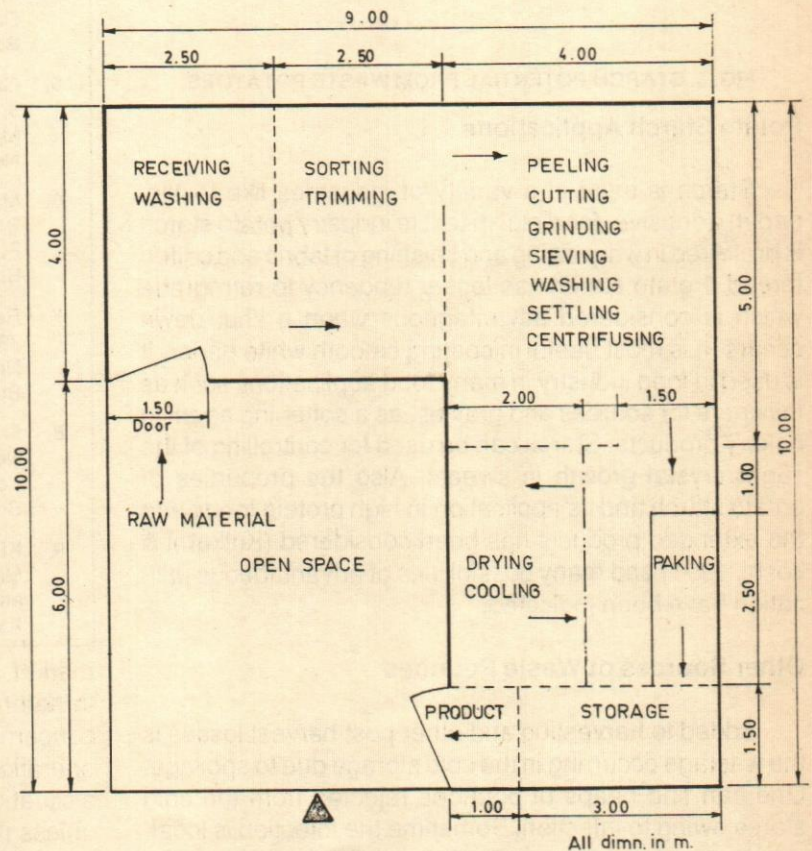


FIG. 4. PLANT LAY OUT AND MATERIAL MOVEMENT

**On all India basis, the starch producing units can employ about 1.5 lakh persons and UP alone can employ over 64000 workers.**



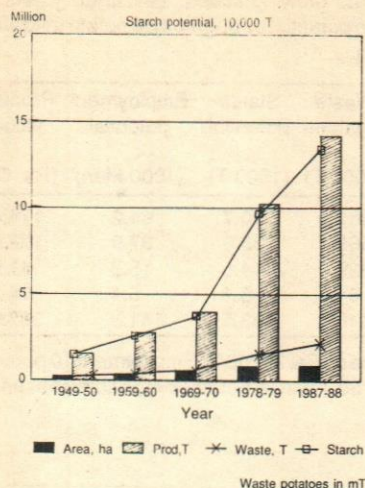


FIG. 5. STARCH POTENTIAL FROM WASTE POTATOES

### Potato Starch Applications

Starch is used in a variety of industries like textile, paper, adhesive, food etc. In textile industry potato starch is preferred in warp sizing and finishing of fabric and cotton thread. Potato starch has lesser tendency to retrograde which is considered advantageous when a shut down occurs. It is most useful in coating smooth white paper. It is used in food industry in many food applications such as thickeners for soups and gravies, as a softening agent in bakery products. Starch can be used for controlling of the sugar crystal growth in sweets. Also the properties of potato starch and its application in high protein foods and the extended products has been considered (Kulkarni & Joshi, 1991) and many possibilities of advantageous utilization have been indicated.

### Other Sources of Waste Potatoes

Added to harvesting and other post harvest losses is the wastage occurring in the cold storage due to spoilage. One can find heaps of potatoes rejected from the cold stores owing to infection. Sometime the infection is localized in a very small area of the tubers. Such tubers can be used for starch production after removing the affected area.

### Glut Situation and Starch

Many times the stage comes when the potatoes are available in abundance and the farmer is not sure of recovering cultivation costs, and is compelled to even leave the crop in the field to avoid additional loss due to harvesting. To avoid such discouragement in a situation of glut in the

Table 4 : List of manufacturers of machinery

Address	Machine
1. Batliboi Pvt. Ltd. Silver Jubilee Park Road, Bangalore-2	Pulveriser
2. B. Sen Barry & Co. 65/11, Rohtak Road, Karol Bagh, New Delhi-5	Peeling machine Pulveriser, Slicer, Cubing, Settling tanks, Shredders
3. Chemida (India) Magunlal Nagar 347, Grant Road Bombay-7	Potato peeler, powder filling machine, pulverisers, shredders, Dryers.
4. Gansons Pvt. Ltd. 6, West View Dadar (CR) Bombay-14	Vacuum shelf dryer, Storage tanks, Powder filling machine
5. Gardners Corporation 6, Doctors Lane (Near Gole Market) P.B. No. 299, New Delhi-1.	Potato Peeler
6. Mather and Platt Ltd. Ballard Estate P.B. No. 327 Bombay-1	Potato Washer
7. Raylons Metal Works 293, Bellasis Road, Next to Byculla Post Office, Bombay-8	Rotary Washer, Peeling machine
8. Frederik and Herbert No. 10, 2nd Pasta Lane Colaba, Bombay-5	Potato Peelers, Pulveriser
9. KRIST Engineering and Manufacturing Corporation 660, G.I.D.C. Makarpura, Baroda-390 010	Potato peeling machine Mixing and mincing machine, Potato chipping machine

market, however, when the interests of the cultivators are threatened Govt. of India lends support, at the request of concerned state Govt. by way of market intervention operation at an agreed indicative price (Anon, 1988). Such a situation can increase the load on Govt. exchequer only unless the product is used for value addition. To achieve this NAFED explores the possibilities of finding foreign markets for Indian potatoes but only limited success has been achieved with 125 tons of export during 1987-88 (Anon, 1988). This makes us think of suitable alternatives and production of starch appears to be the appropriate one. The capacity of a starch extraction unit can be decided depending on the excess quantity available and even large capacity units can be installed for the purpose.

No doubt that the cost of starch obtained from waste potato should be comparable with the other sources, but



**The capacity of a starch extraction unit can be decided depending on the excess quantity available and even large capacity units can be installed for the purpose.**

it does not mean that the starch cost would be higher if sound potatoes are used when glut occurs. The technology remaining the same for the sound potatoes, the farmers/entrepreneurs can take the advantage of glut situation after harvest for making starch from such surplus potatoes. This will not only avoid the glut but also stabilize the potato price. If steps are taken in this direction to utilise the glut, perhaps the efforts to export the potatoes would not cause any worry under such conditions, as it is difficult to transport the potatoes, a perishable commodity, away from the site of production to sea ports. Instead the starch obtained can be exported, without any transportation problem after fulfilling the in-land potato starch requirement.

### Conclusions

Various aspects of starch production from waste potatoes have been considered. There is great potential for using waste potatoes in areas like U.P., West Bengal, Punjab and Bihar for starch production. The production cost of starch, using waste potatoes would be Rs. 28.75/kg. At present there is no factory producing potato starch in the country and India imports some quantity of potato starch from ECE or Japan for its use in industries owing to its special applications. Taking up starch production from waste potatoes can help save the foreign exchange. Look-

ing at the techno-economic feasibility, prospects of effectively utilizing enormous quantity of waste potatoes and curtailment in foreign exchange expenditure. The Government should encourage the entrepreneurs for starting the units of extracting starch from waste potatoes, at least in major potato growing areas.

### References

- Anon. (1988). Agricultural Situation in India, Vol. XLIII No.5, p. 462-164.
- Anon. (1990). Agricultural Situation in India, Vol. XLV No. 1 p. 75-81.
- Joshi, K.C. (1971). CPRI Project (No. 8407701.1) report, Shimla.
- Joshi, K.C. & Kulkarni, S.D. (1991). Produce starch from waste potatoes - a source of additional income, Indian Horticulture, July Sept. issue.
- Kachru, R.P. & Bisht, B.S. (1990). Integrated agro storage-cum-processing complex, Productivity, 31, 2, 232-238.
- Kulkarni, S.D. & Joshi, K.C. (1991). Potato starch soy blends : possible effects of starch properties on few aspects of end products. Paper presented at 9th ICFOST, held at Mysore during 10-12 June.
- M/s Krist Engineering & Manufacturing Corporation, 660, GIDC, Makarpura, Baroda-390 010, Gujarat, (I-290 dt. 18.12.1990).
- Potty, V.H. (1986). Potato utilization - the Indian profile. Paper presented at International Seminar on Modernisation of Food Industry : Potato and Soybeans. Jan. 31, New Delhi.
- Upadhyaya, M.D. (1986). Processing of potatoes in India - future possibilities. Paper presented at International Seminar on Modernization of Food Industry : Potato and Soybeans. Jan. 31, New Delhi.
- Verma, S.C. (1983). Food Value and Utilization of Potato In Potato Production Storage and Utilization Ed. Nigaich, B.B. CPRI Shimla, p. 489, 525.
- Verma, S.C; Joshi, K.C; Sharma, T.R. and Malhotra, V.P. (1972). Relation between specific gravity and dry matter content of potato (*Solanum tuberosum* L.). Indian J. Agric. Sci. 42(8) : 709-712.
- Verma, S.C; Sharma, T.R. and Joshi, K.C. (1975). Relation between specific gravity, starch and nitrogen content of potato tubers. Potato Res. 18, 120-122.





# Prospects of Commercial Crops in Punjab

J.L. Sharma & G.S. Mander

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*This paper is an attempt to analyse the production prospects of some important commercial crops in Punjab. The analysis examines the existing growth pattern of the important commercial crops and studies the possibility of increasing farm income by increasing the cultivation of commercial crops as compared to the principal crops of wheat and paddy.*

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The State of Punjab covers only 1.5 per cent of the area in India, yet accounts for 3.9 per cent of the cropped area of the country. Of the total land area of the State, 84 per cent is under cultivation, of which 89 per cent is irrigated, paddy and wheat being the two principal crops.

Predominance of paddy-wheat-rotation has some far-reaching implications for the State in the form of disturbance of its water balance, deterioration in soil health, multiplication of pests and diseases, intensive use of energy and deterioration in the overall agro-eco-system. Increased area under paddy has resulted in intensive exploitation of underground water resources through installation of tubewells leading to the lowering of water level at a very fast rate in a major part of the central zone of the State. The repetitive uptake of same nutrients because of similar nutritional requirements of both the cereal crops, has caused the problem of micro-nutrient deficiency in soil.

As regards productivity, stagnation appears to have set in. The search is already on for finding out crop alternatives for wheat and paddy. This paper is an attempt to analyse the production prospects of some important commercial crops with the following objectives :

1. To examine the existing growth pattern of important commercial crops and to identify the factors inhibiting their cultivation.
2. To study the economics of commercial crops vis-a-vis principal crops at the optimum level of technology.
3. To examine the future production possibilities of commercial crops.

The data for the study were obtained from Statistical Abstracts of Punjab for the period 1966-67 through 1988-89. The costs and returns data collected by the Department of Economics and Sociology, PAU, Ludhiana, have been used. Six crops, viz. sugarcane, cotton (Am.), gram, rapeseed and mustard, groundnut and moong, which at present are being cultivated were examined in detail.



Compound growth rates were worked out to examine the change in area, yield and production of crops.

### Existing Status of Commercial Crops Cotton (American)

The area under this crop was 3.85 per cent of the cropped area in 1966-67, and 9.51 per cent in 1988-89 (Table 1). The production of this crop experienced a growth rate of 6.15 per cent per annum (Table 2). This increase occurred mainly as a result of growth in area which was at the rate of 5.51 per cent per annum. The growth in yield was 0.59 per cent per annum which was statistically non-significant. This crop is confined to south-western districts of Punjab because of its typical requirements for type of soil.

### Groundnut

The area under this crop which was about two lakh hectares in the late sixties declined sharply from 1977-78 onwards to 19 thousand hectares in 1988-89. Table 2 shows that during the period 1966-67 through 1988-89, the production decreased at a rate of 9.81 per cent per annum. This was mainly due to the decline in area under the crop at a rate of 9.07 per cent. Since relatively better pieces of land were shifted to other economically advantageous crops, the cultivation remained on poor soils and under rainfed conditions, resulting in to a significant fall in productivity of the crop at an annual rate of 0.85 per cent.

### Moong

The production of moong increased significantly at the rate of 17.33 per cent per annum. The area and yield contributed 14.49 per cent and 2.57 per cent per annum respectively (Table 2). The area under this crop has increased because of the introduction of new disease resistant varieties but it has confined to water deficient areas.

### Sugarcane

The area under sugarcane as a percentage of the total cropped area has shown a decline over time (Table 1). The production registered a non-significant growth rate of 0.61 per cent per annum. This increase in production occurred as a result of increase in productivity, the growth rate being 3.15 per cent per annum. The area under this crop declined significantly at the rate of 2.40 per cent per annum. Declining trend in area in spite of significant increase in productivity could be explained by the long duration of the crop and lack of an assured market.

### Gram

The share of this crop in the total cropped area of the State declined from 12.26 per cent in 1966-67 to 0.99 per

**Table 1: Percentage of area under important commercial crops to total cropped area in Punjab, 1966-67 to 1988-89.**

Year	Cotton (Am.)	Groundnut	Moong	Sugarcane	Gram	Rapeseed & mustard
1966-67	3.85	3.46	0.06	3.20	12.26	2.30
1967-68	4.17	14.08	0.07	2.52	9.74	12.92
1968-69	4.33	4.20	0.08	2.97	6.58	1.32
1969-70	4.02	3.38	0.05	2.71	6.91	1.67
1970-71	3.73	3.06	0.12	2.25	6.31	1.81
1971-72	4.30	3.04	0.05	1.80	5.85	2.24
1972-73	3.96	2.70	0.08	1.72	5.38	2.90
1973-74	4.99	2.57	0.17	1.82	5.83	2.97
1974-75	5.79	2.78	0.10	2.08	4.51	3.03
1975-76	5.90	2.69	0.08	1.82	6.09	1.95
1976-77	5.97	2.61	0.06	1.80	5.55	1.07
1977-78	6.89	2.44	0.10	1.80	5.52	2.00
1978-79	7.09	1.95	0.05	1.63	5.29	1.25
1979-80	7.04	1.39	0.08	1.18	3.62	1.35
1980-81	7.42	1.23	0.20	1.05	3.81	2.16
1981-82	7.88	1.33	0.36	1.50	3.51	1.59
1982-83	8.43	1.13	0.42	1.49	1.79	1.23
1983-84	7.97	0.83	0.47	1.27	1.38	1.12
1984-85	5.85	0.64	0.48	1.27	1.48	1.87
1985-86	6.06	0.64	0.63	1.32	1.39	2.09
1986-87	6.88	0.56	0.73	1.35	1.58	1.47
1987-88	7.72	0.44	0.51	1.45	0.90	2.16
1988-89	9.51	0.26	0.61	1.32	0.99	1.55

cent in 1988-89 (table 1). Table 2 shows that during the period 1966-67 through 1988-89, the production of this crop registered a significant negative growth rate of 9.78 per cent per annum. This decrease in production occurred due to a significant decline in area, the growth rate being 8.48 per cent per annum. With the introduction of high yielding varieties of wheat, this crop has become disadvantageous to the farmers in terms of per acre returns. Besides, this crop has more yield and price risk as compared to wheat. The yield of this crop has decreased significantly at the rate of 1.42 per cent per annum. This

**Table 2: Compound growth rates of area, production and yield of crops in Punjab (1966-67 to 1988-89)**

Crop	(Percent per Annum)		
	Area	Production	Yield
Cotton (American)	5.51*	6.15*	0.59
Groundnut	-9.07*	-9.81*	-0.85*
Moong	14.49*	17.33*	2.47*
Sugarcane	-2.40*	0.61	3.15*
Gram	-8.48*	-9.78*	-1.42*
Rapeseed mustard	0.59	3.87*	3.25

\* Significant at one per cent level

\*\* Significant at five per cent level



implies that the production technology used by the farmers needs improvement for attaining a higher plateau in production.

### Rapeseed & Mustard

Area under rapeseed and mustard crops has shown considerable fluctuations year after year (table 1). These crops registered a significant production growth rate of 3.87 per cent per annum. This increase in production was due to the significant increase in the productivity of these crops, the growth rate being 3.25 per cent per annum. The contribution of area towards increased production was positive but, statistically, non-significant. This was due to the fact that rapeseed and mustard crops are highly susceptible to frost, insects and diseases. Moreover, these crops being very sensitive, require an efficient management right from the seedbed preparation to their harvest.

### Commercial Crops vis-a-vis Principal Crops

The costs and returns of different crops presented in table 3 are based upon the optimum level of technology recommended by the Punjab Agricultural University. In a comparative sense the returns over variable costs per hectare from paddy were Rs. 7781 as compared to Rs 5992 from Cotton (American), Rs 6155 from Groundnut and Rs 4556 from Moong. Thus, on the basis of relative

profitability, no other *kharif* crop even at recommended level of technology competes favourably with paddy. There is a limited possibility for increasing area under cotton at the cost of paddy because the cotton and paddy lands are quite different in nature. Due to this, the cotton crop is confined to south-western district of Punjab, where this crop has a relative advantage over the rest of the *kharif* crops. The cultivation of this crop can be extended to other areas by assuring remunerative prices and strengthening extension service for imparting better technical know-how, particularly regarding plant protection measures.

The returns over variable costs per hectare from wheat in 1988-89 were Rs 5904 as compared to Rs 5134 and Rs 4553 from gram and rapeseed and mustard, respectively. On the basis of comparative profitability, considerable scope exists to replace wheat crop to some extent on marginal lands with rapeseed and mustard and gram crops, provided remunerative prices and market clearance is assured.

The returns over variable costs per hectare from sugarcane were Rs. 14039 which was higher as compared to that of paddy and wheat put together (Rs. 13685) on a rotational basis. In view of the level of productivity of this crop in the State, there is considerable scope to shift the area under this crop from wheat and paddy. Declining trend of area under this crop has been observed in the

Table 3: Comparative economics of commercial vis-a-vis principal crops in Punjab (1990-91)

Crop/Season	Average yield	Price	Gross returns	Variable cost	Return over over variable cost	Price at which it would compete with paddy	Yield at which it would compete with paddy	(Rs/hectare)	
								Price at which it would compete with wheat	Yield at which it would compete with wheat
	(Qtls.)	(Rs/Qtls.)	(Rs)	(Rs)	(Rs.)	(Rs)	(Qtls.)	(Rs)	(Qtls.)
<b>Kharif Season</b>									
Paddy (main crop)	73.8	225	16605	8824	7781	-	-	-	-
Cotton (Am.)	17.22	732	12605	6612.5	5992.5	964 (32)	22.68 (32)	-	-
Groundnut	17.22	760	13087.2	6932.3	6154.9	964 (27)	21.85 (27)	-	-
Moong	11.07	726	8036.8	3480.9	4555.9	1500 (107)	22.87 (107)	-	-
Sugarcane	861	45	38745	24705.8	14039.2	-	-	-	-
<b>Rabi Season</b>									
Wheat (main crop)	49.2	245	12054	6150	5904	-	-	-	-
Gram	14.76	605	8929.8	3795.8	5134	-	-	817 (35)	19.92 (35)
Rapeseed & Mustard	12.30	702	8634.6	4081.2	4553.4	-	96	980 (40)	17.17 (40)

Costs and returns estimates are based on optimum level of technology based on PAU's recommendations. Figures in parentheses indicate percentage increase over the existing price/yield.



past, the reason being long duration of the crop and lack of assured market. At present, there are 13 sugar factories crushing inadequately the present production of sugarcane. The area under this crop can be increased, provided more number of sugar mills are installed. Another important aspect is that it is a three-year crop, i.e., one plant and two ratoons. In order to avoid production cycles as has been experienced in the past, the prices of this crop should be determined for four years, which will serve as an economic incentive to farmers to augment the area under this crop.

From this analysis, it was evident that the production technology of commercial crops in the respective seasons needs improvement to bring them at par with wheat and paddy crops. To some extent, it can also be done by making adjustments in the output prices of these crops. As shown in table 3, the yield or price of rapeseed and mustard crops must increase by 40 percent to bring them at par with wheat in *rabiseason*. Similarly, the price or yield of groundnut must increase by 27 per cent to help it compete with paddy in the *kharif* season.

### Future Production Possibilities

Since the country is facing an acute shortage of these commodities, it was assumed that the government policy would be favourable for the production of these crops. Further, natural factors such as rainfall, temperature, etc. were also assumed to be favourable for the production of these crops over the projection period. The production estimates were made for the year 2000.

From the available data, it was evident that the area under the selected crops showed marginal fluctuations from year to year. In view of the fact that further increase in cultivated area of the State is extremely difficult, it was assumed that the present area under these crops will stay.

Productivity per unit of land can be increased even with the existing crop varieties and technology. This was evident from table 4 which indicates yield gaps in all the selected crops between the feasible yield level with improved production technology and the actual average yield realized on farmer fields. In cotton (American), the yield

**In order to avoid production cycles as has been experienced in the past, the prices of this crop should be determined for four years, which will serve as an economic incentive to farmers to augment the area under this crop.**

**Table 4: Potential and average yield of important commercial crops in Punjab**

Crop	Yield per hectare (Qtls.)		Gap (Qtls.)	Per Cent Gap
	Potential	Actual in 1988-89		
Cotton (American)	20.66	16.73	3.93	23.49
Groundnut	17.22	13.66	3.56	26.06
Moong	11.07	5.54	5.53	99.82
Sugarcane	861.00	619.00	242.00	39.00
Gram	14.76	9.89	4.87	49.25
Rapeseed & mustard	13.00	10.13	2.87	28.33

with improved production technology was 20.66 Qtls. per hectare against the State average of 16.73 Qtls. per hectare. Similarly, in the case of groundnut, moong, gram, sugarcane and rapeseed and mustard crops, the yield gap ranged from 26 to 99 per cent. For the purpose of this study, it was assumed that by the year 2000, the existing gap between the potential and average yield per hectare will be narrowed down to the extent of 50 per cent. On the basis of these assumptions, the production estimates made for the selected crops has been shown in table 5.

Table 5 shows that the existing production of cotton (American) is expected to increase by 11.76 per cent. This increase in production will come through increase in productivity mainly through the application of recommended

**Table 5: Estimated production of commercial crops in Punjab in the year 2000**

Crop	Area under the crop 1988-89	Productivity (Qtls/hectare)		Production (000 metric tonnes)	
		Actual in 1988-89	Expected in year 2000	Actual in 1988-89	Estimates for the year 2000
Cotton (American)	702.00	16.73	13.69	1174	1312 (11.76)
Groundnut	19.00	13.66	15.44	25.9	29.3 (13.12)
Moong	44.59	5.54	8.30	24.7	37.0 (50)
Sugarcane	97.00	619	740	6004	7178.0 (19.55)
Gram	73.00	9.89	12.32	72.2	89.9 (24.52)
Rapeseed and Mustard	114.00	10.13	11.56	115.5	131.8 (14.11)

Figures in parentheses show the percentage increase over the actual production in 1988-89.



production technology, particularly spraying schedule. Moreover, this crop has also suffered at the marketing front. Therefore, care must be taken of this aspect for stabilising average and enhancing production.

The production of groundnut in the State is expected to increase by 13.12 per cent through increase in productivity. For enhancing productivity, the production technology of this crop needs improvement particularly with regard to pests, diseases and other related problems.

The production of moong in the State can be increased by 50 per cent. However, this will require remunerative prices, assured market and also improvement in the production technology. Similarly, the sugarcane production can be increased by about 20 per cent.

The production of gram is expected to increase by about 25 per cent through increase in productivity. For this, the production technology of this crop needs improve-

ment. Remunerative price of the crop is a pre-requisite for increasing production.

the production of rapeseed and mustard crops is expected to increase by about 14 per cent. This will be possible if reasonable level of prices and market clearance is assured for this crop. Also vigorous extension efforts are required to be made for educating the farmers regarding pest management and disease control.

From the foregoing analysis, it was evident that even with the available production technology of the commercial crops, the existing production levels can be increased by 12 to 50 per cent. This, however, requires that the existing yield gaps between the potential and actual average yield of selected crops should at least be narrowed down by 50 per cent through identifying and removing the technological, financial, institutional and other socio-economic constraints in the production of these crops.



"Too many people who know all about financial values know nothing about human values."

—Roy L. Smith

We have to learn first how to talk to each other before we can take joint action.

—Leeiacocca



# Economic Analysis of Irrigation in Punjab

Invinder Pal Singh & Sunita Verma

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*This paper attempt to analyse the economics of irrigation in Punjab. It studies the availability of the sources of irrigation, level of irrigation to major crops, utilisation of irrigation resources and their relative cost to the farmers in Punjab.*

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Water is one of the most crucial inputs in agriculture particularly after the evolution of high-yielding varieties and chemical fertilizers (Chopra, 1982, Grewal et.al., 1983). With the growth of agriculture and more so the growth in area under water-intensive crops like paddy, need for irrigation water has risen tremendously, leading to new sources of irrigation. For instance, non-availability of canal water, in desired amount and at desired time led to the installation of tubewells. However, frequent breakdown of electric supply rendered the electric tubewells unreliable, inducing farmers to have diesel operated tubewells to make the system more reliable and flexible (Sidhu, et.al. 1984). These irrigation systems depend upon their relative efficiency, and price. Though electricity and canal are two highly subsidized irrigation inputs in Punjab, they costed the state exchequer rupees 135 crores in 1982-83 (Vaishnav, 1983).

The present study was undertaken with the following objectives :

- (i) to examine the existing irrigation system on different size holdings, in the three zones of Punjab,
- (ii) to examine patten of utilization of different sources of irrigation,
- (iii) to examine the extent of irrigation for major crops namely wheat, paddy and cotton,
- (iv) to work out the economics of irrigation for wheat, paddy and cotton.

## Methodology

Primary data for 1985-86 used in the present study was taken from a major project "Comprehensive Scheme to study the Cost of Cultivation of Principal Crops" in Punjab. The study used the three stage stratified random sampling, with tehsil as the first stage, village as the second and operational holdings as the third and ultimate unit of selection. The state was divided into three zones on the basis of crop-climate-soil complex. Ten tehsils which were proportional to the cultivated area of the zones were



selected from the three zones. These were 4, 3 and 3 respectively for zones-I, II and III. For each selected village, a cluster of two or three villages was formed, with the selected village as the nucleus and one contiguous village each in south and west direction. The enumerated holdings of these villages/culsters were divided into five size classes of operational area based on the national classification,

Size Group I	less than 1 hectare
Size Group II	between 1 and 2 hectares
Size Group III	between 2 and 4 hectares
Size Group IV	between 4 and 6 hectares
Size Group V	above 6 hectares

Two operational holdings from each size group were selected randomly for the village thus making a sample of 40, 30 and 30 holdings for zones-I, II and III. Data from the selected holdings was collected by the Cost Accounting Method. Data for respective size groups and zones was tabulated separately and their average represented the farm situation of that category in the zone. Characteristics studied were irrigation resource structure i.e. number of electric motors, diesel engines and their horse-powers, farm buildings for irrigation structures, utilization of these irrigation resources for wheat, paddy and cotton and for farm as a whole. Irrigation availability and its utilization from canal resources was also studied. Other sources of irrigation, if any, were also taken into consideration. For calculating the total cost of irrigation from different irrigation resources for major crops namely wheat, paddy and cotton, only those farmers' data was compiled who used solely the particular irrigation resource in that fragment.

### Irrigation Resource Availability

Table 1 shows the per hectare availability of horse-power (H.P) alongwith the average and percentage area irrigated by canal on different size holdings in the three zones of Punjab. It revealed that in zone-I, availability of horse-power, on a per hectare irrigated area basis, from diesel engines was generally higher than the horse-power available from electric-motors. Horse-power available from diesel engine showed a tendency to decrease with increase in farm size whereas in case of electric motors, just the opposite trend was observed. Availability of horse-power from electric-motor was higher on large farms which may be due to the reason that large farmers being better-off than the others have relatively easy access to this cheap source of irrigation. The same trend was observed in zone-II. In zone-III, however, mixed results were observed. Availability of horse-power from diesel-engines,

**Table 1: Per hectare availability of horse-power (H.P) from minor irrigation sources in Punjab, 1985-86**

Particulars	Size Groups				
	I	II	III	IV	V
<b>Zone I</b>					
Average area irrigated (Hect.)	0.90	1.77	4.03	4.78	8.35
Availability of H.P. from :					
D.E.	2.92	1.85	0.99	1.17	0.55
E.M.	0.62	0.66	0.83	1.03	0.67
Percentage of area irrigated by canal	34.00	14.68	50.37	28.45	29.70
<b>Zone II</b>					
Average area irrigated (Hect.)	0.86	1.44	2.39	4.69	6.92
Availability of H.P. from :					
D.E.	2.90	3.00	1.43	1.24	1.04
E.M.	0.77	0.98	1.49	1.18	0.83
Percentage of area irrigated by canal	-	-	-	-	-
<b>Zone III</b>					
Average area irrigated (Hect.)	0.84	1.99	4.23	4.71	7.15
Availability of H.P. from :					
D.E.	-	1.75	0.63	1.48	0.48
E.M.	-	1.67	0.00	0.00	0.00
Percentage of area irrigated by canal	100.00	100.00	99.05	88.95	93.70

D.E. and E.M. stand for diesel engine and electric motor.

seemed to show no apparent tendency to increase or decrease with farm size. Almost the entire irrigated area was found to be irrigated by canal in zone-III. Lesser development of minor-irrigation sources in this zone may be due to the fact that underground water in most parts of this zone brackish and investment required to install big tubewells is high.

### Utilization of Irrigation Resources

It was evident from table 2 that in zone-I per cent unit employment of diesel engine showed some tendency to increase with increase in farm size. There was underutilization of this resource in smaller farms. Per unit employment of electric motor was higher in small farms as compared to large farms despite the fact that availability of horse-power from electric motors in small farms was less than that of large farms i.e. better utilization of this resource. In zone-II per unit employment of both diesel engine and electric motor showed tendency to increase with increase in farm size. This reflected that smaller farms were at a disadvantageous position here too as this resource is indivisible to some extent. In zone-III also the same trend was observed. It was found that there was gross under-utilization of their capacities. Smaller farms were relatively at a disadvantageous position as there is a limit to the divisibility of these resources in the shape of limited shareholders, in the contiguous area only.



**Table 2: Per unit employment of Diesel Engine and Electric Motor during the year 1985-86**

(In Hours)

Particulars	Size Group				
	I	II	III	IV	V
<b>Zone -I</b>					
Diesel Engine	122.17	202.43	143.65	201.49	183.28
Electric Motor	1454.13	1278.04	957.97	1129.96	1255.78
<b>Zone-II</b>					
Diesel Engine	224.66	255.71	302.73	361.41	346.00
Electric Motor	889.28	1650.70	1552.22	1398.70	2099.41
<b>Zone-III</b>					
Diesel Engine	-	113.66	340.90	392.32	349.61
Electric Motor	-	783.29	-	-	-

Note: Norms set for diesel engine and electric motor were 2400 hours per annum on the basis of 8 hours per day for 300 days in a year.

**This reflected that smaller farms were at a disadvantageous position here too as this resource is indivisible to some extent.**

### Level of Irrigation

Table 3 shows number of irrigations applied to major crops in different size groups in three zones of Punjab. In zone-I, in the case of paddy, number of irrigations applied on small farms was higher than that of larger farms. However, recommended number of irrigations in paddy according to "Package of Practice in Punjab" were twenty four. It is evident that farmers in size groups I, II, III, and IV applied more number of irrigations than recommended; whereas farmers in size group V applied slightly less irrigation than recommended. In zone-II, in the case of paddy it can be observed that farmers in all size-groups over-irrigated their farms; the number of irrigations being highest in case of size group III. However, paddy area was

**Thus over-irrigation of paddy was the general phenomenon on almost all the farms in Punjab.**

**Table 3: Number of irrigations applied for important crops in Punjab, 1985-86.**

Particulars	Size Groups					
	I	II	III	IV	V	
<b>Zone-I</b>						
Paddy	D.E.	5.86	4.08	0.90	2.82	2.17
	E.M.	27.47	32.49	28.29	23.00	20.44
	Tr.	-	-	-	-	-
	Canal	2.66	0.90	1.99	0.66	0.77
	Total	35.99	37.47	31.18	26.48	23.38
Wheat	D.E.	1.04	0.12	-	0.45	0.19
	E.M.	2.40	3.66	3.64	3.27	4.03
	Tr.	-	-	-	-	-
	Canal	1.29	0.58	0.05	0.54	0.19
	Total	4.73	4.36	3.69	4.26	4.41
Cotton	D.E.	-	-	-	-	-
	E.M.	-	-	-	3.00	1.50
	Tr.	-	-	-	-	-
	Canal	-	-	-	-	-
	Total	-	-	-	3.00	1.50
<b>Zone-II</b>						
Paddy	D.E.	5.69	7.12	2.93	4.30	4.32
	E.M.	19.95	22.68	35.59	27.74	29.05
	Tr.	-	-	-	-	0.33
	Canal	-	-	-	-	-
	Total	25.64	29.80	38.52	32.04	33.70
Wheat	D.E.	0.50	1.40	0.83	0.97	-
	E.M.	5.94	4.11	4.12	4.29	5.46
	Tr.	-	-	-	-	0.15
	Canal	-	-	-	-	-
	Total	6.44	5.51	4.95	5.26	5.61
Cotton	D.E.	3.00	-	1.33	1.33	0.50
	E.M.	-	5.00	3.00	2.00	4.25
	Tr.	-	-	-	-	0.50
	Canal	-	-	-	-	-
	Total	3.00	5.00	4.33	3.33	5.25
<b>Zone-III</b>						
Cotton	D.E.	0.45	0.48	0.53	0.83	0.51
	E.M.	-	0.22	-	-	-
	Tr.	-	-	-	0.01	0.07
	Canal	5.45	5.31	5.82	5.36	5.45
	Total	5.90	6.01	6.35	6.20	6.03
Wheat	D.E.	1.66	1.20	0.53	0.58	0.79
	E.M.	-	0.04	-	0.89	0.03
	Tr.	-	-	-	-	-
	Canal	4.33	5.07	5.71	5.16	4.93
	Total	5.99	6.31	6.24	6.63	5.75

Note: Paddy area was nil in sample farms in zone-III. Recommended level of irrigations were 24, 5 and 5 for paddy, cotton and wheat respectively.

nil on farms in zone-III. Thus over-irrigation of paddy was the general phenomenon on almost all the farms in Punjab.

In case of wheat, the recommended number of irrigations were five. On comparison with the existing number of



irrigations, it was found that most of farmers in different size groups in zone-I, except size group III, applied nearly recommended number of irrigations. However, farmers in size group III under-irrigated their crop. In zone II, however, it was found that, except in size group III, most of farmers in different size-groups over-irrigated wheat crop. Similar was the tendency amongst farmers in zone-III.

In case of cotton, the recommended number of irrigations were five. In zone I, majority of farmers did not grow cotton in their farms. A few farmers raised cotton and they had a tendency to apply less than recommended number of irrigations. In zone II however, farmers in size-groups I, III & IV under-irrigated their crops, where as farmers in size-group II and V over-irrigated their crop. In zone III, farmers in all size-groups had over-irrigate their crop though this zone is a major cotton producing area of the State.

### Economics of Irrigation

Table 4 shows source-wise number of irrigations and their cost on a per hectare basis for important crops in Punjab. In the case of paddy, cost per irrigation by electric motor was Rs. 22.49, whereas that from diesel engine was Rs. 117.16. No sample farmer was found growing paddy on canal irrigation alone. This was also corroborated by Dhawan (1985). However, per hectare cost of canal irrigation to farmers was only Rs. 48.75 as compared to cost of Rs. 903 and Rs. 1986 from electric motor and diesel engine respectively. In the case of cotton, costs per irrigation by electric motor and diesel engine were Rs. 37.86 and Rs. 247.58 respectively. The cost per canal irrigation worked out to Rs. 6.42 only which showed the extent of under pricing possible with canal irrigation as compared to diesel engine and electric motor.

**These figures clearly reflected the tremendous extent of subsidies involved in case of electricity and canal and need to restructure the pricing pattern to bring all resources at par.**

In the case of wheat, cost per irrigation by electric motor was Rs. 27.32 and by diesel engine, it was Rs. 145.08. Whereas cost per canal irrigation was Rs. 5.06 only. These figures clearly reflected the tremendous extent of subsidies involved in case of electricity and canal and need to restructure the pricing pattern to bring all

**Table 4: Source-wise per hectare number of irrigation applied and their cost for important crops in Punjab, 1985-86.**

Particular	Sources of Irrigation		
	Electric Motor	Diesel Engine	Canal
<b>Paddy</b>			
Number of Irrigations per Hectare	40.14	16.95	-
Total Cost (Rs.)	902.85	1985.98	48.75
Cost per Irrigation (Rs.)	22.49	117.16	-
<b>Cotton</b>			
Number of Irrigations per Hectare	3.60	3.50	5.25
Total Cost (Rs.)	136.32	866.54	33.75
Cost per Irrigation (Rs.)	37.86	247.58	6.42
<b>Wheat</b>			
Number of Irrigations per Hectare	6.69	5.52	5.77
Total Cost (Rs.)	182.81	800.49	29.20
Cost per Irrigation (Rs.)	27.32	145.08	5.06

resources at par. The price of electricity could be increased five times under the existing resource use conditions.

### Conclusion

The study brought out the fact that there was tendency of over-irrigation in the case of paddy crop in Punjab. However, there was under-utilization of irrigation sources i.e. diesel engine and electric motor on small farms. The study further brought out that the cost of irrigation was highest with diesel engine followed by electric motor and canal irrigation. The next of differential in cost was as much as about five times in the case of electric motor and diesel engine and about the same gap exists between electric motor and canal which reflects the need to restructure the pricing pattern.

### References

- Chopra, Kanchan (1982) 'Alternative Sources of Irrigation and Land Use Pattern in the Punjab' Indian Journal of Agricultural Economics 37 (2)
- Dhawan, B.D. (1985) 'Questionable Conceptions and Simplistic Views about Irrigated Agriculture of India' Indian Journal of Agricultural Economics 40(1).
- Grewal, S.S. and Rangil, P.S. (1983) 'An Analytical Study of Growth of Punjab Agriculture' Indian Journal of Agricultural Economics 38 (4).
- Punjab Agricultural University 'Package of practices for Kharif and Rabi Crops' 1988-89.
- Sidhu, D.S.; Chand, Ramesh and Kaul, J.L. (1984) 'An Economic Analysis of Various Sources of Irrigation in Punjab' Indian Journal of Agricultural Economics, 39 (3).
- Vaishnav, P.H. (1983) 'Some Constraints on Growth of Agricultural Output in Punjab' Indian Journal of Agricultural Economics, 38 (4).



# Rice Production & Factor Productivity in Nigeria

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*This study examines the impact of production intensification in relation to productivity of factors on rice production in Anambra State of Nigeria. It was found that high income farmers had a relatively positive attitude towards rice production. This paper examines the alternative means of increasing production by a land redistribution programme and adoption of improved production technologies - fertilizers and seeds, improved credit facilities and extension services, etc.*

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Increasing food production to keep pace with demand while retaining the soil quality and ecological balance of production systems is a current challenge to agricultural research and policy in sub-saharan Africa. In response to this challenge, Nigerian agricultural researchers are shifting attention to investigating key variables that affect sustainable production. One of these variables is land-use intensity, which is a measure of agricultural intensification.

Nigeria's agricultural sector provides both enough and well-balanced food for the growing population. However, of late, the annual growth rate of food production is estimated only at 2 per cent whereas the food demand growth is 4 to 5 per cent (Pere & Mahapatra, 1976). Further, the food import bill rose from N43.8 million in 1963 to N1,447.9 million in 1983 (Okpala, 1986), though declined a little bit to N1052.0 million in 1987 (CBN, 1988) due to the effect of introduction of the Structural Adjustment Programme (SAP) in 1986. Clearly this under-scores the effect of inadequate internal food production vis-a-vis food demand.

The demand for all agricultural foods have not been rising equally. While the demand for some agricultural commodities, e.g. cocoyam (*Colocassia esculenta*) and Port may be declining, others are increasing rapidly. For example, the demand for rice has increased from 520,000 tonnes in 1979 to an estimated 4 million tonnes in 1986 (Obobi & Anazodo, 1986). This rapid increase in the demand for rice was mainly due to three factors: (a) a remarkable change in consumer attitude to rice from a food for the rich to that of everybody; (b) the relative increase in rice availability and falling price; and (c) the general increase in the standard of living of Nigerians and the nation's per capita income, especially during the oil boom years. In fact, rice has become a staple food in Nigeria, just like garri, yams, cassava and millet, and is probably the most important food grain permeating states, religions, tribes, and cultures.

Nigeria is capable of being self-sufficient in rice production given the available land, human, and other resources. Most rice production is under small-holder agri-



cultural system. These small-holder farmers cultivate about 2 to 3 hectares on the average, use traditional implements like hoes and machetes, and often do not use improved seeds, agro-chemicals, and appropriate spacings. The factors limiting the productivity of these small-holder farmers have been adequately enumerated by many researchers as land tenure, inadequate and ineffective extension services, inconsistent government agricultural policies, poorly developed rural infrastructure, lack of credit, and labour problems (e.g. Idachaba, 1979; Oyaide, 1979; and Singh, 1979).

Input responses of these farmers under intensified cultivation bring about varied effects on total output, net productivity and marginal input productivity. Though a rational farmer operates at the stage of declining marginal returns, cases of farmers operating at either the stage of increasing marginal returns or negative returns are possible. Apart from determining the responses, this study attempts to know the effect of these responses on total and marginal productivities. In this way, it can be categorically inferred on whether farmers' use of inputs under intensified cultivation is rational or not. Thus, determining and comparing the effects of input use patterns on rice productivity under increased land use intensity is at the core of the matter.

## Methodology

The study was conducted in Anambra State of Nigeria. The choice of the area was primarily based on the understanding that increased population densities have placed the farmland under stress (Anambra State Population Estimates, 1985). Secondly, literature has identified the problem of land-use pressure and high land-use intensity in the State (Greenland-Tahal Report on Anambra State Accelerated Area Development Programme, 1981). Ofomata (1981) also commented that Anambra State provides a good example of a developing nation where land is increasingly becoming a scarce resource, adding that population pressure has not only forced the people to abandon the bush fallow, but also to cultivate areas unsuitable for cultivation. Finally the State is the highest

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producer of rice in the country.

Two hundred and fifty rice farmers in the State were randomly sampled. Data were gathered through personal interviews using a set of pre-tested questionnaires.

Tabular analysis was employed in examining the farmer and farm characteristics that may influence productivity. The multiple regression analysis was used in determining the relationship and effects of farmer and farm characteristics on productivity level. Gross margin analysis was employed to estimate the costs and returns to the average farmer per hectare per annum.

## Results and Discussion

In making the tabular analysis, the farmers were dichotomized into low and high income groups. Low income farmers were those with less than N8369.00 per annum while farmers categorized as high income were those with not less than N8369.00 per annum (table 1). The table reveals that low income farmers had smaller farm size, hired equal number of farm workers (labour),

**Table 1: Farm Characteristics between Income Groups. 250 Rice Farmers**

Characteristics	Income Group*		
	Low	High	Average
Farm size (Ha)	1.68	3.06	2.37
Hired Labour (No. of persons)	3	3	3
Fertilizer application (kg)	128	172	150
Pesticides application (kg)	1	1	1
Planting materials (seeds) (kg)	23	27	25
Rice production intensity (fallow length)	1	2	1.5

\* = 8 Naira (N8) = 1 US Dollar (\$1)

used less quantity of fertilizer, equal quantity of pesticides, less quantity of planting materials (seeds), and allowed shorter fallow period than high income farmers.

Regression analysis reflects the interaction among variables as they would naturally occur in the real world (Koutsoyiannis, 1981). Major independent variables were regressed with output (Y) as the dependent variable. These independent variables are farm size (FS), hired labour (HL), fertilizer (FL), pesticides (PC), planting materials (seeds) (PS), and rice production intensity (IR). The result of the regression analysis is given in table 2.

IR (rice production intensity) alone accounted for about 61 per cent of the variation in output. The addition of FL (fertilizer); PS (planting material), FS (farm size), and HL (hired labour) raised the values of coefficients of determination ( $R^2$ ) to about 64%, 65%, 66%, and 67% respec-



**Table 2: Estimated Stepwise Regression Equations for Interrelated Factors affecting Output (In kilogrammes). 250 Rice Farmers**

Equation	Constant	Explanatory Variables						R <sup>2</sup>	F-value
		IR	FL	PS	FS	HL	PC		
1	2.640245	-0.0633* (0.0209)						0.6073	353.46
2	3.153540	-1.1032* (0.1302)	0.1337* (0.0490)					0.6359	243.24
3	4.112567	-1.0373* (0.1301)	0.4531* (0.1426)	0.2017** (0.0842)				0.6541	174.78
4	3.167117	-1.1906* (0.1605)	0.4132* (0.1468)	0.1717** (0.0854)	0.1058** (0.0644)			0.6624	131.51
5	2.87105	-1.3803* (0.2196)	0.3963* (0.1496)	0.1659** (0.0867)	0.1025** (0.0644)	0.2129 (0.1673)		0.6671	104.17
6	3.002498	-1.4133* (0.2203)	0.4580* (0.1565)	0.1710** (0.0865)	0.1095** (0.0601)	0.0454 (0.0369)	-0.0469 (0.0353)	0.6723	85.45

\* Indicates that coefficient is significant at P = 0.01

\*\* Indicates that coefficient is significant at P = 0.10

Standard Error of coefficient is in parentheses

tively, However, the addition of PC (pesticides) did not improve on the value of R<sup>2</sup>. The analysis further indicates that IR and PC had negative impact on output indicating the need to increase fallow period and to de-emphasize too much use of agro-chemicals as pesticides.

The marginal input productivity analysis in table 3 indicates that the farmers were operating at the stages of increasing and decreasing marginal returns using HL, and IR and PC respectively revealing that they are not optimizing the use of these inputs.

### Gross Margin Analysis

Gross margin analysis estimates the costs and returns per hectare to the average farmer per annum during the

**Table 3: Regression Coefficients, Marginal Input Productivities of Six Independent 250 Rice Farmers.**

Variables	Regression Coefficients	Standard Errors	Marginal Input Productivities	t-values	Levels of Significance
IR	-0.0633	0.0209	353.21	3.0287	0.01
FL	0.1337	0.0490	7.46	2.7286	0.01
PS	0.2017	0.0842	67.52	2.3955	0.10
FS	0.1058	0.0644	373.60	1.6429	0.10
HL	0.0013	0.1673	3.63	0.0078	N.S.
PC	-0.0004	0.0353	3.35	0.0113	N.S.

d.f. = 249

N.S. = Not significant beyond 10% level of probability.

period of study. The variable cost items included are rent, cost of hired labour, cost of fertilizer, cost of pesticides, and cost of planting material (seeds). The revenue sources included are quantities of rice sold, consumed or given away. The profitability or otherwise of the enterprise was

determined by the difference between total revenue (TR) and the total variable cost (TVC) (table 4).

This shows that rice production among these farmers is still profitable, but when the present value of the Naira (N) in relation to cost of living in Nigeria is considered, the margin is not comfortable.

**Table 4: Estimated Costs and Returns to the Average Farmer Per Annum. 250 Rice Farmers.**

Items	Quantity	Price per Unit (N)*	Revenue/Variable Cost (N)
<b>Revenue</b>			
Quantity sold	520kg	15.00	7800.00
Quantity consumed	36kg	15.00	540.00
Quantity given away	2kg	15.00	30.00
Total Revenue (TR)			8370.00
<b>Costs</b>			
Rent	2.62	200.00	524.00
Hired Labour	3	800.00	2400.00
Fertilizer	300kg	1.20	360.00
Pesticides	1kg	50.00	50.00
Planting Materials (seeds)	50kg	12.00	600.00
Total variable cost (TVC)			3934.00

kg = Kilogramme; Ha = Hectare

\* 8 Naira (N8) = 1 US Dollar (\$1)

$$\text{Gross Margin} = \frac{\text{Total Revenue (TR)} - \text{Total Variable Cost (TVC)}}{\text{Farm Size}}$$

$$= \frac{8370 - 3934}{2.62} = \frac{4436}{2.62} = \text{N1693.13}$$

### Conclusions & Implications for Policy

It has been demonstrated in the study that rice production intensity is the most important variable accounting for about 61 per cent of variation in value of total production. If these farmers have access to land, many of them can increase production by reducing fallow period. But unfortunately land is a scarce resource in the State. If these farmers cannot increase farm size, a logical alternative means of increasing production should be to give them more of improved production technologies, especially



improved seed varieties and fertilizers. It is likely that many of them can appreciably increase output as has been demonstrated on farms of only a few hectares in Japan and Taiwan.

Therefore, under the present level of technology and output, the farmers should be helped to increase their farm size through a land redistribution programme by the government or adopt more improved rice production technologies. Thus, credit facilities and extension services (technical assistance) should be made readily available to the farmers in addition to the formulation and implementation of favourable agricultural price policy and provision of rural infrastructural facilities to retain them in rice production.

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### References

**Anambra State Government** (1985), Anambra State Population Estimates by Local Government Areas, Edition 7, Ministry of Finance and Economic Planning, Statistics Division, Enugu, Nigeria.

**C.B.N.** (1988), The Nigerian Food Import Bill for 1981-87, Exchange Control Department of Central Bank of Nigeria and Federal Office of Statistics, Lagos.

**Greenland-Tahal Report** (1981), Anambra State of Nigeria Accelerated Area Development Programme.

**Idachaba, F.S.** (1979), "Some Considerations on Agricultural Input Policies in the Fourth National Development Plan" in The Crop Sub-Sector in the Fourth National Development Plan, 1981-85.

**Koutsoyiannis, A.** (1981), Theory of Econometrics, Second Edition. London. The Macmillan Press Ltd.

**Obobi, A.A. and Anazodo, U.G.N.** (1986), "Appropriate Rice Processing and Storage Technology for Nigeria" A Paper Presented at the National Workshop on Post-harvest Food Losses, Nsukka. Centre for Rural Development and Co-operatives, University of Nigeria.

**Ofofata, G.E.K.** (1981), "The Land Resources of Southeastern Nigeria: A Need for Conservation" in Iqbozurike, U.M. (Ed.), Land Use and Conservation in Nigeria, Nsukka, University of Nigeria Press, pp. 94-106.

**Okpala, E.U.** (1986), "Biodeterioration and Large-scale Planned Food Preservation of Yams, Cassava, Cocoyam, and Maize in Nigeria." Towards a National Workshop on Post-harvest Food Losses and their Control, Nsukka, Centre for Rural Development and Cooperatives, University of Nigeria Nsukka.

**Oyaide, D.F.J.** (1979), "Agricultural Input Supply and Distribution Policy in the Fourth National Development Plan" in The Crop Sub-sector in the Fourth National Development Plan, 1981-85.

**Pere, A.I. and Mahapatra, I.C.** (1976), "Case Studies of Technology Transfer in West Africa: Nigeria and Sierra Leone." Paper Presented at the 2nd NAFPP National Rice and Maize Workshop, Ibadan, Moor Plantation.

**Singh, B.R.** (1979), "Some Considerations on Input Supply and Distribution in the Fourth National Development Plan," in The Crop Sub-sector in the Fourth National Development Plan 1981-85.



"We are indeed in the early stages of a major technological transformation, one that is far more sweeping than most ecstatic of the "futurologists" yet realized, greater even than Megatrends or Future Shock".

—Peter Drucker

A manager's job exists because the task facing the enterprise demands its existence necessity; it must therefore have its own responsibility.

—Peter F. Drucker



# Informal Sector : Income, Employment Generation and Productivity

R.S. Tiwari

*The informal sector constitutes the main source of livelihood for a significant section of Indian society. This paper examines the comparative performance of the informal sector vis-a-vis the formal sector. It analyses the income and employment potential and the state of productivity levels in informal sector in comparison to the formal sector.*

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The increasing growth of urban population raises problems like under-employment and unemployment. The organised and unorganised sectors are the basic sources of employment. However given the current trends of employment growth in this sector on the one hand and expenditure, investment and management capabilities of civic authorities on the other, the prospect of absorbing the growing urban population into organised sector seems very remote. Therefore, the emphasis on urban development based on organised sector development has gradually been reduced and instead urban development emphasising unorganised or informal sector development has been recognised as more 'quick yielding and equitable'. This paper aims at examining the comparative performance of informal sector vis-a-vis the formal sector. It examines the income and employment potential and the state of productivity levels of the informal sector vis-a-vis the formal sector.

## Methodology

The city of Kanpur (UP) being the largest both in terms of area (327 sq. kms.) and population (16.39 lakhs) (Census of India, 1981) has been selected as an illustrative example. As of today, in most of the developing countries, the dualistic nature of economy has persisted. In India, almost all metropolitan cities have two juxtaposed systems or organisations of production of goods and services. While one is derived from the form of production using capital on a consistently large scale, modern technology and know-how, engages highly skilled and trained workers and produces sophisticated goods and services for the higher income groups, the other system is derived from the traditional mode of production. The classifications used to portray the functioning of these two sectors in the urban economy are termed as organised and unorganised, modern and traditional, capitalist and subsistence, protected and unprotected, large and small, regular and casual and formal and informal.



These two way classifications are generally based on the nature of organisation, the level of technology, marketing of products, protective policy of the government and functioning of the labour market conditions between the two sectors. However, owing to the inter-relationship of these different characteristics, it has never been possible to have a precise definition of the formal and the informal sectors. In the present study, based on the availability of information, we defined formal and informal sectors on the basis of the employment criterion in a sectoral perspective.

In the manufacturing segment, formal sector is defined as those firms, employing 10 or more persons with power and 20 or more persons without the use of power. The informal sector is defined to include those, employing less than 10 persons with or without power and less than 20 persons without the use of power. Such a classification is in accordance with the Indian Factory's Act, which says that once employment in a production unit reaches 10 or more, all regulations set for a factory become compulsory to such firm and thereby it becomes a part of the formal sector. On the other hand, such a unit in which employment does not exceed 9, is not required to get registered under Factory's Act and is free to function informally.

The classification of Formal Sector and Informal Sector in the non-manufacturing segment needs to be different when compared to that of the manufacturing segment on account of 'size', 'use of machinery', 'profit margins', and other considerations. Therefore, different cut-off points need to be chosen for which there does not exist any universally acceptable criterion. Given the information base, the employment criterion was once again relied upon. In the non-manufacturing establishments, the formal sector is defined as those employing 4 or more persons, whereas establishments employing less than 4 persons are included under informal sector category. Our sample consists of 77 firms from the formal manufacturing and 73 from the non-manufacturing segments. Similarly, 191 firms from the manufacturing and 635 from the non-manufacturing establishments were selected from the informal sector. The year 1985-86 has been selected as a reference year for the study.

#### **Income, Employment Generation & Productivity**

We have estimated the income both by value added and income accrual methods. Income from primary and secondary activities was worked out through the value added method, whereas, for tertiary activities, the income accrual method was used. Generally, the income was estimated by using the result of our field survey, though in

certain cases the information provided by various governmental and non-governmental organisations was also used. Employment was estimated for certain economic activities through projection method for the year 1985-86. Census 1981 revealed that Kanpur urban agglomeration housed 16.39 lakhs of population. Applying growth rate of 2.85 per cent per annum between 1971-81, we projected the population for 1986 at 18.86 lakhs. Assuming 1981 participation rate of 26.99 per cent to be invariant, we estimated 5.09 lakh workers for 1986. This was further distributed at two digit levels of NIC classifications for 1986 in the proportion revealed by 1971 Census. For any economic activity, whose employment was not found available, we used the projected employment figures. However, for certain economic activities, we used the actual employment figures made available from the records of government and non-government organisations. Such activities included electricity, formal land based activity in the manufacturing segment, and formal transport activity and government employees in the non-manufacturing sector. For the purpose of analysis, we reclassified the city's employment and income into primary, secondary and tertiary sectors.

**Across the different activities, such as, primary, secondary and tertiary, productivity in the informal sector was found consistently lower than that in the formal sector.**

It was found that during 1985-86, the Kanpur city generated employment of the order of 5,84,005 persons and income of Rs. 1234.76 crores. The informal sector accounted for about 37 per cent and 30.37 per cent respectively of the city's total employment and income (table 1). In the manufacturing segment, the informal sector generated employment of 67,366 persons (or 24.39 per cent) and income of Rs. 8131.82 lakhs (or 17.50 per cent). The contribution of the informal sector was truly impressive in the non-manufacturing segment. In this segment, the informal sector employed 48.12% persons and generated an income of 39.80%. The productivity measured by net value added per employee was Rs. 20,558.52 for the city economy, which was lower than average productivity of the formal sector, but higher than that of the informal sector. Across the different activities, such as, primary, secondary and tertiary, productivity in the infor-



**Table 1 : Income and Employment Generation in the City Economy : Kanpur, 1985-86**

Sectors	Persons employed (Nos.)	Net value added per employee (Rs.)	Total net value added (Rs. lakhs)
<b>Primary Sector</b>			
Formal	345	18385.51	63.43
Informal	1447	12371.11	179.01
2 as a ratio of 1	4.19	0.67	2.82
<b>Sub Total</b>	<b>1792</b>	<b>13529.02</b>	<b>242.44</b>
<b>Secondary Sector</b>			
Formal	208517	18357.75	38279.04
Informal	65919	12064.51	7952.81
2 as a ratio of 1	0.32	0.66	0.21
<b>Sub Total</b>	<b>274436</b>	<b>16846.13</b>	<b>46231.85</b>
<b>Tertiary Sector</b>			
Formal	159663	27001.80	44229.53
Informal	148114	19821.88	29358.98
2 as a ratio of 1	0.93	0.73	0.66
<b>Sub Total</b>	<b>307777</b>	<b>23909.68</b>	<b>73588.51</b>
<b>Total</b>			
Formal	368525	22406.07	82572.00
Informal	215480	17398.73	37490.80
2 as a ratio of 1	0.58	0.78	0.45
<b>Rental Income</b>	—	—	<b>3413.00</b>
<b>GRAND TOTAL</b>	<b>584005</b>	<b>20558.52*</b>	<b>123475.80</b>

\* For working out productivity for the city economy, the rental income has been excluded.

mal sector was found consistently lower than that in the formal sector. In the two important segments, i.e., manufacturing and non-manufacturing, productivity per person was significantly higher in the formal than in the informal sector. Productivity per person was Rs. 18,357.75 and Rs. 27,710.80 in the formal manufacturing and non-manufacturing segments. The corresponding productivity was Rs. 12,064.51 and Rs. 19,821.88 per person in the informal manufacturing and non-manufacturing segments.

The above discussion on productivity differential is based on a highly aggregative level., therefore, it needs to be extended to a more disaggregated level. Table 2 shows that in the manufacturing informal sector, per person productivity was higher in chemicals, machinery and repairs than the corresponding formal sector activities. In the rest of the manufacturing products, the formal sector has higher productivity level than in the informal sector. In the non-manufacturing segment, productivity per person in

the informal sector was higher only in transport activity, whereas in the rest of the comparable activities, the informal sector had an edge over, the formal sector. It is significant that in the entire manufacturing and non-manufacturing segment, the informal sector productivity per person was highest in illegal activities, but lowest in textiles. Further, in the informal manufacturing segment, productivity per person in textiles, basic metals and food products was found much below the city's average productivity for the informal sector. Also, in the informal non-manufacturing segment, the productivity per person in community services, personal services trade in food and miscellaneous manufacturing trade in others and recreational and cultural services (Rs. 10,806.45) was found lower than the city's average productivity of the informal sector.

In order to substantiate the above findings in productivity differentials, a statistical exercise was also carried out for the manufacturing segment alone. Productivity per person was used as independent variable, while wages per worker and capital per worker were incorporated as independent explanatory variables. A multiple regression model has been used :

$$\text{Log (V/L)} = a + b \log (W/L) + bl \log (K./L)$$

where,

V/L indicates the net value added per worker, the W/L and K/L show the wages per worker and fixed capital per worker respectively. The results of the model specified above are presented hereunder for the informal as well as for the formal manufacturing sectors.

#### A. Informal Sector

$$\text{Log (V/L)} = -0.06 + 0.72 \log (W/L) + 0.37 \log (K/L)$$

(10.29)\*                      (6.17)\*

$$R^2 = 0.98^*$$

#### B. Formal Sector

$$\text{Log (V/L)} = -0.20 + 0.89 \log (W/L) + 0.22 \log (K/L)$$

(4.94)\*                      (1.47)\*\*\*

$$R^2 = 0.84^*$$

Note : Figures in parantheses show 't' values.

\* Indicates significant at 1 per cent level.

\*\*\* Indicates significant at 10 per cent level.

We find that productivity per worker (in logarathemic form) is explained more significantly by the wages per worker vis-a-vis the capital per worker both for the informal as well as for the formal sectors. This is so because productivity is determined mainly by the capital labour



**Table 2 : Per Person Net Value Added for Various Activities in the Formal and the Informal Sectors : Kanpur 1985-86**

(Value in Rs. per annum)

Sectors	Formal Sector	Informal Sector	3 as a Ratio of 2	City's Average
1	2	3	4	5
<b>A. Manufacturing</b>				
Food Products	22556.12	8459.78	0.37	15671.76
Textiles	14560.12	6447.75	0.44	14324.44
Paper, Printing and Allied	16540.22	10775.95	0.65	13068.10
Leather Products	35679.96	13496.19	0.38	29793.03
Rubber & Plastics	18640.72	14037.14	0.75	17102.79
Chemicals	25560.16	26743.07	1.05	25759.03
Basic Metals	12858.43	7708.09	0.60	11271.59
Metal Products	11550.12	12471.43	1.08	11895.57
Machinery	22465.79	24093.72	1.07	22636.41
Electrical Machinery	26550.05	11190.89	0.42	24139.36
Other Manufacturing	18555.59	12065.16	0.65	16217.04
Repairs	12559.79	14398.66	1.14	14023.52
Electricity, Gas and Water Supply	14588.71	—	—	14588.71
Land Based Activities	18385.51	12371.11	0.67	13529.02
<b>Sub Total</b>	<b>18357.80</b>	<b>12071.10</b>	<b>0.66</b>	<b>18060.19</b>
<b>B. Non-Manufacturing</b>				
Wholesale Trade in Food, Textiles, Live Animals, Beverages & Intoxicants	41132.20	22483.48	0.55	29776.49
Wholesale Trade in Machinery, Transport & Electrical Equipments	—	26973.33	—	26973.33
Trade in Food and Misc. Manufacturing	—	10560.61	—	10560.61
Trade in Food and Food Articles, Beverage, Tobacco & Intoxicants	38870.18	25289.93	0.65	26449.28
Trade in Textiles	36520.35	15496.80	0.42	20424.64
Trade in Fuel and other Household Utilities	28049.39	19616.78	0.70	21344.94
Trade in Others	34136.38	10685.20	0.31	17011.17
Restaurants and Hotels	32140.42	17136.61	0.53	23280.66
Storage and Warehousing	22942.74	13723.13	0.60	17083.85
Educational, Scientific and Research Services	—	12398.47	—	12398.47
Medical and Health Services	—	11798.45	—	11798.45
Community Services	—	9560.31	—	9560.31
Recreational and Cultural Services	—	10806.45	—	10806.45
Personal Services	13260.79	9768.12	0.74	10606.42
Services not elsewhere classified	32606.11	21316.04	0.65	27058.49
Unspecified and Illegal Services	—	41864.41	—	41864.41
Transport Activities	19396.76	20245.06	1.04	20104.05
Communications, Banking, Financial Institutions	28704.05	—	—	28704.05
Provident Fund and Insurance Govt. Employees not included elsewhere	22444.73	—	—	22444.73
<b>Sub Total</b>	<b>27701.80</b>	<b>19821.88</b>	<b>0.71</b>	<b>23909.68</b>
<b>GRAND TOTAL</b>	<b>22406.07</b>	<b>17398.73</b>	<b>0.78</b>	<b>20558.53</b>



ratio. When a comparison is made between the input elasticities between the informal and the formal sector, it is found that the coefficient of (W/L) is higher for the formal sector, while the coefficient of (K/L) is significantly higher in the informal sector vis-a-vis the formal sector. The above findings therefore suggest that higher productivity in the formal sector is relatively due to higher wages paid to workers. A more clear relation can also be observed if one regresses per worker productivity with wage rate alone.

We obtained the following results :

#### A. Informal Sector

$$\text{Log (V/L)} = -0.25 + 1.15 \text{ log (W/L)} \\ (19.17)^*$$

$$R^2 = 0.84^*$$

#### B. Formal Sector

$$\text{Log (V/L)} = -0.14 + 1.16 \text{ (W/L)} \\ (58.00)^*$$

$$R^2 = 0.97^*$$

Note : Figures in parantheses show 't' values.

\* Indicates significant at 1 per cent level.

The analysis, thus, confirmed that productivity differentials are primarily on account of differences in wage rates prevailing in both the sectors of the city economy. During our field enquiry, it was revealed that formal sector paid Rs. 9811 which was much higher than the wages paid by the informal sector of Rs. 5894 per annum.

### Conclusions

The foregoing exercise examined the contribution of the informal sector in terms of employment and income generation vis-a-vis the formal sector. It was found that the informal sector contributed handsomely in terms of employment and income of the city economy. The contribution of the informal sector was more significant in non-manufacturing so called trading and service based activities than in the manufacturing segment. However, compared with the formal sector, the share of the informal sector was less significant; it accounted for 37 per cent in terms of employment and 30.37 per cent in terms of income. The productivity of the informal sector has been found considerably lower in the informal vis-a-vis the

formal sector. This is true for the manufacturing and the non-manufacturing segments. The main causal factor for the productivity differentials between the two sectors is discovered as the different level of wages paid to the workers.

Also the low level of productivity in the informal sector vis-a-vis the formal sector is the outcome of various factors such as, technological backwardness, poor and inadequate infrastructure facilities and the inefficient marketing network. Machines and equipments used by the informal establishments are generally out dated, and once rejected by the formal entrepreneurs. It was also underscored that informal entrepreneurs were seen facing severe difficulties on account of procurement of raw materials, shortage of credit and space constraints. As far as marketing is concerned, most of the informal sector entrepreneurs were seen competing severely not only with one another but also with the large scale organised firms. Also, factors like inferior quality of the products and higher price were reported to have affected adversely the sale of the informal sector goods.

Thus, in order to improve the productivity of the informal sector, certain steps are required to be undertaken. First, there is an urgent need to provide credit at lower rate of interest to the informal sector entrepreneurs. This, in turn, would help in modernising the informal establishments. Of course, it would be essential to see that credits extended to them are productively utilised by the informal sector entrepreneurs. Second, it would be useful if government makes arrangement to overcome the problems arising on account of shortage of raw materials, infrastructure and so on. And third, the linkages of the informal sector with the formal sector should be strengthened. It could be facilitated by enhancing the purchases and sales of the formal with the informal sector. Also, the upgradation and extension of training for the informal sector workers would help a great deal to enhance the productivity of this sector.

### Acknowledgements

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# A Guide to Productivity Measurement in Public Agencies

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*The public agencies (Govt. Service, as they are broadly called) are important from the point of view of not only the nature of the services rendered by them, but the sheer number of persons (and their qualifications, as well) also. In many of the developing nations these agencies account for about 25% of the GDP. It is conventionally believed that, due to the very nature of the activities rendered by these agencies, their productivity cannot be measured and, therefore, implicitly at least, improved also. This paper attempts to prove it otherwise.*

There has been a great deal of discussion recently about productivity and the economic benefits that can be gained from productivity improvement. Demand for public sector products and services continues to rise while the availability of resources to produce them is increasingly constrained. With greater public scrutiny of the resources allocated to Government, increasing demands are made on public sector organisations to measure and enhance their productivity. Given this, and moves towards enterprise-based wage negotiations based on productivity improvement, the Department of Productivity and Labour Relations recognises many organisations within the public sector would benefit from a document explaining what productivity is and how to go about measuring it. The concepts discussed in this document place productivity within familiar concepts of corporate management and strategic planning.

## What is Productivity ?

- \* Total Productivity is the optimal achievement of economic and social benefits through the appropriate use of labour, capital and other resources to provide quality goods and services.

The three elements which contribute to Total Productivity are Labour Productivity, Capital Productivity and Social Productivity.

- \* Labour Productivity is the ratio between the output of quality goods and services and the labour input required to produce that output.

That is, it involves the level of employees' skills and knowledge and use to which these are put in order to produce the goods and services of the organisation.

- \* Capital Productivity is the ratio between the output of quality goods and services and the capital input required to produce that output.

This refers to the quality and quantity of building, plant equipment and technology, and the resources devoted to research and development.

*Exerpts from a recent Report prepared by the Department of Productivity and Labour Relations (Govt. of Australia), Policy Development Branch.*



\* Social Productivity is the relationship between socially desirable outcomes and the way in which all resources are utilised in producing quality goods and services

That is, it refers to the social impact of the processes involved in producing goods and services and the social impact of those goods and services themselves.

All three aspects of productivity need consideration in any attempt to measure productivity.

### Why Measure Productivity ?

Productivity measurement is important primarily because it provides invaluable feedback on the performance of an organisation. The information thus provided can be used to enhance productivity. They can function at any level within an organisation, including as evaluators as part of programme management. Furthermore, the recent interest in productivity bargaining means that measuring productivity is becoming a greater priority. Without productivity measures or indicators, it is impossible to evaluate whether workplace initiatives have increased an agency's productivity.

In terms of productivity measurement and improvement for enterprise bargaining purposes, individual organisations need to decide on productivity improvement initiatives which will achieve the productivity gains they require and which will qualify employees for wage increases under the wage fixing principles. The productivity measurement methods outlined in this paper should be useful in helping organisations measure any changes in their productivity, but the range and types of measures used will vary from organisation to organisation. Individual organisations, therefore, need to reach agreement on measures which are appropriate for their particular situations.

### Measures and Indicators

Before proceeding further it is important to distinguish between productivity *measures* and productivity *indicators*. Measures purport to measure a complete set of data which will evaluate the performance of an organisation or part thereof, whereas indicators gather a representative set of data which will show a trend in the performance of an organisation or part thereof. Whilst measures are preferable, the value of indicators should not be underestimated.

### Productivity Measurement : The Process

Figure 1 is a simplified generic model of an organisation's operations. The model shows a progression from an agency's mission statement and objectives, down through the costs, inputs, outputs and outcome.

**Mission** : the agency's mission statement should clearly identify the social function or need which it has been created to fill.

**Objectives** : the agency's objectives should identify more specifically the particular outputs and outcomes which the agency plans to achieve.

**Costs** : the costs represent the dollar value assigned to the resources used by the agency.

**Process** : the way in which the input are combined to produce the outputs.

**Inputs** : the inputs represent the resources, both human and physical, used to produce the agency's goods and services.

**Outputs** : the outputs are the goods and services produced by the agency.

**Outcomes** : the outcomes are the impacts on, or consequences for, the community as a result of the agency's outputs. These can be expressed in monetary or non-monetary format.

### Productivity Measures

Using these six "building blocks" we can construct a variety of productivity measures which act as links between each block.

Figure 2 shows how the relationships between these building blocks provide us with appropriate productivity measures.

1. The relationship between costs and inputs is commonly called an *economy* measure. That is, it measures whether the best possible use is being made of an agency's spending power.
2. The relationship between inputs and outputs is commonly referred to as an *efficiency* measure for example, the number of services or products delivered per agency Full Time Equivalent (FTE).

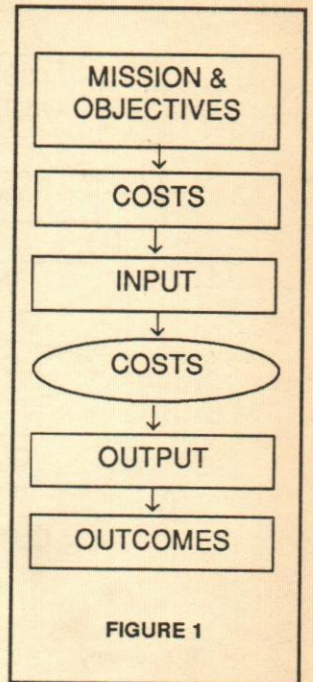
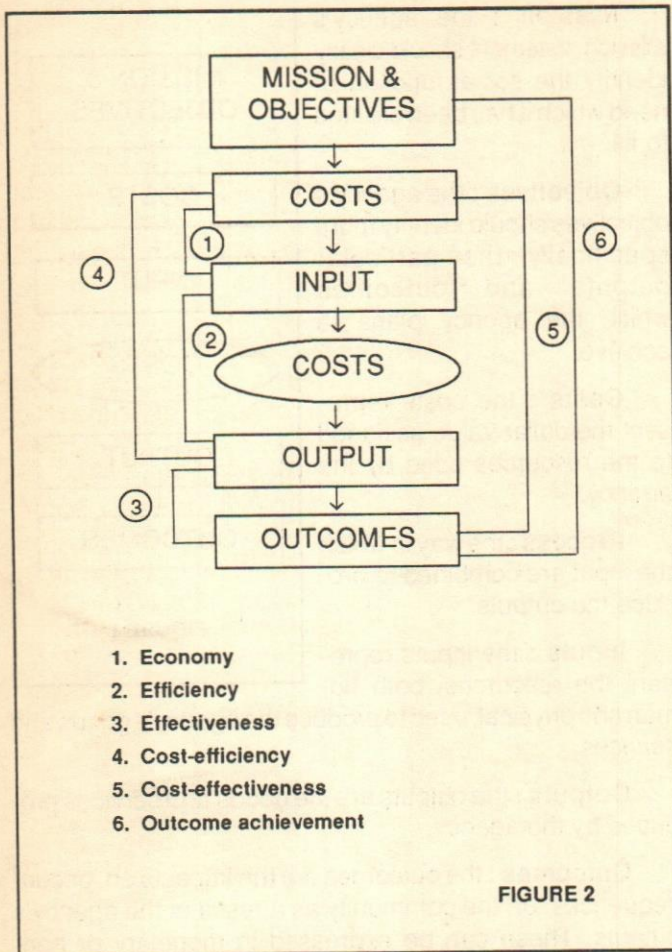


FIGURE 1





3. **Effectiveness** can best be defined as the relationship between outputs and outcomes. That is, they measure how well the outputs of the agency create the desired consequences for the community.
4. **Cost-efficiency** measures express the relationship between outputs and costs.
5. Similarly, **cost-effectiveness** measures compare outcomes to costs.
6. **Outcomes achievement** measures examine the extent to which an agency achieves its mission and objectives. The agency's outcomes are the yardstick against which all else should be measured. There is very little point running an economical and efficient department if the outcomes are not those required by Government or the community. In this model, outcomes means the impact of the agency's output, both in terms of social and financial impact. Outcomes, therefore, can be expressed in dollar

terms or in other terms, both quantitative and qualitative.

### Key Elements in Productivity Measures

Successful productivity measures work together to form a composite picture of an organisation's performance. It is necessary, therefore, that a variety of measures are developed, and each measure is as comprehensive as possible. The following points should be considered before any productivity measures are finalised.

It is necessary, therefore, that a variety of measures are developed, and each measure is as comprehensive as possible.

### Feedback

Productivity measures are primarily intended to give management information about the performance of an organisation or sections of that organisation. They should, therefore, be constructed so that the information they provide will be useful to management. If organisational changes are implemented (such as job redesign), the measures should show any resultant change in performance. For example, if an agency decides to increase the percentage of Aboriginal officers employed as field officers in rural areas with the aim of improving community interaction with Aboriginal people, then any measures of productivity should include an effectiveness measure of client satisfaction.

### Client or User

In line with providing useful feedback, the client group for which each productivity measure has been developed should be defined. Productivity measures may be required by the management of an organisation, they may be demanded by clients both internal and external, such as a Minister or the community, or they may be required by legislation.

In each of these cases, the type and level of measures most appropriate will vary. Management will probably require detailed measures at the programme level, whereas the Minister may require a macro-level measure of productivity, and community groups may require measures of the



**As these productivity measures are developed, their purpose and, where appropriate, the client group for which they have been developed should be stated.**

productivity of particular programmes or services which have immediate impact upon their lives. In a similar way, some of these measures will be formulated as outputs compared with inputs, some as outcomes compared with costs, and some as outcomes compared with mission statements and objectives. As these productivity measures are developed, their purpose and, where appropriate, the client group for which they have been developed should be stated.

### **Level of Measurement**

Productivity can be measured at the community level, for example through State or industry productivity statistics. It can also be measured at organisational level, for the organisation as a whole, or at the level of a work group or section within the organisation. In many cases, the same measures can be developed to measure the productivity of a section, and then adapted to measure the productivity of the complete organisation.

### **Time Frame**

In developing productivity measures, the time over which the measure will be used should be established. That is, the time frame for each measure should be agreed from the beginning.

### **Benchmarks**

A number of different benchmarks can be used in measuring an agency's productivity. The best results will be achieved by using an appropriate combination of benchmarks, including the following :

- \* a minimum standard
- \* an optimal standard
- \* the agency's own past performance
- \* the performance of similar others
- \* client expectations
- \* the agency's own goals.

A minimum standard might be used as a benchmark in cases where legislation sets out minimum safety standards for example. This would normally be combined with an optimal standard or the target the agency or section has set itself. In many cases, the most effective use of productivity measures will be to compare one year or half-year with the next. If this is desired, then it is clearly important for the measures to be developed carefully from the start so that they can be duplicated each year. However, it is also possible to compare an organisation's productivity with other like organisations, both public and private, or, in some cases, to compare it with an industry or State-wide average. An example of this type of measures is the ratio between the number of days lost due to accidents and industrial disputes and the number of days worked. The expectations of an agency's client-groups can also be used as a benchmark of productivity measurement. The extent to which expectations are met year by year or in different programmes can be compared. decogun

### **Data Characteristics**

Data used in productivity measures should be :

- \* Accurate
- \* Available
- \* Appropriate
- \* Relevant
- \* Valid.

Clearly, all efforts should be made to ensure that data collected is statistically valid. Unless it is accurate, appropriate and relevant, the measures and indicators developed will be of little use as information on the performance of an agency or programme. It is also important that the data is easily accessible, for if the data is costly and difficult to collect, the likelihood of successful collection over time is obviously low. Finally, it should also be made clear when a direct cause and effect relationship is claimed and when it is not. For instance, if after a twelve month programme publicising Fremantle as a tourist destination, the numbers of tourists visiting Fremantle Museum rises substantially, it is not clear that the publicity campaign is directly and solely responsible for the increase in tourist numbers. It may be that more package tours are visiting the Museum now because the Perth Museum has been temporarily closed, or because the Fremantle Museum has reduced its entry charge, or for any of a number of other possible reasons. In this example, the increased tourist numbers are an indicator of the programme's effectiveness, rather than a measure.



## Objective/Subjective

Productivity measures can be both objective and subjective. The objective measures will be more reliable, but may well focus only on specific aspects of output or outcome. More subjective measures include, for example, the level of client satisfaction with a service, or the level of Ministerial endorsement for a new proposal, and can therefore be important measures of agency effectiveness.

Productivity measures and indicators can and should be both quantitative and qualitative. Few public sector organisations have mission statements which do not incorporate qualitative aspects of service or product delivery. For example, if a hospital adopted productivity indicators or measures which concentrated purely upon dollars or patient numbers, it would receive only some indication as to the hospital's efficiency. Qualitative data is also required to ensure these efficiencies are not made at the expenses of the quality of patient care or recovery rates which are far more closely linked to the hospital's mission.

**Productivity measures and indicators can and should be both quantitative and qualitative.**

## Consultation

It is important a consultative process is used to develop productivity measures. Agreement should be obtained from all those involved in collecting and supplying the information. They should be viewed by employees as a tool rather than another way of monitoring their work. This process of consultation should ensure that the measures are clear and realistic.

## Examples

Although every public sector agency is different and has different mission statements and objectives, the methods by which they develop productivity measures are likely to have much in common. For this reason, a number of examples of the type of measures and indicators which can be developed are given below. The majority of these examples are in fact performance indicators taken from past annual reports. Used in combination with other measures and indicators, they are a significant step along

the path to productivity measurement. It should also be noted that a number of public sector agencies have now gone beyond those performance indicators published in their annual reports to develop sophisticated measures and indicators :

### 1. Economy (cost per unit of input)

(Generic Measures)

Labour cost per Full Time Equivalent (FTC).

Cost of running and maintenance of equipment per piece of equipment.

Cost of labour turnover. (This can be compared with total labour costs.)

Costs of days lost through absence and accidents. (This can be compared with total labour costs.)

### 2. Efficiency (output per unit of input)

*Stateships* : Extent of operational delays, expressed as a percentage of total working days and compared with previous year.

*Hospital Laundry & Linen Service* : Kilogram of linen cleaned per operator hour, compared with previous years.

*SECWA*: GWh of electricity sold per employee.

*WA Museum* : Number of visitor enquiries handled per Full Time Equivalent (FTE).

*Homeswest* : Average number of days a rental unit is left vacant in the metropolitan area (i.e. measuring speed of use of rental units once they are vacated).

In agencies with trading status, sales revenue divided by total assets is an efficiency measure.

### 3. Effectiveness (outcome as a result of output)

*Health Department* : Percent of target group awareness of health promotion campaigns such as Quit and Drinksafe.

*SECWA* : Electrical accidents investigated (where all reported accidents are investigated) per 100,000 customers (i.e. the lower the number of accidents, the more effective the service).

*Department of Corrective Services* : Rate at which prisoners escape from custody, compared with previous years.

*Transperth* : Passenger boardings per thousand seat kilometre.

### 4. Cost-efficiency (cost per unit of output)

*WA Fire Brigades Board* : Cost per head of population protected from fire.

*Department of Corrective Services* : Annual cost per offender subject to community based supervision.

*Transperth* : Cost per traffic kilometre of bus, train and ferry services.



5. **Cost-effectiveness** (cost of successful outcomes)

*Police Service* : Cost of clearance of offences per 100,000 population, compared with previous years.

*Health Department* : Cost of different health promotion campaigns, factoring in their effectiveness rates.

6. **Outcome achievement** (comparisons of outcomes to mission and objectives)

Indicators under this heading generally require a narrative description by way of background information, expansion as to the meaning of certain terms and explanations of connections. These often technical details will obviously be very different from agency to agency.

Often an agency's outcome achievement will be affected or influenced by external factors over which it may have no control. There is unlikely to be a simple numerical ratio of outcome achievement for an agency. Other productivity measures and indicators will combine to assist the development of an agency's outcome achievement.

Given these caveats, some examples of outcome achievement measures are listed below. These may provide a basis for more substantial and useful descriptions.

The Lotteries Commission objective is :

*To raise money for the hospital fund, for charitable purposes, for sports and for culture.*

Therefore, the extent to which the money that they raise and distribute increases year by year may well be an outcome achievement measure.

One of the corporate objectives of SECWA is :

To maintain an economical and reliable supply of electricity and gas to our customers.

Therefore, the extent to which the supply of gas and electricity is available, safe and affordable will be the basis of an outcome achievement measure.

**Type of Agency**

As the above examples demonstrate, a wide variety of measures can be developed within the public sector. Clearly, the more concrete a product or service an agency

is delivering, the easier it is to develop productivity measures. Those agencies with missions and objectives which can be measured in quantitative terms have a distinct advantage. However, it would be wrong to see a simple divide between utility and service agencies, as almost all utility agencies also have a service component in their mission of objectives.

To give two examples, one of Transperth's corporate goals is :

To design and provide at minimum cost the network of bus, train, ferry and other *appropriate* urban public transport services which *best meets* the transport needs of the community;

and the WA Water Authority's corporate objectives are:

To ensure availability of water related services at minimum long term cost and to a *standard acceptable* to the community, and

To ensure the assessment and *efficient management* of the State's water resources for the *continuing benefit* of the community.

Emphasis has been added to highlight the service aspects of the objectives.

The second major difference between utility and service agencies is the level of influence they have over the outcomes of their work. For example, one of the Health Department's objectives is "to reduce the prevalence of behaviours that contribute to illness, disability and premature death", but that Department alone cannot be held responsible for the widespread prevalence of such behaviours. SECWA, however, does have a monopoly on the supply of electricity and gas. These comments are not to suggest that service agencies cannot develop productivity measures. They are rather intended to acknowledge that there may be some difficulties confronting public sector agencies and to suggest that each agency will need to provide its own solutions. The examples above will be most usefully viewed as ways of thinking about productivity measurement and cannot necessarily be transferred directly to other agencies.





# Training for Productivity-International Experiences

## Training — An Integral Productivity Approach

Productivity training forms part of a productivity culture which takes many years to develop in a country. While attitudes towards productivity are largely formed by a country's education system, specific training programmes are needed to develop productivity improvement skills.

Productivity training has to be seen in the context of the productivity improvement approaches in a country, region or enterprise. Many productivity training programmes fail not because of the inappropriate content, but because of the lack of appropriate organisational structures as well as insufficient management support and worker resistance. This is particularly true in countries where little or no productivity culture exists. Therefore, productivity training can only be successful if there is first, the will to change and second the resources. This requires the creation of a receptive context, or in other words, a fertile soil to improve productivity. If we analyse economic and socially successful countries—each of which differ substantially in their productivity approach—we may, however, find some common denominators, as to how these countries succeeded in creating a fertile soil for productivity improvements.

## Productivity Management is Concerted Action

In the long run productivity can only be improved if workers and employers co-operate. This requires the establishment of *confidence between management and the work force*. If there is no mutual trust, workers will tend to resist the proposal of productivity improvement made by management, and management will not sufficiently delegate responsibilities to the workers in order that they can develop their own initiatives. The second precondition of the concerted action towards productivity, is a respective *qualification for employers, management and workers*. A workers' representative will be more prepared to enter into discussions on proposals for productivity improvement with management if he understands the proposals and

knows where they will lead to. That is why productivity training has to also include representatives of the workers. However, it is equally true that both managers and employees must understand how the productivity improvement process works. High productivity countries are taking this into account and offer productivity training for staff of all levels of the enterprise, from the shop floor to top management.

Employer/worker co-operation on productivity matters must be based on a *coherent organisational system* where the rules of the play are clearly defined. This applies not only to responsibilities but also to procedures such as the establishment of incentive systems or standard times in production.

## Productivity Management is Participation

Co-operation between employers and workers is most efficiently put into practice by different forms of participation, such as suggestion systems and small group activities like quality circles, or the delegation of responsibilities. Participation requires the establishment of common goals, it means team work on all levels and it requires discipline and commitment, but it also motivates and increases job security. One major objective of productivity training programmes is to learn how to participate effectively and to reach the common goal of productivity improvement.

## Productivity Management is Information Management

A major obstacle of productivity improvement is very often the lack of communication in the enterprise. Produc-

**High productivity countries are taking this into account and offer productivity training for staff of all levels of the enterprise, from the shop floor to top management.**



**A major component of productivity training should therefore concentrate on information management.**

tivity training must overcome this by creating a common language for all enterprise levels concerned. Some countries overcome the language barrier by offering similar courses to all levels of management. The communication aspect within the enterprise in order to achieve high productivity cannot be over-emphasized. There is a need for continuously comparing reality versus forecast, and creating a feeling that the workers are being informed of what is happening in their enterprises and how they can contribute to improve enterprise performance. A major component of productivity training should therefore concentrate on information management.

### **Productivity Training Contents and Form**

If we look again into productivity improvement programmes of the economically and socially successful countries, we may formulate the following learning objectives for productivity training. Productivity training should enable employers, managers and workers to :

- Take responsibility and act appropriately;
- Solve problems systematically,
- Induce a continuous process of change;
- Develop personality and expertise;
- Adapt continuously to a changing environment,
- Develop social responsibility.

It may surprise some that this list does not appear to emphasize technical skills. It is not that technical skills are not important, but in most of the economically and socially successful countries they are taken for granted. Developing countries must certainly put more emphasis on technical skills. Even though someone is illiterate, that person may have acquired good skills relating to a specific job and may know how to improve productivity. The working person will be willing to share his/her information with management if he/he will be rewarded for the contribution.

In the most productive countries of the world, middle management plays a crucial role in improving productivity, hence the reason why middle managers often form the

main target group for productivity training. They must be able to take responsibilities, solve problems systematically and motivate the workforce. Upper management will have to know how to induce continuous processes of change and how to adapt continuously to a changing environment.

What are the most appropriate forms of productivity training? There are several answers to this question. While programmes to raise productivity awareness should contain theoretical concepts and some practical cases, specialised training programmes to obtain the necessary skills to improve productivity must go a different way to validate these skills in practice. There are for example action learning, or training courses combined with project work in companies. The latter has proved successful in enterprises where there is no productivity infrastructure and expertise existing as yet.

As the needs for productivity training vary widely from country to country, enterprise to enterprise and from target group to target group, the International Labour Office is currently preparing a "Modular Programme for Managing Productivity Improvement" which is structured in such a way that the institution imparting the training can adapt the programme to its own needs. The Modular Programme can be used as a basis for productivity training courses, for designing productivity improvement programmes in a company, to guide outside consultants on how to tackle productivity programmes and how to solve specific productivity related questions. The programme is divided into two parts, the first focuses on the productivity improvement process from productivity measurement and analysis to the management of organisational change. The second part looks into the potential productivity improvement areas and techniques (consult the annexed module list). Such a modular approach is able to meet different training needs but also helps to assist concrete productivity improvement projects. The programme will be available by 1992.

### **Conclusions**

We may conclude that productivity training programmes have to prepare the soil for productivity improvement and prepare the enterprises to practically improve their productivity with a minimum of cost and specialised human resources. This would call for a combined training and consultancy approach. By integrating short training programmes with pilot projects in the enterprise, enterprises should be able to overcome the most obvious obstacles hindering higher levels of productivity by improving factory layout, material handling, utilisation of machine capacity,



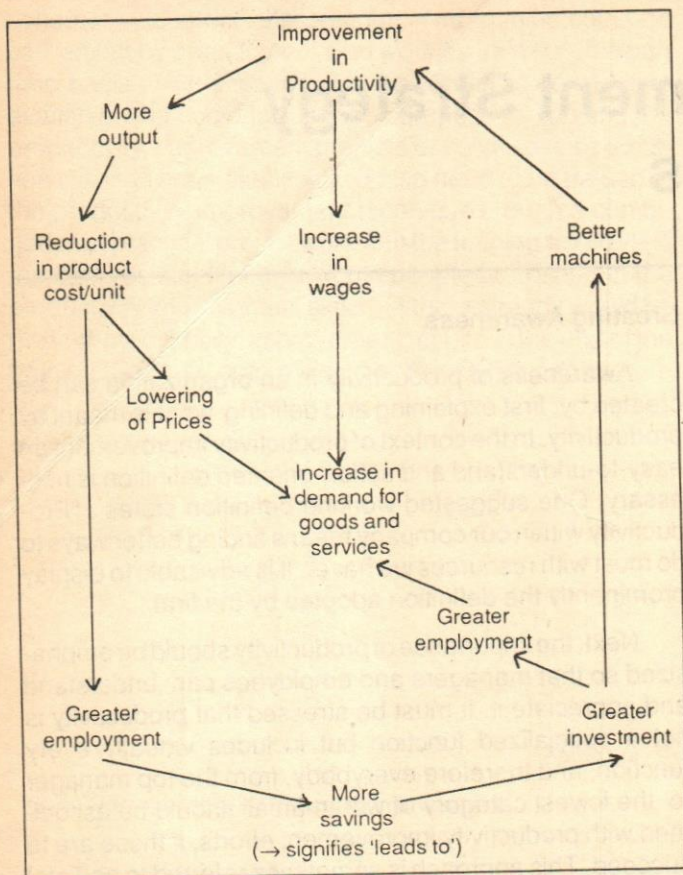


FIG. 1: THE DYNAMICS OF PRODUCTIVITY CHANGE

lar inputs and outputs lies in converting all component elements into monetary units. To account for inflation, these monetary values are deflated to prices prevailing during a suitably selected base period.

Software known as TOPROD, usable on IBM compatible PCs, has been developed by the author to measure the productivity of a manufacturing company or department. The software consists of five computer programmes. A sixth supplementary programme SUPP may be used to correct errors in data entry, and also to play "what-if" games. The software is designed to handle upto 1000 kinds of capital equipment, 50 categories of raw materials, 62 categories of other direct costs, 90 categories of indirect costs and 700 product items. A short description of each module follows :

**RIP/1 :** This programme computes the resource input partial (RIP), representing the depreciation on capital equipment during the period being evaluated. The depreciation charges on capital equipment are computed for a 10-year period (regardless of the actual life of the machine), using the straight-line method.

**RIP/2 :** This algorithm is used to compute the partial resource input, representing the direct costs of direct labour, power input, fluids used to run equipment, raw materials and purchased parts, and tools and maintenance materials for production machines.

**RIP/3 :** This programme is used to compute the indirect costs associated with, management, supervisory staff, clerical workers, indirect labour, computers and office equipment and miscellaneous indirect materials and supplies

**Output :** This programme computes the value of total outputs by multiplying the output quantities of items produced by prices prevailing during the base period.

**Productivity :** The expressions for total productivity index (TPI) and partial productivity index (PPI) take the form :

$$TPI(\%) = \frac{\frac{OUTPUT_m}{RIP_{1m} + RIP_{2m} + RIP_{3m}}}{\frac{RIP_{1b} + RIP_{2b} + RIP_{3b}}{OUTPUT_b}} \times 100$$

where m and b denote the subscripts for measured period and base period respectively.

$$PPI(\%) = \frac{\frac{OUTPUT_m}{PI_m}}{PI_b} \times 100$$

where PI is the partial input, for either fixed capital, labour, energy or raw materials.

The following computations indicate the possible source of changes:

$$OUTPUT(\%) = \frac{OUTPUT / (RIP_{1m} + RIP_{2m} + RIP_{3m})}{OUTPUT_t / (RIP_{1t} + RIP_{2t} + RIP_{3t})} \times 100$$

Here the subscript t denotes cumulative values for the measured year to date. Similar calculations apply to RIP/1, RIP/2 and RIP/3.

At the end of a time period (either a week or a month), the 5 modules generate reports, informing the manager of the quantities of various inputs utilized and outputs produced as well as productivity ratios, and changes from the base period. The computer printout of the final programme of TOPROD is shown in Fig. 2.

### Productivity Evaluation

This phase forms the transitory stage between measurement and planning and is of significance to productivity



PRINTOUT OF PROD. 1.1.90 TO 1.2.90	
<b>TOTAL PRODUCTIVITY</b>	
BASE PERIOD RATIO	0.969
CURRENT PERIOD PRODUCTIVITY	109.5 %
CUMULATIVE PRODUCTIVITY	107.0 %
<b>PARTIAL PRODUCTIVITY OF FIXED CAPITAL</b>	
BASE PERIOD RATIO	5.30
CURRENT PERIOD PRODUCTIVITY	109.1 %
CUMULATIVE PRODUCTIVITY	107.2 %
<b>PARTIAL PRODUCTIVITY OF DIRECT LABOUR</b>	
BASE PERIOD RATIO	3.16
CURRENT PERIOD PRODUCTIVITY	109.0 %
CUMULATIVE PRODUCTIVITY	106.8 %
<b>PARTIAL PRODUCTIVITY OF ENERGY</b>	
BASE PERIOD RATIO	10.92
CURRENT PERIOD PRODUCTIVITY	108.6%
CUMULATIVE PRODUCTIVITY	107.0%
<b>PARTIAL PRODUCTIVITY OF RAW MATERIALS</b>	
BASE PERIOD RATIO	9.72
CURRENT PERIOD PRODUCTIVITY	108.3 %
CUMULATIVE PRODUCTIVITY	106.8 %
CHANGE, CURRENT COMPARED TO CUMULATIVE AS PERCENT OF CUMULATIVE	
OUPUT=	102 %
RIP1 =	101 %
RIP2 =	100 %
RIP3 =	99 %

FIG. 2

planners in companies. Evaluation has two aspects. The first involves comparisons of productivities in different time periods; generally the present productivity is compared with some past performance, usually the base period.

The second aspect of evaluation is the construction of various feasible paths of theoretically possible changes that result in changes of productivity. Those paths that decrease or cause productivity to remain stationary are eliminated. Paths showing improvement of performance are further examined for their feasibility, and the most suitable one selected for implementation. The technique commonly used in this regard is computerized simulation. The SUPP programme of TOPROD software, allows changes in various parameters, such as capital, raw materials, energy and labour inputs as well as outputs to be simulated. The effect of the changes on total and partial productivities can then be observed.

Productivity evaluation further involves an analysis of the causes or past trends—particularly when the trend is declining or not displaying satisfactory improvement. This calls for a management audit. All company functions,

**Causes are variables or factors that contribute to the variation of level of the results.**

organizational as well as technical are examined in the audit.

Known as the fish-bone diagram, the cause-and-effect diagram relates an observed effect with its possible causes. Causes are variables or factors that contribute to the variation of level of the results. Causes can usually be categorized broadly as Products, Management, Workers, Machines and Input materials. Figure 3 depicts a generalized cause-and-effect diagram for low productivity in Indian industries.

### Productivity Planning

The productivity measurement and evaluation steps must be followed by a scheduled programme of action. Productivity planning is concerned with two activities : (i) the setting up of target levels of total and/or partial productivities and (ii) devising ways and means of improving productivity.

#### Target Setting

While setting productivity targets there are three levels which must be considered :

- (i) the present productivity level,
- (ii) the desired productivity level, and the time required to achieve it,
- (iii) a number of intermediate stages.

For example, if it is desired to improve the productivity of a system by 30 percent within 6 months, and if the improvement process is expected to follow a linear trend, the productivity plan may envisage the setting up of two intermediate targets at the end of the 2nd and 4th month, corresponding to 10 and 20 percent improvement, respectively. The actual productivity should be evaluated at these intermediate points, and any deviations from plan rectified.

#### Long and Short-term Plans

It is advisable to have long-term productivity planning, along with short-term productivity planning in a company. Short-term plans, having a horizon of less than one year,



### 1. Output increases, input decreases

This is the most commonly encountered situation. To illustrate the application of linear programming, a company having a number of inputs and outputs is assumed. It is also assumed that total outputs, total inputs and various constraints with regard to production capacity, marketing, resource availability etc. can be expressed as linear functions.

Let  $X_1$  = quantity of output 1 produced

$x_2$  = quantity of output 2 produced

:

$x_n$  = quantity of output n produced

$$\begin{aligned} \text{Then } O &= a_{11} x_1 + a_{12} x_2 + \dots + a_{1n} x_n \\ &= F_1(x) \end{aligned}$$

where  $a_{11}, a_{12}, \dots$  are unit output prices prevailing during the base period.

Total input may be expressed as

$$\begin{aligned} I &= a_{21} x_1 + a_{22} x_2 + \dots + a_{2n} x_n \\ &= F_2(x) \end{aligned}$$

where  $a_{21}, a_{22}, \dots$  are base year unit input costs.

The various constraints may be expressed as linear functions  $F_3(x), F_4(x), F_5(x)$ , etc.

The linear programming formulation then takes the following form :

$$\text{Maximize } O = F_1(x)$$

subject to

$$F_2(x) < K \text{ [input constraint]}$$

$$F_3(x) \leq C \text{ [machinery constraint]}$$

$$F_4(x) \leq L \text{ [manpower constraint]}$$

$$F_5(x) \leq M \text{ [resource constraint]}$$

$$F_6(x) \leq N \text{ [Market constraint]}$$

where, K, C, L, M, N are constraints

### 2. Output increases, input remains constant

The L.P formulation in this case would be

$$\text{Maximize } O = F_1(x)$$

subject to

$$F_2(x) = K$$

$$F_3(x) \leq C$$

Table 1: Results from a NGT Session

Group	: Machining Department		
Facilitator Name	: A. Saha		
Date	: September 24, 1990		
No. of Participants	: 7		
n (no. of measures asked to vote for)	: 7		
Task Statement	: Please identify measures, ratios and/or indices of performance to monitor, evaluate and control the performance of the machining department.		
Criteria	Votes Received 7 = Most important 1 = Least important	Total (No. of votes/total vote score)	Weightage (Total vote score/grand total) × 100
M/c utilization :	6-5-7-7-3-7-4	7/39	22
Run time/total time			
Quality :	2-6-7-6	4/21	12
Defectives/total units			
Scrap :	3-7-6-1-7	5/24	14
Scrap wt./matl. consumed			
Mean tardiness :	7-2-4-6	4/19	11
Deviation in completion times/no. of jobs			
Overtime :	2-6-4	3/12	7
Overtime hrs./regular hours			
Setup time :	1-2-5	3/8	4
Setup/(setup + operation)			
Absenteeism :	5-4-1-4	4/14	8
Absent hrs./regular hours			
Mean rework period :	6-4-1-5-2-1	5/19	10
Rework time/no. of jobs			
Safety :	5-1-2-5-5-3	6/21	12
Mandays lost in accidents/total mandays			

### 3. Output remains constant, input decreases.

This situation is encountered in case of limited or fixed demand. The L.P. formulation takes the form

$$\text{Minimize } I = F_2(x)$$

subject to

$$F_1 = P$$

$$F_3 \leq C$$

4. Output increases, input increases but at a slower rate

5. Output decreases, input decreases but at a more rapid rate

Ordinarily, the application of linear programming in the above manner improves productivity in those situations where the L.P. technique has not been previously applied. Most problems in industry require the use of a computer for



solution. Computer software, such as Lindo and QSB (Quantitative Systems for Business), are available for the purpose. If output and input expressions are non-linear, then non-linear programming methods may be employed. If the company has different objectives which it wants to include in the output, goal programming may be used. But these techniques are more complicated as compared to linear programming.

## Management

The word management in the context of the individual enterprise refers to the organization of human and non-human resources to attain the end-objective of production. The efficiency with which the task of management is performed in a company, to a large extent, determines its productivity.

An important function of management is decision-making. In areas involving non-human resources, a modern manager has at his disposal a number of theoretical quantitative models to enable him to make good decisions. These models, incorporating well-known industrial engineering techniques, mostly aim at reducing costs, thereby improving productivity. Managing human beings, however, presents challenges which are not amenable to quantitative treatment. Here, the problems encountered call for abilities of a different type. An individual manager who has to deal with people has at his disposal a number of theories of motivation and control devised by behavioural scientists.

An important theory of human motivation is associated with the name of Frederick Herzberg who discovered that two groups of factors motivated employees at work. These he labelled as "motivating factors" and "hygienic factors". Motivation was defined as an influence that had an uplifting effect on productivity, whereas hygienic factors merely provided a base of tolerable conditions. Job characteristics traditionally considered as motivators, such as salary, status, security, relationship with peers, supervision and company policy were classified by Herzberg as hygienic factors, and motivating factors were achievement, recognition, work itself, responsibility, advancement and growth. It follows that Indian managers must take both motivating and hygienic factors into account in order to motivate their

employees to improve productivity.

## Control Reporting

This is the final phase of the corporate productivity improvement strategy. A well-designed system for reporting is an essential part of any successful company productivity programme. Responsibility for the design of a reporting system rests with the management services department (MSD). Each operational unit should be provided with detailed guidelines of the items to be recorded and reported to the MSD, and the specified times when the reports are to be submitted. Preparation of appropriate forms is necessary. The guidelines for control reporting are in two parts. The first deals with reporting progress in the implementation of the productivity programme while it is being implemented for the first time. The second part provides ongoing information for use in controlling the performance of the department or company after installation of the productivity programme. As reporting utilizes company resources and by itself does not contribute to performance improvement, it is desirable for the design of the reporting system to be based on careful cost-benefit analysis. Information to be reported must be sufficiently elaborate for useful analysis to be performed, but every item required to be reported should be capable of being justified. Having obtained the relevant data, the MSD analyses them and prepares reports, charts, trend diagrams, correlation coefficients etc. for presentation to top management. Recommendations are based on the analysis of data.

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## References

- Belcher, J.G. *Productivity Plus*. Houston: Gulf Publishing, 1987.
- Jamali, S., "Putting a Productivity Improvement Programme Into Action: A Six-Step Plan", *Industrial Engineering*, Feb. 1983.
- Saha, A. "The Measurement & Improvement of Producting", *Udyog Pragati*, Jan.-June 1989.
- Stewart, W.T., "A Productivity Improvement Strategy at the Firm Level", *Manufacturing Productivity Frontiers*, Jan. 1980.



# ISO 9000 : An Opportunity or a Nightmare ?

## The Concept

In the present day competitive world, quality is perhaps the most critical aspect for any manufacturer or supplier to concentrate on. Total Quality Management (TQM) has emerged as the most integrated form of organisation development. It is important to understand the meaning of quality in TQM philosophy. In simple terms, quality is customer satisfaction and fitness for use (meeting all the expectations of the buyer of goods or services). The technical definition of quality is given in the International Standards ISO 8402 (Quality - Vocabulary) as "The totality of features and characteristics of a product or service that bear on its ability to satisfy stated or implied needs." In TQM the quality goes beyond. It is the customer delight and not just satisfaction. That means an organisation must plan for ACE (Above Customer Expectations). This will happen when quality is seen as integrated or total quality and the organisations' efforts are guided by the sharp focus on quality and customer.

**In simple terms, quality is customer satisfaction and fitness for use.**

**The ISO 9000 series embodies comprehensive quality management concepts and guidance together with models for quality assurance requirements.**

their national standards. The initial market success of the ISO 9000 series is testimony to the concern for quality improvement in India. The ISO 9000 series embodies comprehensive quality management concepts and guidance together with models for quality assurance requirements. Using an integrated system architecture, the standards are packaged under a harmonised, easily memorable numbering system. These features have high value for the industrial and commercial needs of international trade.

The Technical Committee ISO/TC 176 was formed in 1979 when 'quality' was emerging with a renewed emphasis in trade and industry. The success of ISO 9000 series speaks volumes of the important achievements of the TC 176 Committee. More recently, it is preparing additional international standards in quality audit, quality assurance etc. Some of these are becoming parts of ISO 9000 series while others will be included in the ISO 10,000 series.

## How The ISO 9000 Series Works

The ISO 9000 standards on quality system provide a sound base for Total Quality Management. It requires the manufacturers and suppliers to establish and maintain a documented quality system as a means of ensuring product conformance to specified requirements. The ISO 9000, an international standard for quality systems, is voluntary in nature but market driven. The ISO 9000 series can be used by any organisation employing 10 or 10,000 people, using manual work or robotised technology. It is, therefore, a practical standard for a quality system.

The ISO 9000 standards consist of six components. The first component ISO 8402 covers definitions of vari-

## ISO 9000 Standards

The International Organisation for Standardisation (ISO), first published ISO 9000 series of International Quality Standards in 1987. Since then they have made a major contribution in harmonising the content and meaning of quality on a global level. The interest shown by industry and trade in ISO 9000 series of quality management and assurance standards is an evidence of the growing quality awareness. It helps organisations to set a direction of change which is quality-oriented.

The ISO 9000 series has quickly been adopted by many nations and regional bodies in rapidly supplanting



**The ISO 9000, an international standard for quality systems, is voluntary in nature but market driven.**

ous concepts connected with quality system and provides the standard vocabulary. The second part gives the guidelines on use of three quality assurance models, namely ISO 9001, ISO 9002 and ISO 9003. These three models for quality assurance are used under situations where a contract, specially requires, design effort, manufacturing and installation and customer service depending upon the activities of the manufacturers or suppliers. Annexure 1 provides a cross-reference table for comparison between ISO 9001, ISO 9002 and ISO 9003. It is clear that ISO 9001 is the most stringent and covers the entire range of activities. The ISO 9003 is easier to adopt and implement but it covers mainly the final inspection and testing systems. ISO 9002 is somewhere in between and does not include design control and customer services.

The three quality assurance models are additive and progressive. The ISO 9003 is included in ISO 9002 which is included in ISO 9001.

The ISO 9004 is a non-contractual standard providing guidelines on elements of quality management system and is used for internal quality improvement purposes. Throughout ISO 9004, emphasis is placed on the satisfaction of the customer's needs, establishment of functional responsibilities and the importance of assessing the potential risks and benefits. Figure 1 gives the structure of these standards. The equivalent quality system standards for India and Europe are presented in Figure 2.

The quality assurance models in this international standard are prepared for 2-party situations, these are now used as the basis for third party certification/registration. The certification for ISO 9000 series has gained high popularity across the world in general and in Europe in particular.

### Use of International Standards

After consulting the international standard, supplier and buyer should refer to the quality assurance models ISO 9001, ISO 9002, ISO 9003 to determine which of these models is most relevant to the contract. The selection and application of a model for quality assurance

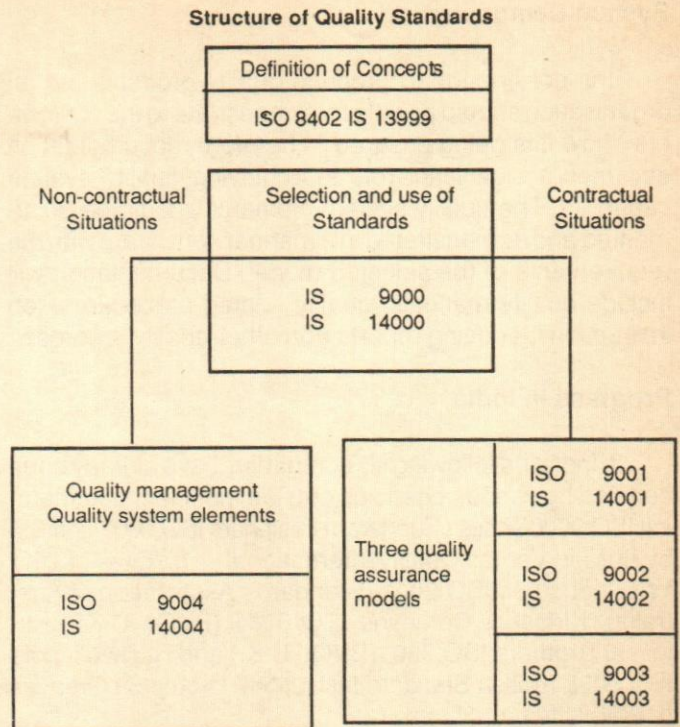


FIG. 1

### Equivalent QSS

ISO	IS	EN	Title
9000	14000	29000	Quality management and quality assurance standards - selection and use
9001	14001	29001	Model for quality assurance in design/dev, production, instr. and servicing — all elements.
9002	14002	29002	Model for Qlty. Assurance in production & installation
9003	14003	29003	Model for quality assurance in final inspection and tests
9004	14004	29004	Guidelines on development of quality management systems to minimise costs and maximise benefits

FIG. 2

appropriate to a given situation will provide advantage to both buyer and supplier. Simultaneously, examination of the risks, costs and benefits will determine the nature and extent of reciprocal information and the measures each one must take to promote adequate confidence that the intended quality will be achieved. In addition to several other criteria, the following factors should be considered for selecting an appropriate model for a product or a service - Design process, Design maturity, Production processes and complexity, Product characteristics, safety and costs.



## System Demonstration

It is not enough to produce quality products but an organisation should be able to demonstrate to the customers 'how it is being ensured'. Therefore, documentation assumes a significant role in achieving quality system capability. The quality system elements should be documented and demonstrated in a manner consistent with the requirements of the selected model. Documentation will include quality manuals, quality related procedures, job instructions, auditing reports and other quality records.

## Progress in India

In India the following six companies have already been certified by various agencies outside India for implementing ISO 9000 series : Sundaram Fasteners ISO 9002 (certified by Bureau Veritas Quality International — BVQI — of UK), W.S. Industries ISO 9001 (Standards Association of Australia), Kirloskar Cummins ISO 9001 (BVQI, U.K.), Kirloskar Brothers ISO 9001 (BVQI, U.K.) and Ralliwolf India ISO 9002 (British Standard Institution), Crompton Greaves (BVQI, U.K.).

The certification secured by these companies has already enhanced their image and prestige in the world market. A large number of Indian manufacturing organisations are preparing themselves for systematic quality management introduction as per these standards.

## An Opportunity or Nightmare?

Many consider that ISO 9000 is part of a plot to keep us out of the European market after 1992. ISO 9000 is being used by the 12-nation European Economic Community (EEC) to provide a universal frame work for quality assurance. As trade barriers go down by the EEC agreement and Europe becomes economically unified, ISO 9000 has become a tool to guarantee global quality.

The purpose of using the deadline is to provide a uniform set of quality system standards to facilitate the unification of economies in the EEC. This presents a challenge to Indian companies and also offers an opportunity to do increased international business. If three suppliers try to get the same contract, the one who is ISO registrant will have a substantial competitive edge. This will become nightmare to companies that have not prepared their quality system and will offer opportunities to

**This presents a challenge to Indian companies and also offers an opportunity to do increased international business.**

those companies who meet requirements of ISO 9000.

In fact, the stakes are higher for Indian companies. Given the direction in which the Indian economy is proceeding in terms of liberalisation, international trade and business, we will be facing world competition on our own soil. The domestic market which was protected until now, will not be so any more. In such a case, quality improvement through total quality efforts and ISO 9000 will be a competitive weapon. Indian companies, therefore, should no longer drag their feet and must pursue quality improvement and systems certification seriously.

## Total Quality & Product Quality

Total quality management is a journey without destination except for a wish to continuously improve. If TQM is a journey without destination, ISO 9000 is the starting point.

A number of product-related standards are already existing the world over. All these standards are used in end-product testing. The actual performance of products, size, specifications, safety and other features are covered by these standards. The ISO 9000 focuses on 'how-part' of these standards, in making sure that the service, material or a product is capable of meeting the performance specifications. Therefore, there is a clear distinction between assessing a company for ISO 9000 quality system and certifying the final product.

ISO 9000 may be compared to an entrance examination to an Engineering College or University. It ensures admission if qualified but the rest depends on the performance in actual studies which will decide the end-product. Quality, therefore, cannot be evaluated in vacuum.

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### Annexure 1 : Cross-reference list of quality system elements

(This annex is given for information purposes and does not form an integral part of the standard.)

Clause (or sub-clause) No. in ISO 9004	Title	Corresponding clause (or sub-clause) Nos. in		
		ISO 9001	ISO 9002	ISO 9003
4	Management responsibility	4.1 ⊗	4.1 ⊕	4.1 ∅
5	Quality system principles	4.2 ⊗	4.2 ⊗	4.2 ⊕
5.4	Auditing the quality system (internal)	4.17 ⊗	4.16 ⊕	—
6	Economics - Quality-related cost consideration	—	—	—
7	Quality in marketing (Contract review)	4.3 ⊗	4.3 ⊗	—
8	Quality in specification and design (Design control)	4.4 ⊗	—	—
9	Quality in procurement (Purchasing)	4.6 ⊗	4.5 ⊗	—
10	Quality production (Process control)	4.9 ⊗	4.8 ⊗	—
11	Control of production	4.9 ⊗	4.8 ⊗	—
11.2	Material control and traceability (Product identification and traceability)	4.8 ⊗	4.7 ⊗	4.4 ⊕
11.7	Control of verification status (Inspection and test status)	4.12 ⊗	4.11 ⊗	4.7 ⊕
12.	Product verification (Inspection and testing)	4.10 ⊗	4.9 ⊗	4.5 ⊕
13	Control of measuring and test equipment (Inspection, measuring and test equipment)	4.11 ⊗	4.10 ⊗	4.6 ⊕
14	Nonconformity (Control of nonconforming product)	4.13 ⊗	4.12 ⊗	4.8 ⊕
15	Corrective action	4.14 ⊗	4.13 ⊗	—
16	Handling and post-production functions (Handling, storage packaging and delivery)	4.15 ⊗	4.14 ⊗	4.9 ⊕
16.2	After-sales servicing	4.19 ⊗	—	—
17	Quality documentation and records (document control)	4.5 ⊗	4.4 ⊗	4.3 ⊕
17.3	Quality records	4.16 ⊗	4.15 ⊗	4.10 ⊕
18	Personnel (Training)	4.18 ⊗	4.17 ⊕	4.11 ∅
19	Product safety and liability	—	—	—
20	Use of statistical methods (Statistical techniques)	4.20 ⊗	4.18 ⊗	4.12 ⊕
—	Purchaser supplied product	4.7 ⊗	4.6 ⊗	—

#### Key

- ⊗ full requirement
- ⊕ Less stringent than ISO 9001
- ∅ Less stringent than ISO 9002
- Element not present

#### Notes

- 1 The clause (or sub-class) titles quoted in this table have been taken from ISO 9004; the titles given in parentheses have been taken from the corresponding clauses and sub-clauses in ISO 9001, ISO 9002 and ISO 9003.
- 2 Attention is drawn to the fact that the quality system element requirements in ISO 9001, ISO 9002 and ISO 9003 are in many cases, but not in every case, identical.



# Indian Machine Tools Industry

NPC Research Division

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*Starting as late as 1956 with a meagre output of Rs. 1.21 crores, the Indian Machine Tools Industry has grown to an output of Rs. 1000 crores. There are now about 160 units in the organised sector and another 300 or so in the small scale sector. It is estimated that the machine tools industry supports directly a manpower of approximately 50,000 at present. This study reviews the current status of productivity in the Indian Machine Tools Industry and identifies major problem areas.*

*Prepared by a team consisting of N.K. Nair, Director (Research), Anil Kumar, Assistant Director (Research) from the National Productivity Council and K.D. Kohli, Management Consultant.*

Despite being young, the Indian machine tools industry has earned for itself an important place within the Indian manufacturing in less than three decades. Starting as late as 1956 with a meagre output of Rs.1.21 crores, it had notched up a production of Rs.700 crores in 1990 and is now set to achieve a targetted output of Rs.1000 crores this year. Although some machine tools were produced (copies of imported machines) on a small scale even during the British time, it was only after Independence that it really began to shape into a distinct industry group. There are now around 160 units in the organized sector and another three hundred or so in the smallscale sector. The machine tools industry meets about 80-85 per cent of the domestic requirements (IMTMA, 1991). The balance, generally consisting of sophisticated, special purpose/precision machines are being obtained from other countries of Europe and USA. India now occupies 21st position amongst the World's machine tools' building countries.

Being a highly capital intensive industry, the scope for employment in the machine tools industry is comparatively low. Despite its strategic importance to the security and economic development of the country, the growth of employment in the machine tools sector has been rather moderate as compared to other industrial sectors. Nevertheless, it has maintained a steady rise in employment during different plan periods. It is estimated that the machine tools industry supports directly a manpower of approximately 50,000 at present (Facts for You, 1991).

The growth of machine tools industry in its early years of development was both slow and uneven. During the last three decades, the machine tools industry took great strides and its growth rate went up as high as 22% last year (table 1). In the early years the industry occasionally showed negative or very low growth. It has also had to face recessionary tendencies whenever some of its major end users like Railways, Defence and the Automobiles witnessed a slowing down of their investment activities and expansion plans. This prompted some of the main machine tools producers to take up diversification projects such as the manufacture of watches, electric bulbs and



Chart 1

Important Events in the Growth of Machine Tools Industry in India	
* Commencement of regular production of foreign designed machines	— 1950
* HMT came into being	— 1953 (Feb.)
* HMT commenced regular production	— 1956
* Production of machine tools crossed Rs. 100 crores mark	— 1956
* Production of special purpose machines commenced	— 1960
* Recession in machine tools industry	— 1967
* Regular Export of machine tools commenced	— 1969-70
* 70% self sufficiency in machine tools reached	— 1970
* CNC technology brought to India	— 1970
* 85% self-sufficiency reached	— 1978
* 1st CNC lathe produced by HMT	— 1979
* Imports of machine tools by India crossed Rs. 100 crores mark	— 1980
* No. of machine tools manufacturers in India crossed 100	— 1980
* Export of CNC machines commenced	— 1986
* No. of machine tools produced in India reached 10,000	— 1987
* Export of machine tools (all types) crossed Rs. 100 crores	— 1990
* Highest growth rate of 26% reached	— 1990

tubes, agricultural machinery, pumps, engines and other general engineering products.

Despite the spectacular growth in the production of machine tools during recent years the quality of Indian machines, their cost and finish, as well as the technology employed continue to be matters of grave concern. While the role of machine tools industry may be critical for laying the foundation for the country's industrialization, it does not seem to be an ideal choice to become the leading sector in exports; it has yet to emerge even as a gainful export sector on the industrial map of the country.

### Capacity Utilization

The machine tools industry, like its other counterparts, suffers from underutilization of capacity suggesting lack of adequate planning and proper market research prior to

setting up new units or creating additional capacities (table 2). While upto 1975 the capacity utilization was fluctuating between 50% and 70%, it has in recent years

Table 1 : Machine Tools Production in India

Year	Output * (Rs.Crore)	% Growth
1942	0.06	—
1943	0.64	266
1945	1.12	75
1947	0.46	-143
1949	0.47	2.2
1951	0.47	0.0
1953	0.44	-6.4
1955	0.74	68.2
1957	2.51	239.0
1959	4.39	75.0
1961	7.76	77.0
1963	15.44	99.0
1965	22.26	44.0
1967	21.58	- 3.1
1969	21.92	1.6
1971	37.11	69.3
1973	44.16	19.0
1975	77.83	76.0
1977	78.49	1.0
1978	102.81	31.0
1981	146.21	42.2
1982	171.75	17.5
1983	177.64	3.4
1984	186.73	5.1
1985	195.58	4.7
1986	225.70	15.4
1987	246.40	9.2
1988	282.00	32.4
1989	339.00	20.2
1990	413.00	21.8

Source : IMTMA Annual Reports  
Business Standard (1990) Annual  
Industrial Data Handbook - 1991-92  
\* Group A data only

Table 2 : Capacity Utilization % in Machine Tools Industry

Year	Capacity (Rs. crores)	Production (Rs. crores)	Capacity Utiliza- tion	CU Mfg. Sector	CU Non- Electrical Machinery
1970	72.1	42.2	56	85	76
1975	133.0	104.0	78	73	77
1980	190.0	186.0	98	73	86
1982	290.0	267.0	92	74	77
1983	340.0	275.0	81	73	80
1984	342.0	299.0	87	75	84
1985	405.0	301.4	74	77	83
1986	405.0	312.8	77	77	85
1987*	370.0	327.0	88	78	—
1988*	350.0	265.0	76	—	—
1989*	450.0	355.0	79	—	—
1990*	500.0+	420.0+	84	—	—

Source : CMIE (1987) and CEI Hand Book (1990)  
\* Data pertains to financial years  
+ Targeted



Manufacturing Unit	Product	Unit	Capacity	Prodn.	CU %
ELGI Equipment (1990)	Air Compressors	Nos.	18,500	26,479	143
	Lifting Ramp	"	970	632	65
	Washing Pump	"	3,830	1,255	33
	Pasteurizing Plant	"	60	9	15
SLM Maneklal (1989)	Roots Blower	Nos.	500	340	68
XLO Machine Tools (1990)	Precision Boring & SP Machines	Nos.	536	36	7.5*
	CNC Machines	—	—	4	
HMT (1990)	Machine Tools	Nos.	2,375	2,178	92
	Metal Forging Press	Nos.	28	24	86
	Watches	Nos.	7,095	5,938	84
	Tractors	Nos.	17	17,171	101
PRAGA TOOLS (1988)	CNC Machining Centres	Nos.	12	18	150
	Surface Grinders	Nos.	—	265	—
	Screw Couplings	Nos.	2,529	1,814	72 *
	Forgings	Tonnes	—	1,000	—
	M/C Tool Accessories	Rs Lakhs	—	797	—
Alfred Herbert (1990)	Metal Cutting/Grinding M/c's	No	76	3	4
	Inter Mixers	No	15	11	73
	Shear Strip Tube Presses	No.	75	12	16
	Tyre Building Machines	No	6	4	67

\* Does not take into account the output of other items.

Source: CMIE July 1991 & Jan. 1992 Volumes.

manufacture, which is evident from the fact that no major new machine tools unit has been floated during the past one decade or so. Machine tools industry is a business which holds no special fancy for purely business minded entrepreneurs (Patil, 1986). What is true of India of course holds goods in other countries too. Out of the 15 investment projects currently under implementation in the machine tools sector, there are only four projects which relate to the manufacture of machine tools at an estimated capital cost

Gross Profit* (Rs. 000')	
1967	-28755
1968	-54066
1969	-43573
1970	-33080
1971	-16816
1972	-1708
1973	13400
1974	75600

\* Value added less wage/salaries + depreciation

of Rs.55.81 crores out of a projected total investment of Rs.376.96 crores.

It is significant that of the Rs.55.81 cores, 85 per cent is from the public sector and a mere 15 per cent from single private sector company.

Company	Type of investment	Product	Capital outlay (Rs. Crores)	Present Status
Hindustan Cables Ltd.	Renovation/Modernization-	SPM	6.45	Under Implementation
HMT Ltd.	—do—	M/C Tools	32.79	—do—
Praga Tools Ltd.	Indigenization	CNC Machining Centres	8.07	—do—
Somany Monforts Ltd.	New	High Precision Cutting Machines	8.50	—do—

Source: CMIE (1990)

### Productivity : Industry Wide Trends

In order to assess the efficiency in factor use and the contribution the technical progress towards output growth of the machine tools industry, we have arrived at the



**Table 4 : Financial Performance of Machinery Manufacturers other than Transport and Electrical**

Item	1987-88			1988-89		
	Machinery Mfrs (1)	Engg. Industry (2)	All Industry (3)	Machinery Mfrs.(1)	Engg. Industry (2)	All Industry (3)
Mfg. Expenses	1917.90 (60.4)	7196.70 (64.9)	24610.50 (62.7)	2478.00 (62.1)	9045.20 (65.8)	29494.00 (62.7)
Non-Indl. Services	393.90 (12.4)	1129.60 (10.2)	4837.40 (12.3)	489.60 (12.3)	1384.90 (10.1)	5831.40 (12.4)
Cost of Manpower	411.90 (12.9)	1325.60 (12.0)	4518.70 (11.5)	486.10 (12.2)	1548.90 (11.3)	5138.80 (10.9)
Depreciation	134.20 (4.2)	449.40 (4.1)	1829.80 (4.7)	140.80 (3.5)	493.0 (3.6)	1991.30 (4.2)
Interest	186.20 (5.9)	579.70 (5.2)	2066.00 (5.3)	212.00 (5.3)	657.40 (4.8)	2421.70 (5.1)
Profit before Tax	132.80 (4.2)	404.80 (3.7)	1399.00 (3.6)	181.50 (4.6)	616.40 (4.5)	2180.20 (4.6)
Tax	54.80 (1.7)	152.00 (1.4)	565.70 (1.4)	67.20 (1.7)	191.60 (1.4)	725.80 (1.5)
Profit after Tax	78.00 (2.5)	252.80 (2.3)	833.30 (2.1)	114.30 (2.9)	424.80 (3.1)	1454.40 (3.1)
Dividend	40.60 (1.3)	124.20 (1.1)	545.60 (1.4)	49.00 (1.2)	152.30 (1.1)	689.20 (1.5)
Retained Profit	37.40 (1.2)	128.60 (1.2)	287.70 (0.7)	65.30 (1.6)	272.50 (2.0)	765.20 (1.6)
Total Expenditure (1 to 6)	3176.90 (100)	11085.80 (100)	39261.40 (100)	3988.00 (100)	13745.80 (100)	47057.40 (100)

Source : CEI Handbook of Statistics 1990.  
(1) 63 Units (2) 191 Units (3) 622 Units

Note : Figures in brackets represent the % age to total expenditure.

industry-wide trends in the total and partial productivity indices. The data for this purpose has been obtained from the CSO's Annual Survey of Industries (ASI) for the industry code 357, during the period 1974-75 to 1987-88. The labour and capital productivity have been calculated as simple ratios of output to the respective inputs. The Total Factor Productivity (TFP) or the Index of Technical Progress has been measured alternatively by the Solow and the Translog indices. While the Solow index (based on a Cobb-Douglas production function) assumes constant returns to scale, unitary elasticity of substitution among the factor inputs, Hicks neutral technical change and factor payments according to their respective marginal products, the Translog index is characterised by variable elasticity of substitution and does not involve the assumption of Hicks-neutral technical change. The TFP index is measured as the ratio of output to the total factor inputs. Total factor

inputs is given by a weighted combination of labour and capital inputs. The share of emoluments in the output during each year has been taken as the share of labour which has been used for weighting the labour input. The share of capital which was used for weighting the capital input has been arrived at as the remainder of the output.

The output here has been measured by the net value added at current prices deflated by the Index Number of Wholesale Prices (1980-81=100) of Machine Tools and Parts Industry. The labour input is measured by the number of employees and capital input by fixed assets at 1980-81 prices. Fixed assets at constant (1980-81) prices is arrived at by a simple deflation of the net fixed capital stock each year by the corresponding Index Number of Wholesale Prices of Machinery and Machine Tools. The results shown in table 5 do not strongly indicate the presence of any technical progress in the industry during the period 1974-1987. Rates of growth in the case of Translog index were not found statistically significant during 1974-81, 1982-87, and 1974-1987. Solow index on the other hand is characterised by a compound growth of 1.78 percent which is acceptable at 5 percent level of significance. Labour and capital productivity indices were found growing at unimpressive rates of 2.65 percent and 2.06 percent during 1974-87.

### Productivity in Machine Tools Companies

In order to assess the status of productivity in a selected group of machine tools companies, we have utilised another set of parameters mentioned below.

1. Ratio of Total Earnings (T) to Conversion Cost (C) (T/C).
2. Ratio of Purchased Services (PS) to Total Earnings(T) (PS/T).

**The results do not strongly indicate the presence of any technical progress in the industry during the period 1974-1987.**



**Table 5 : Total & Partial Productivity Indices of Machine Tools Industry**

Year	Solow Index	Translog Index	Labour Productivity	Capital Productivity
1974-75	100.00	100.00	100.00	100.00
1975-76	98.12	104.41	88.47	104.19
1976-77	88.36	91.07	91.69	97.49
1977-78	87.11	91.39	80.99	82.32
1978-79	85.90	99.24	84.11	94.90
1979-80	96.19	100.31	92.12	103.75
1980-81	88.37	113.24	83.04	93.39
1981-82	123.29	128.71	118.04	137.18
1982-83	119.18	137.63	112.63	120.19
1983-84	128.29	137.54	127.97	118.76
1984-85	115.86	113.24	116.22	120.34
1985-86	105.22	119.92	124.71	119.06
1986-87	124.99	130.49	111.77	117.79
1987-88	99.64	49.86	109.29	113.41

Period	Trend Rates of Growth @			
1974-81	-0.0157 (0.0111)	0.0135 (0.0144)	-0.0201 (0.0122)	-0.0086 (0.0163)
1982-88	-0.0355 (0.0188)	-0.1103 (0.0565)	-0.0097 (0.0112)	-0.0217 (0.0076)
1974-88	0.0178* (0.0088)	0.0002 (0.0178)	0.0265** (0.0078)	0.0206** (0.0072)

\*\* Significant at 1% level

\* Significant at 5% level

@ Estimated from an equation  $\log x_t = \mu + bt$  where x stands for the Index and t for for the year.

3. Percentage of Wages/Salaries (W) to Net Sales (S) (W/S).
4. Ratio of Profit (P) to Conversion Cost (C) (P/C).
5. Percentage of Profit (P) to Net Sales (S) (P/S).
6. Profit (P) per Employee (E) (P/E) (Rs.Lakh).
7. Net Sales (S) per Employee (E). (S/E) (Rs. Lakh)
8. Value Added (VA) per Employee (E) (VA/E) (Rs. Lakh).

Each of these parameters involves basic information on some inputs and outputs. The precise definition of each of these parameters is given below :

1. Sales(S) : Total sales value less excise and credit.
2. Throughput Materials (M) : All raw materials and bought out parts and packaging actually consumed.
3. Total Earnings (T) : S — M
4. Total Wages/Salaries (W) : Total employee costs including wages, salaries, and other em-

ployee costs (e.g. pensions, holiday pay & employee welfare etc).

5. Total Purchased Services (PS) : All purchases from outside other than raw materials & bought out parts. This includes, energy costs, rents, rates, telephones. bank charges, processing materials, touring costs etc.
6. Net Profit (P) : Gross profit less provision for taxes.
7. Depreciation (D) : Wear & tear costs shown as depreciation in company accounts.
8. Conversion Cost (C) : the sum of W, PS and D.
9. Value Added (VA) : Employee costs plus operating profit.
10. Employees (E) : Total No. of employees including casuals/part timers adjusted to full time.

Most of the information required for assessing these parameters is generally available from company records. Approximately 40 companies were approached for information, but only a few responded positively. We, therefore, took recourse to other indirect sources for compilation of the required data. We could obtain the sought for information from 19 companies which forms our sample for the productivity assessment exercise. The composition of the sample is :

- Group A Companies — 6  
 " B Companies — 7  
 " C Companies — 6

**Chart 2**

The Statistics on machine tools are compiled under three groups

*Group A*

Metal cutting and metal forming machine tools

*Group B*

Welding, Plastic die casting and pneumatic equipment machine tools accessories etc.

*Group C*

Small & cutting tools, testing and measuring equipment

The sample includes both public sector and private sector units and also covers small and large size units. The computed ratios are presented in Appendices 1 to 8. Five years' average of various productivity ratios for the sample companies are given in table 6.



**Table 6 : Five Years' Average of Productivity Ratios**

Company	Total Earning to Conversion Cost T/C	Purchased Services to Total Earnings PS/T	Wages & Salaries to Sales % W/S	Profit to Conversion Cost P/C	Profit to Sales % P/S	Profit per Employee Rs.Lakh P/E	Sales per Employee Rs.Lakh S/E	Value added per Employee Rs. Lakh VA/E	
AIR CONTROL	1.1	0.5	25.0	0.04	2.5				
ADDISON	1.1	0.5	16.8	0.08	3.9				4 years' average
ATLAS COPCO	1.05	0.5	12.8	0.07	2.2	0.18	7.93	1.68	
CONSOLIDATED PNEUMATIC	1.1	0.3	20.3	0.13	5.0				
DAGGER FORST	1.3	0.3	31.6	(0.03)	(1.9)				4 years' average
EMA	1.5	0.36	12.9	0.26	9.4				3 years' average
IFB	1.1	0.6	3.4	0.5	9.0				4 years' average
INGERSOLL	1.8	0.3	9.9	0.5	12.4	0.82	6.58	2.04	4 years' average
KG KHOSLA	1.26	0.4	16.0	0.06	2.2				
KIRLOSKER PNEUMATIC	1.2	0.4	17.7	0.04	1.8	0.05	2.68	0.73	
SS MIRANDA	1.2	0.5	12.8	0.09	3.4				
WIDIA	1.3	0.5	14.8	0.1	6.4				
BP&C	0.9	0.5	19.3	(0.5)	(20.8)	(0.41)	1.96	0.35	
ELGI	1.3	0.5	8.3	0.2	4.8				
SLM MANEKLAL	0.9	0.4	28.7	(0.15)	(7.1)				
PRAGA	1.1	0.35	19.4	0.13	5.2	0.09	1.71	0.53	
XLO	1.0	0.2	51.2	(0.05)	(3.4)				4 years' average
HMT	1.1	0.3	24.3	0.02	0.08	0.014	1.64	0.54	
ALFRED HERBERT	1.2	0.32	11.5	0.05	1.2				

Note : Most companies have changed over to accounting year ending on 31st March from 1989 onwards. All figures pertain to the year ending 31st March except where indicated otherwise

### **Total Earnings (T) to Conversion Cost (C)**

An indicator of overall productivity, this ratio measures the general conversion efficiency of a manufacturing unit. The TE to C ratios of the sample companies show that almost all companies, have achieved a score of one or above. Only two companies (BP & C, SLM) show an average ratio of 0.9 which, as would appear from Appendix I is the result of somewhat poor performance in one or two years. This can perhaps be attributed to temporary slackness in managerial control. Of the four other companies (Atlas Copco, Consolidated Pneumatic, Praga and XLO), two—XLO and Atlas Copco—seem to show signs of sliding down as their ratios have dropped to 0.96 in the year 1990. Apparently the two need to step up managerial vigilance

on their resources management. The other two companies also need to tone up their managerial control as the T/C ratio has dropped below unity, albeit by a small margin.

### **Purchased Services (PS) to Total Earnings (T)**

By and large the machine tools industry, as represented by the sample seems to be exercising effective control on the use of purchased services. Barring one company (IFB) whose purchased services to total earnings ratio has reached 0.6, all other companies have held it at 0.5 (seven companies) or below - with three companies (KG Khosla, SLM, Kirlosker) scoring even a lower ratio of 0.4. Seven other companies have ratios



ranging between 0.3 and 0.36 with one (XLO) showing the lowest ratio of 0.2. A reference to Appendix 2 shows that in the latest year the PS to T ratio is showing a rise in some companies (as high as 0.7 in Atlas Copco). At the same time, at least in one case (BP & C), the ratio has come down substantially (0.2) much below their five year average of 0.5. Apparently, managerial control over the utilization of this multi faceted resource ( the ratio was as high as 0.8 in 1989), has led to a drastic reduction of this ratio in BP & C during 1990, suggesting that this can be done by others too only if they maintain a closer watch on related costs, exercise necessary controls and carry out corrections promptly when necessary.

### Wages and Salaries (W) to Sales (S)

What a company spends on wages and salaries to achieve its sales assumes considerable significance because of its ultimate impact on the company's financial stability and competitiveness. Table 6 shows that employee costs in relation to sales are indeed quite high in the Indian machine tools industry. It ranges from a minimum of Rs. 3.4 (IFB) to a maximum of Rs. 51.2 (XLO) for every hundred rupees of sales. While there are at least six companies (Air control, Consolidated, Dagger Forst, SLM, XLO & HMT), with a W/S ratio of 20 per cent and above, only two firms (IFB & ELGI) have achieved a ratio below 10 percent. As expected the high wage/sales ratio companies have generally turned in poor performance, which can be seen from the average profit earnings of these companies (table 7) during the latest accounting year (1990).

Overstaffing, underutilization of manpower and or poor employee productivity usually lead to high W/S ratio

**Table 7 : Relationship between W/S Ratio and Company Performance**

Company	Average W/S ratio	Average Profit/Loss (Rs. Crore)	Profit Last Year (1990) (Rs. Crore)
XLO	51.2	(3.4)	(0.50)
Dagger Forst	31.6	(0.14)	0.18
SLM	28.7	(1.75)	(5.3)
Air Control	25.0	0.15	0.08
HMT	24.3	3.98	3.19
Consolidated Pneumatic	20.3	1.43	0.21
PRAGA	19.4	1.9	0.44
BP & C	19.3	(8.06)	(8.08)
Kirlosker	17.7	1.33	1.67
K.G. Khosla	16.0	0.63	0.19

Source : Table 6 and CMIE (1991)

in a company. Periodical monitoring of W/S ratio is therefore essential to forestall a possible disaster. Appendix 3 shows that there is a general upward trend in this ratio in the Indian machine tools industry. Of the 19 sample companies at least in ten, such a trend is clearly visible whereas in the remaining nine the downtrend is either negligible or none at all.

### Profit(P) to Conversion Cost (C)

Like most other industries Indian machine tools industry also has its quota of loss making companies. Amongst the 19 companies examined, at least four (Dagger Forst, BP & C, SLM, XLO) have shown consistent losses (on an average) during the past five years, with at least two of them (BP & C, SLM) being in the red for the best part of the period. Of the remaining 15 companies, there are at least three more (Air Control, Consolidated, Atlas Copco) who have incurred losses for two or more years and/or made very nominal profits (Khosla, Kirlosker, Miranda, HMT & AH). Quite a number of the rest show a declining trend or wide fluctuations in profits and seem to be heading for the red line. No doubt, there are a few (Praga, Ema, Widia, Elgi) amongst the group exhibiting a steady profit performance but only three (Ingersoll, IFB & Addison) whose profit fortunes seem to have remained on the upswing throughout.

Considered in the light of the above analysis the profitability ratios shown in table 6 and appendices 4, 5 & 6 should serve as a warning to these and other machine tools manufacturers. They need to investigate individually into the causes for the current state of profitability. The highest ratio of 50 paise profit for every rupee of conversion cost has been achieved by IFB and INGERSOLL followed by EMA (26 paise) and ELGI (20 paise), with most of the remaining earning less than 15 paise for each rupee of the conversion cost. Similarly in the case of ratio of profit to sales (P to S) INGERSOLL stands above the rest with 12.4 per cent followed again by EMA (9.4) and ELGI, (9.0). The rest of profit makers are gathered together at the bottom with ratios ranging from 0.08 (HMT) to 6.4 (WIDIA). Obviously there is an urgent need to improve the profitability of the industry. The highest loss of Rs.20.8 for every hundred rupees of sales has been incurred by BP & C. The other three loss makers are Dagger Forst (1.9), XLO (3.4) and SLM (7.1). All these companies need to review their current strategies so as to adopt suitable measures to come out of the red. 5/6 years P to S ratios shown in Appendix 5 indicate poor performance by as many as 9 companies out of 15 current profit makers. Similarly amongst the four loss makers only one



has shown any sign of improvement in the latest year's performance.

### Employee Productivity

The results obtained under the three parameters employed for assessing employee productivity in the machine tools industry present an overall dismal picture. By and large, the ratios of the public sector companies under the three parameters show that their employee productivity is quite unsatisfactory as compared to that of the private companies which is illustrated by the comparative figures given below :

Company	Private Setor Companies			Public Sector Companies		
	(A)	(B)	(C)	(D)	(E)	(F)
P/E	0.18	0.82	0.05	(0.41)	0.09	0.014
S/E	7.93	6.58	2.68	1.96	1.71	1.64
A/E	1.68	2.04	0.73	0.35	0.534	0.535

Labour productivity in Indian industries has been quite low in comparison to those in other countries (see for instance NPC Research Division, 1991). One of the reasons for poor performance of our industries in general is the low output turned in by their employees. What is true of the industry in general is equally applicable to the machine tools industry also. It is widely held that machine tools manufacture in India is still an inefficient operation. A comparison of labour productivity growth in India and Japan shown in Table 8 goes to underpin the fact that India's growth of labour productivity in the machine tools sector is far below that of Japan's.

**Table 8 : Growth of Labour Productivity in Machine Tools Sector of India & Japan**

Year	India		Japan	
	1960-70	1960-74	1970-74	1970-78
1960	10.7	10.7	—	—
1970	17.0	—	17.0	8.2
1974	—	19.4	19.4	—
1978	—	—	—	18.2
AAG : (O/E)	3.4%	4.3%	3.4%	10.4%

Source : Ron Mathews (1982)

### Consumption & Indigenisation

India produced about 9,000 machine tools (Group A) in 1990. Top 10 companies in the organized sector account for 75-80% of the output of the machine tools industry. HMT heads the list with a production of 2364 machine tools (1988-89). Table 9 shows the number of

**Table 9 : No. of Machine Tools Produced by the Indian Machine Tools Industry (Group A)**

Year	Nos.
1980	11,546
1981	11,448
1982	10,187
1983	9,930
1984	9,460
1985	9,284
1986	11,097
1987	10,475
1988	8,526
1989	7,911
1990	8,963

Source : FACTS for You, Aug. 1989, IMTMA, Bulletin, July 1991

machine tools produced by the Indian machine tools industry from 1980 onwards. The table shows a declining trend in output from 1980 onwards, It improved a little in 1986 but again went on a downside until 1990. There could be various reasons for this decline in numbers of which the more important one is that the production of more expensive machines such as NC/CNC is now preferred by the machine tools industry to the manufacture of general purpose machines which are much cheaper to produce and also take less time to build.

The consumption of machine tools in India in rupee terms has been steadily rising in keeping with the development of the engineering industry which represents the core of the process of industrialization of the country. It is estimated that of the 1.3 million machines installed in the country at least 88 percent are of indigenous production. Table 10 shows the production and consumption of machine tools in India from 1960 to 1990. While in the early years of industrialization only 20-50% of the domestic demand for machine tools was met from indigenous production, from 1970 onwards the trend has been reversed and the indigenous content has progressively gone up, having reached 75 per cent by 1985.

Even though machine tools manufacture is one of the latest and a smaller segment of the Indian industries, its growth so far has been fairly rapid, though fluctuating. Considering that even in 1960 machine tools production

**It is estimated that of the 1.3 million machines installed in the country, at least 88 percent are of indigenous production.**



**Table 10: India's Machine Tool Production and Consumption\***  
(Rs. Crores)

Year	Production	Consumption*	Production as % of Consumption
1960	5.9	26.8	21.9
1970	37.2	52.7	70.6
1974	88.4	110.8	79.8
1975	104.0	139.9	74.3
1976	116.9	144.4	80.9
1977	109.6	131.6	83.2
1978	121.1	140.6	86.1
1979	155.8	209.7	74.3
1980	185.9	269.9	68.9
1981	234.2	321.0	73.0
1982	266.5	363.0	73.4
1983	200.0	375.0	53.3
1984	282.7	424.1	66.6
1985	342.0	468.0	73.1
1986	372.0	500.0	74.4
1987	417.0	547.0	76.2
1988	463.0	617.0	75.0
1989	555.0	675.0	82.2
1990	699.0	815.0	85.8
1991	750.0+	NA	—

Source: IMTMA Annual Reports, DGTD  
Economic Times 16th May 1991

\* Consumption = Domestic Output + Imports - Exports  
+ Estimated

constituted only an insignificant 0.3 percent of the total manufacturing output, its growth from a mere Rs. 5.9 crores in 1960 to Rs. 700 crores in 1990 tells its own tale. During the past few years the production growth has fluctuated between 9 and 12 percent upto 1988. In the last two years the growth rate has more than doubled (table 11) which when compared to that of 11.7% growth of the engineering sector during the Seventh Plan can be regarded as highly satisfactory.

In the Seventh Plan the national economy was set to achieve a growth rate of a little over 5% per year, with the overall industrial growth set at 7-8% and the total manufacturing at 8%. Within the manufacturing group, engineering industry was slated to reach a growth rate of 10.5% per

**Table 11: Growth of Machine Tools Industry, 1985-90**

Year	Value of Output	Growth
1985	342.2	12
1986	371.7	9
1987	417.3	12
1988	463.2	11
1989	555.0	20
1990	699.0+	26
1991	750 +	—

Source: Financial Express, (May 11, 1991) PTI (1991)  
+ Provisional

annum. While the engineering industry has exceeded the annual growth target, the machine tools industry has done even better. The overall growth rate for the machine tools industry set in the 7th Plan was 19.5% which has been exceeded by a fair margin but only during the last few years (table 12). If, however, the current inflation rate is taken into account, the recorded growth rates of the machine tools industry will become negative as the expert group set up by the Ministry of Industry have pointed out in their report.

**Table 12: Growth of Machine Tools Industry during 7th Plan**

Description	Production (Rs. Cores)				
	1986	1987	1988	1989	1990
<b>Schedule A</b>					
Metal cutting & metal forming machine tools	225.8 (15.5)	245.4 (8.7)	275.2 (12.2)	339.3 (23.3)	413.20 (21.8)
<b>Schedule B</b>					
Welding, plastic, die-casting machinery hydraulic/pneumatic equipment machine tools & accessories	146.0	171.8 (17.7)	188.0 (9.4)	216.0 (14.9)	286.21 (32.5)
<b>Schedule C</b>					
Small cutting tools testing and measuring equipment	—	—	145.0 (23)	177.0 (22)	204.72 (15.7)
<b>Total</b>	371.8 (8.7)	417.2 (12.2)	608.2 (45.8)	732.3 (20.4)	904.12 (23.5)

Source: Kothari (1991), IMTMA

The overall growth profile of the machine tools industry would appear to lend the impression that all is well with the industry. The recent turn of events, however, belie this. In the first two months of the current year, it is reported that there is a negative growth leading to a fall of 8.8% in output from the engineering sector. The manufacturing sector has registered a fall of 2.4%, while the overall industrial growth in April & May 1991 is lower by 0.3 percent. This general decline may be attributed to the recent industrial policy changes and import compression measures and could be a mere passing phase. However, the rate of replacement of machine tools in various industry sectors continues to shrink. The agewise distribution (1985) of machine tools in India is reported to be around 10 to 15 years in 53 percent cases and about 20-25 years in another 21-22 percent cases which is somewhat unusual. Unless the current rate of replacement of old machinery and plan improves, there may be some more slackening of the growth of the machine tools industry in the coming



years. Apparently managerial conservatism in the industry has hindered the promotion of a systematic modernization which alone can ensure a steady indigenous demand for machine tools. It would appear, therefore, that the proposed 8th Plan growth target of 20% may remain unfulfilled. Moreover, the demand for machine tools is likely to remain much below the industry's expectations due to the current recessionary phase, disintegration of USSR and political changes in the East European countries. Besides, if better part of the industry remains content with the production of general purpose conventional machines as hithertofore, its growth is bound to remain restricted. It must therefore go in for sophisticated machine tools in increasing numbers which will on the one hand help to reduce imports and on the other open up new market opportunities in the hard currency areas where much of its future fortunes would seem to lie. No doubt, low profitability, long gestation period and heavy capital investment also act as a barrier to growth but with proper encouragement from govt. sources, in the form of depreciation allowance, and excise reliefs etc. these can be overcome without much difficulty. The recent budgetary recommendations would seem to show that the government is sensitive to the industry's problems.

**Apparently managerial conservatism in the industry has hindered the promotion of a systematic modernization which alone can ensure a steady indigenous demand for machine tools.**

### Technology Upgradation & R&D

In addition to general purpose machines, India now manufactures specialized machines - single & multispindle automats, copying lathes, gear hobbors, gear shapers, crankshaft grinders, crankshaft twisting presses, transfer lines, unit heads etc.. The production range also covers a wide spectrum of technologies which include wire cut EDM, industrial robots, flexible manufacturing cells, laser cutting machines and other advanced technology machine tools. One recent addition to this list is the NC-numerically controlled machines and CNC - computer numerically controlled machines. NC & CNC machines generally include lathes, milling machines, turning centres, horizontal & vertical machining centres etc.

NC automation was first introduced in 1950 whereas CNC came to be introduced much later. NC technology

was introduced in India in the seventies and its maturation by the eighties was spurred by the expansion of the automobile sector including that of 2 wheelers & 3 wheelers and the modernization of the engineering industry in general. The demand projections of CNC and non-CNC machine for the automobile sector shown below clearly indicate this linkage.

	1984	1985	1986	1987	1988	1989	1990
CNC machines	28	141	197	199	111	70	40
Non-CNC machines	795	1114	942	1584	841	696	392

Source: The Automobile Industry-Statistical Profile, 1985  
— Commerce, Feb. 1986

Computer aided/based technology has enabled the industry to introduce machines which help improve productivity, reduce costs and bring a high degree of flexibility in manufacturing. The production of CNC machine tools in India has risen sharply in recent years. From 65 CNC machines produced during 1985, it has now reached a somewhat respectable figure of 560 valued at Rs. 137 crores (table 13). However, this is not enough, as our production of NC/CNC machines compared to other

**Table 13: NC/CNC Machine Tools Production from 1985**

Year	Production of NC/CNC Machine Tools		% Share in Total Production (Group A)
	Nos.	Value (Rs Crores)	
1985	65	13.00	7
1986	93	19.00	9
1987	200	47.88	20
1988	282	69.92	25
1989	457	105.00	31
1990	560	137.00	33

Source : Financial Express, May 11, 1990

developing countries, is dismally low. While in India, with as many as 32 foreign collaborations, the production of CNC/NC machines is just about 19% of the total output of machine tools (schedule A&B), in countries like Japan, Germany, USA etc., the percentage ranges from 40 to 70. In fact, our present annual production of NC/CNC machines is just about one or two months' output of such machines by some of the foreign manufacturers. Machine tools industry must gear up to build exports of such machines not only because it will bring in foreign exchange but also because it will help it to keep abreast of the modern technology trends in machine tools manufacture. Upto & including 1985, almost 90% of NC/CNC machines in use in the country (1182) were of imported origin. With



**Machine tools industry must gear up to build exports of such machines not only because it will bring in foreign exchange but also because it will help it to keep abreast of the modern technology trends in machine tools manufacture.**

an anticipated rise in the local demand of NC/CNC and other modern technology machines, the industry is reported to be already taking active steps to meet these requirements. Some organized sector units are known to have already begun negotiations for foreign collaborations for advanced technologies. The focus of these efforts seems to be on the following main points (Naidu, 1990) :

- (a) Retro-fitting NC/CNC to existing machine tools to the extent possible.
- (b) Undertaking manufacture of new NC/CNC machines such as turning centres, grinding centres & machining centres etc.
- (c) Development of non-traditional machining and flexible manufacturing cells & systems.
- (d) Development of CAD
- (e) Producing CNC systems.

Over 100 technical collaborations are already in operation in the machine tools industry. Of these, 32 collaborations are for CNC machines (IMTMA, 1991). Most of these are with reputed manufacturers from USA, Japan & Europe, with a few from other parts of the world.

During the last ten years foreign collaborations approved by the Govt. of India exclusively for machine tools were as under (CEI, 1988 & 1990) :

1980	26	1986	13
1981	22	1987	10
1982	29	1988	21
1983	44	1989	9
1984	34	1990	24
1985	32		

Foreign collaborations in the machine tools industry have been progressively going up. From 6 approvals in 1970 and 12 in 1975, these went upto 44 in 1983 and then dropped to a low of just 9 in 1989.

The countrywise breakdown of all foreign collaborations for the engineering industry (including machine tools) is shown in Table 14. The most preferred countries in the engineering sector are Germany, USA, UK, Japan, France

**Table 14 : Countrywise Distribution of Foreign collaborations in Engineering Industry**

Country	1985	1986	1987	1988	1989	Total	% of Total
Australia	5	7	8	5	5	30	1.0
Austria	13	11	6	5	6	41	1.4
F.R.G.	153	129	117	129	83	611	20.0
France	50	29	33	32	15	159	5.0
Italy	43	35	27	29	11	145	4.8
Japan	90	84	49	67	33	323	10.6
Netherlands	13	15	11	10	9	58	1.9
Sweden	27	21	16	8	9	81	2.7
Switzerland	38	19	17	23	12	109	3.6
U.K.	117	97	92	100	56	462	15.2
U.S.A.	151	125	126	124	68	594	19.6
U.S.S.R.	3	1	3	6	6	19	0.6
N.R.I.	31	13	10	14	9	77	2.5
Total (Including Others)	811	650	570	631	375	3037	100

Source : Indian Investment Centre  
CEI (1988 & 1990)

and Italy in that order. These six countries account for 76 per cent of all foreign collaborations in the engineering industry.

Despite the liberal attitude adopted by the Govt. towards technological collaborations in the past and an impressive growth in the process of indigenization, there are still a lot of technology gaps which need to be bridged. Due to the foreign exchange crunch, foreign collaborations involving an outgo of foreign exchange are unlikely to find favour for some time. The alternative obviously is to put greater stress on in-house R&D. One of the reasons for the past rapid growth of the machine tools industry is said to be the relative ease with which foreign collaborations could be secured. Such total dependence on foreign collaborations may not be in our long term interests and the machine tools industry must seriously consider developing new technologies within the country itself. R&D thus assumes strategic importance in the current situation where technology upgradation and modernization have become a major challenge for the machine tools industry. To plug technology gaps R&D efforts must be accelerated. Since the world market trend has already transited from sellers to buyers and competition has hotted up, the industry will have to give very serious and urgent attention to R&D. Currently India spends just about 1% of its GNP on R&D effort which, as compared to some of the developed and developing countries, is very low. While expenditure on national R&D effort has increased considerably over the years (table 15), there is need to give more attention to this important area in the machine tools industry as well so as to enhance both our competitiveness and product quality through the development of better



**Table 15 : R & D Expenditure by Machine Tools Industry**

(Rs. Lakhs)

	1984-85	1985-86	1986-87	1987-88	1988-89	No. of Units
Public Sector	388.40*	344.00*	465.06	614.31	606.73	3
% of Total	(65.6)	(56.0)	(62.8)	(63.3)	(64.8)	
Private Sector	203.76*	269.85*	275.92	256.24	329.95	15
% of Total	(34.4)	(44.0)	(37.2)	(36.7)	(35.2)	
1.Total Machine Tools Industry	592.16@	613.85@	40.98	970.25	936.68	18
2.Total Industry	38207.49**	42599.15**	50550.00	57550.47	69786.83	949
% of 1/2	(1.5)	(1.4)	(1.5)	(1.7)	(1.3)	

\* No. of Units-1                      + No. of Units-9  
 @ No. of Units-10                  ++ No. of Units -876

Source : Deptt. of Science & Technology (1988-89)

**Such total dependence on foreign collaborations may not be in our long term interests and the machine tools industry must seriously consider developing new technologies within the country itself.**

technologies within the country. Of the total R&D expenditure in India a little over 1 per cent is spent on research and development in the machine tools industry 64.8 per cent of which is incurred by the public sector units. Private sector units particularly those in the organized sector seem to be somewhat averse to invest on R&D. According to the Department. of Science & Technology (1988-89), machine tools industry falls in the category of low R&D intensity as the following indices show :

- (i) R&D expenditure as % of sales turnover — 0.21
- (ii) R&D personnel per 1000 employees — 34

This state of affairs must change towards the better if the industry wishes to create a worthwhile niche for itself in the world machine tools market. According to one estimate, every rupee spent on R&D in industry contributes Rs. 12 worth increase in annual turnover of the companies. This is regarded as relatively small and must increase to Rs.25 at least (Times of India, Dec. 10, 1991).

Central Machine Tools Research Institute (CMTI) established under govt. aegis in 1965 plays an important role in the development of the industry. It has been, no doubt, rendering useful R&D services to all categories of machine tools manufacturers. It provides for various facili-

ties as well as the services of highly qualified and experienced manpower. It offers guidance in almost all aspects of machine tools manufacture. Recently a further assistance to CMTI amounting to Rs.7 crores has been announced by the UNDP.

This lone effort is not enough for entering the world markets in a big way. The current inhouse R&D activity in the machine tools industry is evidently too low and must improve fast if the industry wishes to keep pace with the technological explosion taking place in the world. We have already lost valuable time and now must act faster lest we may be pushed out of the international scene as far as machine tools are concerned.

A number of incentives have been announced by the govt. from time to time, for setting up R&D units within the industry. Industry in general and machine tools industry in particular must seize the opportunity and take fresh initiatives to make R&D a worthwhile proposition. Obviously it cannot remain content with the current inputs which flow to it by way of foreign investments, technology collaborations, import of industrial machinery and other capital goods. That we may end up with a mediocre status which certainly cannot be the industry's objective.

### **Structural Characteristics & Role of Public Sector**

It is wellknown that the machine tools industry is dominated by HMT which was set up in 1953. The decision to set up a public sector machine tools plant in collaboration with a Swiss firm was taken in 1949. Initially HMT concentrated on the manufacture of H-22 lathes in deference to the Swiss firm's plan but the govt. later decided to buy out the Swiss firm's interests so that a new diversified production plan could be put into operation. HMT expanded its capacity, and its machine tools output, thereafter, went up rapidly during the period 1956 to 1961 accounting for about 55 percent of India's then total production of machine tools. To cater to the increasing demands of the engineering industry, HMT continued to enlarge its



production activities and by 1975 had acquired seven machine building plants spread all over the country. Simultaneously alongwith these efforts when compelled by severe recession in the industry during 1967-68, it opted for diversification but continued to play a major role in the production of machine tools. This move did help HMT to maintain viability of its operations. Today its market share stands at 24% as the following sales figures show (Naik, 1991) :

Company	Sales (Rs. Crores)	Market Share %	For the year ending
HMT Ltd.	178.15	23.8	March 1990
Klockner Windsor Ltd.	55.94	7.5	Sept. 1990
Battilboi & Co.	51.70	6.9	June 1990
Mysore Kirlosker	34.81	4.6	June 1990
Premier Automobiles	33.36	4.4	June 1990
PRAGA Tools	32.52	4.3	March 1990
Voltas	17.77	2.4	March 1990

Along with its subsidiaries HMT and other public sector units now contribute over 50% of the total output of machine tools in the country. As in production, it leads by a big margin in the area of exports of machine tools also.

Apart from the quantitative increase in the output of machine tools there has been a perceptible change in the composition of HMT's production over the years. Besides general purpose machines HMT now produces specialized machines including NC/CNC machines, keeping ahead of all other manufacturers of machine tools in India. Although amongst the major machine tools manufacturers in the country there are old firms like Cooper Ltd (1937) and Kirlosker Bros. (1938) which entered the machine tools arena long before independence, HMT dominates the scene today and is likely to continue to do so because of its bigger and stronger production base and a well built technical infrastructure.

The development of the machine tools industry in India has unfortunately been lopsided. A small number of units in the organized sector contribute bulk of the production whereas the small size units contribution is no more than 20 percent of the total output of machines. This is contrary to what happens in the industrialized countries where several small size units account for a substantial part of the total production of machine tools made in the country. Moreover, these factories contribute a great deal to the latest technological innovations in the form of designs and application engineering. Most such units thus play a vital role in the overall development and strengthening of the machine tools industry. They are both aggressive and influential and concentrate on the production of high quality precision machines. Numerous examples of

**A small number of units in the organized sector contribute bulk of the production whereas the small size units contribution is not more than 20 percent of the total output of machines.**

such manufactures exist in Switzerland, Germany, USA, UK, France & Japan. In India, however, the position is quite the reverse which has resulted in the scope for overall technological upgradation and innovative designs being circumscribed and restricted to those units which can contribute little to these important developmental aspects because of their preoccupation with the production of general purpose machines. The Indian machine tools industry leans heavily on the government even for its survival and shows little eagerness to seize opportunities to attend to such serious matters as research, design and innovation. It may not be possible to restructure the industry in the immediate future but what can be done is to carryout greater dispersal of R&D facilities so as to introduce and bolster design innovation and manufacturing capabilities to some of the deserving small scale units.

**The Indian machine tools industry leans heavily on the government even for its survival and shows little eagerness to seize opportunities to attend to such serious matters as research, design and innovation.**

### Imports & Exports

Although the Indian machine tools industry has travelled a long way on the technology road during the past four decades, it is yet far from the self sufficiency goal of meeting the needs of India's fast developing industries both engineering and others. Import of special purpose and precision machines has been continuing over the years in fairly large numbers as table 16 shows. During the last decade the import of machine tools has been of the order of 33 per cent or more of its total consumption, going up in some years to as high as 40 per cent.

Machine tools are a highly traded item in the world market. Except for Japan all countries including highly developed ones (like USA, Germany etc.) import machines from other countries for different reasons. India's import of machine tools as percentage of World imports



**Table 16 : Import of Machine Tools**

(Rs. Crores)

Year	Total Imports	Total Consumption	% of Consumption
1980	104.84	269.96	39.0
1981	110.00	320.97	34.3
1982	120.00	362.97	33.1
1983	150.00	375.00	40.0
1984	161.60	424.10	38.1
1985	155.00	468.00	33.1
1986	175.00	500.00	35.0
1987	206.00	547.00	37.7
1988	218.00	617.00	35.3
1989*	264.02	675.50	39.0
1990*	319.39	815.00	39.0

Source : IMTMA (1990), Facts for You (1984)

\* For financial years 1988-89 and 1989-90

doubled during the ten years from 1975 (0.68%) to 1985 (1.5%). The share of imports in consumption, however, declined from 77.9% in 1960 to 35% in 1988 and 39% in 1989. Machine tools imports, however, still form a small fraction of the total imports of all commodities (table 17).

**Table 17 : Imports of Machine Tools vis-a-vis Total Imports**

Year	Machine Tool Imports (Rs. Crores)	Total Imports (Rs. Crores)	% Col 2 to Col.3
(1)	(2)	(3)	(4)
1985-86	175.00*	19657.69	0.9
1986-87	206.00*	20083.53	1.0
1987-88	218.00*	22243.74	1.0
1988-89	264.02	28193.65	0.9
1989-90	319.39	35411.88	0.9

\* Figures pertain to calendar years 1986, 1987 & 1988

Almost half of the value of imports is accounted for by machine tool accessories/attachments. Other major imports consist of Gear cutting machines, Boring machines, Lapping/honing and polishing machines, Grinders, Shapers, Slotters, Bending/punching/notching and Shearing machines, Presses, and other general purpose metal cutting/working machines such as Lathes, Milling & Drilling machines etc. Besides these, high precision NC/CNC Lathes and Grinders are also being imported in fairly large numbers. Amongst the accessories almost all machine tools manufacturers use imported CNC systems and components like AC/DC drives, controllers and ball screws etc. Most of these items remain to be developed and produced within the country. It is here that the role of research & development assumes considerable significance.

**Most of these items remain to be developed and produced within the country. It is here that the role of research & development assumes considerable significance.**

Despite the production of machine tools rising sharply during the past few years, the exports of machine tools in relation to output are trivial. The potential for machine tools export remains very high but the industry's performance on the export front falls far short of expectations. During the past ten years exports have gone up no doubt but are still far from a reasonable volume (table 18). Although the machine tools industry started exporting machines as far back as 1955, its export performance remained almost negligible till 1962. A concerted drive later pushed up exports to about Rs. 8 crores in 1975. The exports, thereafter, rose to a reasonable figure of Rs.79 crores in 1989 and are expected to cross rupees hundred crores mark in 1990. With the machine tools output rising at a fairly fast pace, the percentage of exports to output is still fairly low, hovering between 7% and 15% during the past 10 years. While the output of machine tools has risen by 276 per cent during 1980-1990, the exports have gone up by a mere 52% during the period.

India's export of machine tools in relation to world trade is even today insignificant. While the world consumption of machine tools is nearly Rs. 23,000 crores per year, India's current exports are just a paltry 0.4% of this volume. The main reasons cited for such a poor performance are :

**Table 18 : Exports of Machine Tools**

(Rs. Crores)

Year	Value of Exports	Output	% of Output	Value of Imports	Deficit
1980	20.85	185.95	11.2	104.84	83.99
1981	23.25	234.22	9.9	110.00	86.75
1982	24.16	266.51	9.1	120.00	95.84
1983	25.00	200.00	12.5	150.00	125.00
1984	20.00	282.27	7.2	161.60	140.80
1985	30.00	342.00	8.8	155.00	125.00
1986	46.00	372.00	12.4	175.00	129.00
1987	70.00	417.00	16.8	206.00	136.00
1988	46.00	463.00	9.9	218.00	172.00
1989*	79.00	555.00	14.2	264.00	185.00
1990*	119.00	700.00	17.0	319.39	200.39
1991+	750.00	75.00	10.0	NA	—

Source : IMTMA Annual Reports

Naidu (1990)

Investment Week Oct.29 Nov. 4, 1990

\* For financial years 1988-89 and 1989-90, + Estimated



- \* Lack of exportable surplus due to the Indian machine tools industry's strong inclination towards meeting the domestic demand in preference to exports, as the margin in the later case is much less but the hassels involved are far too many.
- \* Cost of production is comparatively very high making our machines uncompetitive, because of low productivity levels, high input costs, high incidence of taxes and costly imports etc., infra-structural bottlenecks like power, and import restrictions etc. also add to the high cost.
- \* High dealer's margins which inflate marketing costs. Export markets being highly brand conscious Indian machine tools do not get the same market response.
- \* High incidence of inland rail freight and high ocean freight charges which with insurance is said to account for 32 per cent of the FOB value.
- \* High costs of seaworthy packing and painting to export specifications
- \* Marketing promotion facilities abroad are totally unsatisfactory, if not missing.
- \* The quality and finish of our machines are comparatively poor.

Foreign buyers of machine tools generally look for the following :

- \* A quality product
- \* Prompt after sales service
- \* Product reliability
- \* Operational accuracy and high standard of performance
- \* Easy maintenance and availability of spares.
- \* High degree of operational safety
- \* Non deformation under load and prolonged operation
- \* Good and attractive finish.

Unfortunately the quality and finish of our machine tools is not quite up to the world standard. This turns away customers from hard currency areas to other countries. For durability and performance accuracy the machine tools exporting units must enforce high standards of quality at all stages of production including a strict watch

**Unfortunately the quality and finish of our machine tools is not quite up to the world standard. This turns away customers from hard currency areas to other countries.**

on the design aspects, quality of the direct materials used and the workmanship employed. Similarly efficient after sales service should also include offer of assistance to the customers of finding solutions to any production and tooling problems that may arise and provide for complete tooling up of machines where required, besides a prompt break down service.

Currently the major direction of our machine tools exports is to countries having rupee trade account with India, such as USSR, Bulgaria, GDR, Algeria, Iraq and Poland. USSR & Bulgaria alone are reported to account for 81% percent of machine tools exports from India (table 19).

Considering the current state of our overall foreign trade, it is vital that machine tools industry should look beyond domestic markets to ensure that a much larger share of our exports goes to the hard currency areas. As the things stand at present, the situation is just the opposite with exports to rupee trade countries rising steadily during the past few years, which will be clear from the figures shown below (IMTMA, & Financial Express, May 90) :

Year	Total Exports Group A+B (Rs. Crores)	% Export to GC Countries	% Export to Rupee trade countries
1986	46.00	58	42
1987	69.90	57	43
1988	46.00	44	56
1989	79.67	43	57
1990	118.76	32	68

Considering that our imports of special purpose and high-tech precision machines will continue in any case, the industry must launch a vigorous drive to emerge as a net foreign exchange earner. With political and economic instability prevailing in the erstwhile USSR and some of its former allies, it is necessary that the industry should take active steps to create favourable conditions for increasing exports to other developed and developing countries of Europe, America and Africa. The opportunities for exports from India are vast, if only we could gear up our resources,



**Table 19 : Direction of Machine Tools Exports (1987)**

(Rs. Crore)

Country	Value of Exports	% of Total
USSR	29.90	42.0
Bulgaria	28.00	39.0
FDR	4.98	7.0
USA	3.83	5.3
Algeria	1.67	2.3
GDR	0.75	1.0
Australia	0.69	1.0
U.K.	0.65	0.9
Canada	0.54	0.8
Africa	0.48	0.7
Total	71.49	100.0

Source : Technocrat Aug. 1988

improve the quality and finish of our products and reduce costs so as to gain a competitive edge over other machine tools exporting countries.

As the erstwhile USSR market may dry up soon, Indian machine tools industry will in any case have to look for fresh markets in other countries, where the Asian tigers like South Korea and Taiwan are already well entrenched. It is therefore necessary for the Indian machine tools industry to adopt a high pressure market penetration strategy similar to the one that helped some of the Asian giants to gain a firm foothold in the world markets, adapted to our special needs and culture. The Japanese became market leaders in machine tools exports by successfully shifting to mass production of cheap, low powered and standardized machine tools. The Japanese firms laid greater stress on simplification and thereby achieved a great deal of cost reduction to become competitive. While the Indian manufacturers seem to emphasise performance, their counterparts in S.Korea, Taiwan etc. are able to market their machines (EPW, 1991) at 20-30 percent below our prices of similar machines. Apart from high prices, our competitiveness is seriously jeopardized on account of other non-price factors such as speed of delivery, credit terms etc.

The leading exporters of Indian machine tools at present are the following :

	Exports during 1990 (Rs. Crores)
1. HMT (International) Ltd.	30.34
2. Bharat Fritz Werner	13.46
3. Premier Automobiles	9.12
4. Mysore Kirlosker Ltd.	8.61
5. Electronic Sales & Services	8.65

6. PMT Automatics	3.51
7. Batliboi & Co. Ltd.	3.05

Besides machine tools, other Group 'C' products are also being exported. Some of the important exporters of these products are

( Rs. Crores)

Klockner Windsor India Ltd.	39.19
Addison & Co.	8.62
Widia (India) Ltd.	4.50

Since the bulk of the exports are from the public sector units, greater responsibility for improving our export prospects abroad devolves on this sector. This should not, however, mean that other exporters can dispense with the need to bolster their export efforts through quality and productivity improvement.

### World Trade & India

Although Indian machine tools are exported to as many as 46 countries our share in the total world trade amounts to no more than a fraction. It is estimated that some 35—40 percent of the world's machine tools production enters the international markets. Being a late starter, India may not be able to match the performance of the developing countries like China, S. Korea, Singapore & Taiwan in a hurry. It will have to first put its own house in order and then relentlessly pursue its goal of making a mark in the world machine tools markets to become a major foreign exchange earner in the coming years. Table 20 freezes the 1990 position of world trade in machine tools. India's position was 21st amongst 35 machine tools building countries but featured much lower as an exporter of machine tools being 27th amongst the machine tools exporters. Compared to the world leaders in machine tools production, we are thus nowhere and totally out of reckoning at present.

Our exports of machine tools at 0.13 percent of World exports is clearly insignificant. No doubt our exports of machine tools have risen sharply in the past few years but to achieve that our imports of accessories and components have also gone up thus adding to the worsening balance of payments position. This will be amply clear from the following figures of foreign exchange earnings/spendings of some of the main machine tools exporters. This trend can no longer be ignored and the Indian machine tools industry must seriously concern itself with means and methods that will help correct this aberration as quickly as possible in the interest of its own well being.



### Selected Countrywise Export of Machine Tools - 1990

(US \$ million)

Country	Value of Exports*	% of Total
Germany(FRG)	5159.1	23.6
Japan	3996.6	18.3
Switzerland	2749.5	12.6
Italy	1983.0	9.1
USA	1060.0	4.8
U.K.	835.3	3.8
Germany(GDR)	775.0	3.5
Taiwan	648.2	2.9
Belgium	586.6	2.7
Yugoslavia	451.5	2.1
Netherlands	217.3	1.0
Czechoslovakia	187.7	0.9
Singapore	120.5	0.6
South Korea	92.0	0.4
India	28.9	0.1
Total (including others)	21873.9	

Source : IMTMA (1991)

\* Estimated

### Foreign Exchange Spendings/Earnings of Some Machine Tools Exporters (1989-90)

(Rs. Crores)

	HMT	Lakshmi	Ingersoll	Batliboi
Earnings	40.61	40.57	33.15	10.99
Spendings	2.54	43.15	15.76	3.18
Net Earnings	38.07	(-) 2.58	17.39	7.81

While the scope for further expansion of machine tools exports from India is vast, the industry must be prepared to face very stiff competition from other established exporting countries. Most of the developed countries have closed their production lines of general purpose machines thereby providing an opportunity for our machine tools manufacturers to penetrate these markets. Through direct collaboration with the erstwhile producers of such machines in the developed countries Indian machine tools manufacturers can open up new markets for themselves. However, as the industry cannot grow only by producing conventional machine tools, it must also keep its production pattern linked to the changing nature of the demand for machine tools in the world market. While doing this Indian machine tools industry should continue to concentrate on the more sophisticated high-tech special purpose machine tools which are likely to become the main export items of the future world trade in machine tools. It is a well known fact that even countries with highly developed machine tools industry import anywhere between 30 to 35 percent of their total requirements of machines. There is, therefore, no danger of the market for machine tools getting saturated at any stage.

Table 20 : World Trade in Machine Tools—1990 (Estimated)

(Million US \$)

Country	Production			Trade	
	Cutting	Forming	Total	Export	Import
Japan	8957.8	1874.3	10,832.1	3996.6	640.8
Germany (FRG)	6215.8	2610.6	8826.5	5159.1	2113.4
Soviet- Union	3840.0	740.0	4580.0	1380.0	1700.0
Italy	2825.8	1140.2	3966.0	1983.0	1100.7
Switzerland	2604.8	578.8	3183.6	2749.5	868.3
United States	2200.0	940.0	3140.0	1060.0	2340.0
UK	1269.2	450.5	1719.7	835.3	915.7
France	1014.3	350.4	1364.8	534.8	1696.7
Germany (GDR)	895.0	210.0	1985.0	775.0	290.0
Taiwan	775.0	259.9	1034.9	648.2	361.2
Spain	798.4	236.5	1034.9	248.0	507.6
S. Korea	600.5	132.8	733.3	92.0	820.0
Yugoslavia	466.2	162.8	629.0	451.5	95.0
Romania	463.4	67.3	530.7	140.6	86.5
Brazil	350.0	100.0	450.0	25.0	35.0
Canada	221.5	147.4	368.9	222.4	738.4
Austria	235.6	44.9	280.5	353.5	395.9
Belgium	32.3	239.6	271.9	568.6	599.2
Sweden	26.3	125.4	251.7	237.3	389.8
India	212.5	31.1	243.5	28.9	114.6
Poland	155.0	45.0	200.0	27.5	35.0
Czechoslovakia	143.1	48.8	191.9	187.7	158.5
Bulgaria	150.0	10.0	160.0	120.0	75.0
Hungary	81.2	16.6	97.8	88.0	41.3
Netherlands	49.9	47.9	97.8	217.3	381.7
Denmark	55.2	152.2	80.3	70.6	137.9
Singapore	60.2	5.5	65.7	120.5	243.2
Finland	17.1	40.7	57.8	38.1	176.0
Argentina	27.0	11.2	38.2	24.2	22.0
Mexico	13.9	7.6	21.5	10.8	258.0
Portugal	7.0	10.5	17.5	10.0	35.0
Australia	10.9	4.7	15.6	7.8	82.6
Hong Kong	6.0	6.0	12.0	0.5	8.0
S. Africa	1.9	7.8	9.7	0.4	116.3
China	716.5	273.2	989.7	248.0	548.0
Total	35,579.3	11003.2	46582.5	21873.9	11,117.3

Source : IMTMA Bulletin Sep. 1991 and American Machinist.

**There is, no danger of the market for machine tools getting saturated at any stage.**

The key to successful export effort lies in total co-operation between the industry and the government without which our efforts to penetrate hard currency markets and displacing other established countries may come to nought. We have a lot to learn from Japan where the government and industry interaction is so close and con-



stant that one is confused with the other. If, therefore, our efforts to enter new markets are to succeed, we cannot do without such co-operation.

An Exim Bank Study sometime back had identified the following market segments for machine tools.

Type of Machine	Countries
Lathes	USA, UK, France
Milling & Boring	USA, Germany, France
Machining Centres	USA
Transfer Machines	Canada
Presses	USA, Canada, Germany
Punching & Shearing	USA, France

While the above provide a general guidance for our export marketing efforts, it would be useful to develop a definite market strategy through another study with the help of our missions abroad or by a team drawn from the industry itself.

### The Future Outlook

Although our machine tools industry has shown impressive growth in recent years, it has still a lot of leeway to make up, considering the vast potential existing both in the domestic and world markets. The past performance of the industry bears adequate testimony to its dynamic nature and capability to meet the future demands of the manufacturing industry in the country. The current economic situation may be a temporary damper but the industry itself should be able to overcome such short term hurdles and take steps to meet the challenges of the nineties and beyond and attain the goal of self reliance as soon as possible.

The perspective plan prepared by a ministerial committee envisages substantial growth in the production of machine tools. It has projected an output of Rs. 1200 crores by the terminal year of the Eighth Plan (1990-95) which amounts to an annual growth rate of about 20 per cent. During the same period the perspective plan envisages the share of NC/CNC machines to go up to 30 percent of the total output. In other words, the value of production of NC/CNC machines will amount to about Rs. 360 crores consisting of 800 machines of all types. The actual output planned for each year of the now postponed Eighth plan is shown in table 21.

Apparently the actual output of machine tools during 1990 has already exceeded the projections for 1990-91 by a wide margin as it is reported to be around Rs. 700 crores. Similarly the production of NC/CNC machines during 1990

Table 21: Eighth Plan Projections of Machine Tools 1994-95

Year	(Rs. crores)		
	Total Production	NC/CNC machines Production	Share of NC/CNC Machines %
1990-91	600 (8%)	120 (3%)	20
1991-92	690 (15%)	140 (16%)	20
1992-93	830 (20%)	200 (43%)	24
1993-94	1000 (20%)	250 (25%)	25
1994-95	1200 (20%)	360 (44%)	30

Source : Naidu, (1991)

was worth Rs. 137 crores which too is well above its projected value of Rs. 120 crores during 1990-91. The postponed 8th Plan projections, it seems, were based on an average annual growth of 20%, although it was 26% in 1990. In the case of NC/CNC machines the average growth rate during the plan period is 40%, despite the fact that its past performance has been much better. However, there are a number of recent events which may not have been anticipated by the ministerial sub-group on machine tools when formulating their projections. The current foreign exchange crunch in the country, the recession sweeping USA, and economic downturn elsewhere in Europe and Japan and the prevailing political and economic instability in the Commonwealth of Independent States and its former allies in Europe are some of the factors which are bound to have a far reaching impact on the future of our machine tools industry.

NC/CNC and other high-tech machines have a fairly high import content which includes such vital elements as electronic/computer system components and other critical mechanical parts. Import restrictions placed on the industry in general may render it more difficult for our machine tools industry to meet the projected production targets. While the full implications of the budget proposals are yet to be worked out, the fear is that the anticipated growth rate may not be reached. The hurdles are further accentuated by the fact that countries like Germany are refusing to supply CNC systems and components for political reasons. The industry, however, feels the machine tools sector which accounts for barely 2% of the total individual production, foreign exchange requirements may not amount to much particularly for meeting its small needs of a few



critical components being imported at present. Indigenous development of these critical components may not also be possible for quite sometime because of the high cost oriented developmental cycle. Virtually no efforts in this direction seem to have been initiated so far. In regard to flexible manufacturing systems (FMS) the problem seems to be the setting up of a suitable infrastructure, which may be a more difficult one to get over. While the FMS has many positive benefits for the manufacturing industry, the size of investment coupled with the suspected non-viability of such production lines may prove to be major hurdles in the coming years.

Exports of machine tools on which the future growth of the machine tools industry will henceforth depend to a large extent are likely to receive a serious setback as a result of the world economic recession and political turn-around in USSR and some of the European countries to which over 60% of our exports are currently directed. This in turn may affect the overall growth of the industry. Considering these factors, it is doubtful if the Indian machine tools industry can reach a growth rate of even ten percent in the first few years of the nineties.

According to a survey conducted by IMTMA, the industry has an optimistic future outlook and hopes for better business opportunities (table 22). While the machine tools industry has undoubtedly done well during 1990 both on the production and export fronts, its expectations for a repeat performance during 1991 and thereafter may not materialize because of the problems already mentioned. It seems the IMTMA survey findings were based on the anticipated growth of the domestic engineering industry and better response from the world markets both of which are unlikely to come about in the immediate future.

**it is doubtful if the Indian machine tools industry can reach a growth rate of even ten percent in the first few years of the nineties.**

The other factors which may affect the future performance of the machine tools industry are :

- (a) High cost of our machines and low volume production. Prices of most Indian machines are more than FOB prices of imported machines. A study conducted by BICP showed that prices of local machine tools were higher by 86% to 137% as com-

**Table 22 : Future Trends in Indian Machine Tools Industry**

	Better	Same	Worse
General Business Outlook	27%	53%	20%
Cost of Production	1%	-	99%
Capacity Utilization (CU)	20%	58%	22%
30% respondents expect to achieve CU above 75%			
64% respondents expect to achieve CU between 50% and 75%			
6% respondents expect to achieve CU below 50%			
Major Constraints on output (% of respondents)			
Finance	67%		
Power	12%		
Raw material	40%		
Delayed Imports	A few		
Exports	52%	31%	17%
Inflow of Orders	25%	41%	34%

Source : IMTMA Bulletin Sep.1991

pared to the cost of machines imported by our engineering industry.

- (b) Quality of our products not being upto the international standards.
- (c) Infrastructural bottlenecks such as power, water, trained manpower etc.
- (d) Changing pattern of consumer needs.
- (e) Low grade technology and inadequate R&D.
- (f) Lack of high level technology necessary for the manufacture of sophisticated CNC machines such as 5 axis, 7 axis CNC machines, FMS, FMC etc.
- (g) Inability to compete in international markets because of high cost low volume syndrome.

The machine tools manufacturers on the other hand seem content to sell their products within the country where most of the above factors do not cause any serious marketing problem. A marketing strategy is as important as a sound design, technology and good production in the machine tools industry. Till now Indian machine tools industry has not worked out any definite market strategy which would have helped it to establish itself as a reliable exporter of machine tools. Perhaps the need for such a strategy was not felt so long but under fast changing conditions it has become paramount now and the producers must therefore establish closer contacts and meaningful dialogues within their ranks and the government on the one hand and potential trading partners on the other. The industry has a long way to go and therefore cannot afford



to delay this any further. To this end the industry, EEPC and Govt will have to line up their resources and work out jointly a viable strategy to crash into the world markets as quickly as possible.

It is a well known fact that the Japanese machine tools industry has developed under circumstances almost similar to those of the Indian industry today. While the Japanese machine tools industry was no doubt in existence long before the Second World War, it was totally destroyed during American bombing of Japan. It was not therefore until 1950 that the Japanese machine tools industry began to revive itself. It was also around this time that the Indian machine tools industry began to shape itself. Obviously, because of their past experience, the Japanese could be said to have had the advantage of possessing skills and technology infrastructure, but this could not have been of much significance in the choice of the development strategy adopted by them. In any case, the impact of the development strategies adopted by the two countries has been apparently quite different as far as growth of output, technology upgradation and production efficiency of the machine tools industry in the two countries are concerned. It does not require any special evidence to show the vastly superior state of the Japanese machine tools industry in almost all areas of production, export, design, innovation and labour productivity. Considering that the policies pursued till now for the development of our machine tools industry have failed to produce the kind of results the policy makers expected, it would be worthwhile to review these critically so that these can be modified or replaced, as necessary.

### Problems & Policies

It is recognized by some that govt. policy has a profound impact on the industry's future growth and advancement. Some others feel the kind of protection as practised in India so long has led to slackness of efforts in acquiring/absorbing/incorporating and strengthening of technological base of the domestic machine tools industry. Prolonged protection no doubt has proved to be counter-productive. It is, therefore, not very unnatural to find that the machine tools industry has not been able to gain the confidence of the user industry groups in its products.

Until recently when the new industrial policy was announced, a number of measures conducive to the development of the machine tools industry were in operation and may still be effective—some of them if not all. These are :

- (1) Raising the ceiling on investment in plant and

machinery for SS industries from Rs. 35 lakhs to Rs. 60 lakhs. This measure should help the small scale sector to modernize and upgrade its technology levels. This has now been enhanced to Rs.100 lakhs.

- (2) Allowing import of capital goods upto landed cost equivalent to 30% of the total value of plant & machinery.
- (3) Liberalized policy on foreign collaboration procedures provided the royalty payment does not exceed 5% of domestic sales and 8% of exports.
- (4) Permitting investment upto 40% of equivalent capital to facilitate technology absorption, subject to the condition that landed value of imported goods should not exceed 30% of the value of plant and machinery.
- (5) Introduction of automatic licensing scheme to enable import of raw materials, components and consumables subject to certain limits.
- (6) Raising the limit for import of prototypes and samples, designs & drawings.
- (7) Revising upwards the replacement rates of machine tools from 15% to 20%.
- (8) Broadbanding of production.
- (9) Financial assistance at concessional rates of interest and facility to import capital equipment at a concessional duty rate of 40% under the Technology Upgradation Scheme (TDS).

**The current duty structure makes the import of finished product more attractive to the local buyers than a comparable indigenous product.**

The industry however feels the govt. must relax some of the financial restrictions in the form of high excise and import duties. Apparently there are some glaring anomalies in the import duty structure which need to be carefully studied and rectified. For instance, the duty differentials on finished products, intermediates and their components/parts/raw materials etc. are not properly inter-related which in many cases works against the local manufacturers of machine tools and exporters. The current duty structure makes the import of finished product more attractive to the local buyers than a compa-



rable indigenous product. Apparently there is no sound reason for such import levies. Its serious long term impact on the industry demands a thorough re-examination so that these may not come in the way of our machine tools becoming competitive in the world market. The ball however still lies in the industry's court. One only hopes that it will rise to the occasion and play its rightful role in stabilizing the industry and thereby enable it to contribute its mite to the economic development of the country at large.

### Abreviation used

AH	Alfred Herbert (India) Ltd.
CAD	Computer aided Design
CAM	Computer Aided Managing
CIE	Confederation of Engineering Industry
CIER	Centre for Industrial & Economic Research
CMIE	Centre for Monitoring Indian Economy
CU	Capacity Utilization
EPW	Economic & Political Weekly
EDM	Electric Discharge Machine
FE	Financial Express
ICICI	Industrial Credit & Investment Corporation of India
GCC	General Currency Countries
HMT	Hindustan Machine Tools
IIC	Indian Investment Centre
IMTMA	Indian Machine Tools Manufacturing Association
PTI	Press Trust of India
RBI	Reserve Bank of India
SLM	SLM Manekalal & Co. Ltd.
SPM	Special Purpose Machines

### REFERENCES

- Asha Rai, Export potential unexploited, *Economic Times*, May 16, 1991.
- Bajpai, S.B., 'Export of Machine Tools, *Commerce* Feb. 6, 1971.
- Business Standard**, Rs.800 crore shortfall in machinery imports, Oct.1990.
- Business World**, Engineering exports - a new thrust, July 19- Aug. 4, 1989.
- Business Standard**, Machine Tools - Unsung leader, Dec. 1990.
- Business Express**, Telling tale of machine tools, July 14, 1989.
- Commerce**, Machine Tools Sophistication - Need of the hour, Feb. 8, 1986.
- CEI, Note on Strategic Plan for Industrial growth for next 15 years. Mar. 1988.
- CEI - Handbook of statistics - 1988 & 1990.
- CIER - Industrial Data Book 1988-89 & 1991-92.
- CMIE- Key financial Data on larger Business Units, July 1991 - Jan. 1992 Volumes
- CMIE - Production & Capacity Utilization in 600 Industries Oct. 1987.
- CMIE -Shape of things to come. survey of 2200 Investment Projects, Vol. 1990.
- Damodaran, G.R., Presidential Address, 24th AGM of IMTMA, Bangalore, Feb. 4, 1971.
- Damodaran, G.R., Pace-setter for other Industries, *Commerce*, Jan. 29, 1972.
- Department of Science & Technology**, Govt. of India, Research & Development in Industry, 1988-89, Oct. 1990
- Das, Arvind, N., Problems of Structural Adjustment, *Times of India*, Nov. 12, 1991.
- Economic Times**, Need to bridge technology, May 16, 1991.
- Economic Times**, Policy Changes Needed for Export Thrust, May 16, 1991.
- Facts for you**, Indian Machine Tools, Jan. 1991.
- Financial Express**, The Machine and Hand Tool Industry Today, Aug.13, 1991.
- FE Investment Week**, Machine Tools. - Favourable policies, Admirable growth, Oct. 29 -Nov.4, 1990.
- Financial Express**, Machine Tools exporters urged to tap hard currency markets, Feb.1, 1991.
- Financial Express**, Machine tools Industry wary of preshipment inspection, Feb.9, 1991.
- Financial Express**, Machine Tools-Need to raise Exports, May 11, 1990.
- Financial Express**, Machine Tool Exports, June 11, 1991.
- Financial Express**, Budget hits Machine Tools Industry, March 4, 1992
- Govt. of India**, Ministry of Finance, Economic Survey 1990-91.
- IIC, Machine Tools Industry, Monthly Newsletter, Dec. 1987.
- Indo-German Economy**, World Machine Tool Statistics 1987, No.1, 1989.
- Industrial News Digest**, Industry Profile-Machine Tools Industry, Feb. 1984.
- Kothari's Yearbook**, Industry Profile, Machine Tools, 1991.
- Mathews, Ron**, Development of India's Machine Tool Industry, *Economic & Political Weekly*, Oct.1, 1988.
- Mathews, Ron**, Industrial Strategy & Technical dynamism in Machine Tool Manufacture, *Research Policy Studies*, LUND 1982
- Naik, S.D**, Machine Tools the backbone of Engineering Industry, *Economic times*, May 16, 1991.
- Naidu, M.R.**, Present and future prospectives - Machine tools, *Financial Express* Feb. 9, 1991.
- National Herald**, Inadequate funds a constraint in achieving Export Target, Oct.22, 1989.
- NPC Research Division**, "Productivity levels in Asian Nations," *Productivity*, 32(2), 1991.



Patil, S.M., Facing challenges ahead, Commerce Jan 29, 1972.

Patil, S.M. The challenge ahead for the Indian Machine Tools Industry, Industrial Products Finder, Feb. 1986.

Patil, S.M., Engineering Industry - Need to spur exports, Economic Times, Dec. 29, 1988.

Patil, S.M., Machine Tools Industry—A survey, Commerce Jan.29, 1972.

PTI, Corporate Trends, Industrial Production. Slowdown and after, Oct.10, 1991.

PTI, Corporate Trends, Trends in Industrial Production, July 25, 1991.

PTI, Corporate Trends, Gearing for Export Thrust, March, 25, 1991.

PTI, Economic Service, Engineering Exports, Oct. 1, 1991.

PTI, Economic Service Machine Tools Industry, June.1, 1991.

Sengupta Arjun, Interview with Times of India, Nov.17, 1991.

Sheth, Shailesh, More Investment in R&D needed, Economic Times, May 16, 1991.

Suvarthan, PI, Machine Tool Industry—Export Performance and Prospects. Economic and Political Weekly, Feb. 23, 1991.

Singh, Gurbachan, New Trends in Machine Tools, Financial Express, May 11, 1990.

Sulakhe, S.D., Breakthrough in World Markets, Financial Express, May 11, 1991.

Sulakhe S.D., Machine Tools - status of the Industry, Financial Express, May 11, 1990.

Srinivasan, R., Machine Tools Industry - Status & Problems, Economic Times, Feb. 4, 1989.

Swaminathan S. Aiyar, Lessons from East Germany, Times of India, Oct.6, 1991.

Times of India, BPC earns cash profit of Rs. 3.1 crores Nov. 12, 1991.

Times of India, HMT meets EC standards", 7th Dec. 1991.

Times of India, HMT signs MOU for 1991-92, Oct. 9, 1991.

Times of India, Shed Inhibitions to be Competitive, FM, Jan. 7th, 1992.

Times of India, R&D in industry, Dec. 10, 1991.

Times of India, Exports decline by 8% in Dollar terms, Oct. 22, 1991.

Times of India, Shortfall in Engineering Output, Exports rise, Oct. 2, 1991

Times of India, Anomalies in import duty structure other industry, April 2, 1992.

#### Appendix I : Ratio of Total Earnings to Conversion Cost

Company	1985	1986	1987	1988	1989	1990	
AIR CONTROL	1.0 (18m)	1.2	1.1	—	1.4 (18m)(18m)	1.3	Year ending Sept.
ADDISON	—	1.1	1.2	—	0.96	1.1	—
ATLAS COPCO	1.6	1.4	0.97	—	0.91 (15m)	0.99	Year ending Dec.
CONSOLIDATED	1.2	1.1	1.2	—	1.3 (15m)	0.96	—do—
DAGGER FORST	—	1.1	1.08	1.4	1.5 (18m)	—	Year ending June
EMA	—	—	—	1.6	1.6 (11m)	1.4	Year ending April
IFB	0.8	1.1	0.4	1.7	1.1	—	Years ending Dec. 1984 to 1988
INGERSOLL	1.9	1.7	1.8	—	1.7 (18m)	1.8	Year ending Dec.
KG KHOSLA	1.3 (11m)	1.3	1.2	1.2	1.2 (15m)	—	Year ending June
KIRLOSKER PNEUMATIC	1.0	1.1	1.3	—	1.2 (18m)	1.2	Year ending Sept.
SS MIRANDA	1.3	1.2	1.1	1.0	1.1 (15m)	—	Year ending Dec.
WIDIA	1.2	1.3	1.2	1.2	1.3	—	—do—
BP&C	—	1.3	0.9	0.6	0.6	1.4	—
ELGI	—	1.2 (13m)	1.2	1.5	1.3 (11m)	1.3	Year ending April
SLM MANEKLAL	0.9	1.0	1.2	1.1	0.6	—	—
PRAGA	—	1.3	1.2	1.2	1.0	0.99	—
XLO	—	0.8-	1.0	—	1.0-	0.96	Year ending Sept.
HMT	—	1.0	1.1	1.1	1.1	1.1	—
AH	1.6	1.0 (15m)	1.0	1.3	1.1 (15m)	—	Years ending June 1984 to 1988



**Appendix 2 : Ratio of Purchased Services to Total Earnings**

Company	1985	1986	1987	1988	1989	1990	
AIR CONTROL	0.8 (18m)	0.4	0.4	—	0.4 (18m)	0.3	Year ending Sept.
ADDISON	—	0.5	0.5	—	0.6	0.5	—
ATLAS COPCO	0.3	0.3	0.5	—	0.5 (15m)	0.7	Year ending Dec.
CONSOLIDATED	0.3	0.4	0.3	—	0.3 (15m)	0.4	—do—
DAGGER FORST	—	0.45	0.4	0.2	0.2 (18m)	—	Year ending June
EMA	—	—	—	0.3	0.3 (11m)	0.4	Year ending April
IFB	0.8	0.6	1.6	0.5	0.6	—	Years ending Dec. 1984 to 1988
INGERSOLL	0.2	0.3	0.3	—	0.3 (18m)	0.3	Year ending Dec.
KG KHOSLA	0.4 (11m)	0.4	0.4	0.4	0.36 (15m)	—	Year ending June.
KIRLOSKER PNEUMATIC	0.5	0.4	0.4	—	0.4 (18m)	0.4	Year ending Sept.
SS MIRANDA	0.5	0.5	0.4	0.4	0.4 (15m)	—	Year ending Dec.
WIDIA	0.6	0.5	0.6	0.5	0.5	—	—do—
BP&C	—	0.3	0.5	0.7	0.8	0.2	—
ELGI	—	0.5 (13m)	0.5	0.4	0.5 (11m)	0.5	Year ending April
SLM MANEKLAL	0.4	0.4	0.3	0.3	0.6	—	—
PRAGA	—	0.3	0.3	0.3	0.4	0.4	—
XLO	—	0.28	0.2	—	0.2	0.2	Year ending Sept.
HMT	—	0.3	0.3	0.3	0.3	0.3	—
AH	0.25	0.35 (15m)	0.37	0.3	0.34 (15m)	—	Years ending June 1984 to 1988

**Appendix 3 : Percentage of Wages/Salaries to Sales**

Company	1985	1986	1987	1988	1989	1990	
AIR CONTROL	16.8 (18m)	28.6	27.9	—	29.0 (18m)	29.0	Year ending Sept.
ADDISON	—	18.5	17.9	—	17.4	14.7	—
ATLAS COPCO	12.4	10.2	12.4	—	14.7 (15m)	13.6	Year ending Dec.
CONSOLIDATED	20.5	19.2	18.5	—	21.0 (15m)	22.1	—do—
DAGGER FORST	—	32.7	35.3	32.4	29.5 (18m)	—	Year ending June
EMA	—	—	—	13.9	11.6 (11m)	13.2	Year ending April
IFB	8.5	4.4	2.6	2.2	4.4	—	Years ending Dec. 1984 to 1988
INGERSOLL	10.6	9.6	9.8	—	10.3 (18m)	9.7	Year ending Dec.
KG KHOSLA	13.6 (11m)	15.5	15.5	16.1	18.8 (15m)	—	Year ending June
KIRLOSKER PNEUMATIC	16.5	19.6	15.9	—	18.0 (18m)	18.5	Year ending Sept.
SS MIRANDA	13.1	10.6	13.7	16.0	12.8 (15m)	—	Year ending Dec.
WIDIA	13.2	14.3	15.3	15.7	14.9	—	—do—
BP&C	—	14.2	17.7	22.0	20.9	22.8	—
ELGI	—	10.7 (13m)	8.2	7.2	9.2 (11m)	7.8	Year ending April
SLM MANEKLAL	26.9	28.3	27.2	25.8	36.4	—	—
PRAGA	—	21.0	15.4	17.1	21.0	22.3	—
XLO	—	59.5	50.9	—	49.4	48.9	Year ending Sept.
HMT	—	25.3	22.9	24.2	24.1	25.0	—
AH	8.4	11.4 (15m)	10.9	13.3	15.1 (15m)	—	Years ending June 1984 to 1988



Appendix 4 : Ratio of Profit to Conversion Cost

Company	1985	1986	1987	1988	1989	1990	
AIR CONTROL	0.1 (18m)	(0.06)	(0.01)	—	(0.003) (18m)	0.03	Year ending Sept.
ADDISON	—	0.08	0.05	—	0.05	0.11	—
ATLAS COPCO	0.2	0.25	0.07	—	(0.03) (15m)	(0.03)	Year ending Dec.
CONSOLIDATED	0.14	0.26	0.26	—	0.06 (15m)	0.02	—do—
DAGGER FORST	—	0.007	(0.11)	(0.06)	0.03 (18m)	—	Year ending June
EMA	—	—	—	0.25	0.35 (11m)	0.19	Year ending April
IFB	0.4	0.4	0.6	0.5	0.5	—	Years ending Dec. 1984 to 1988
INGERSOLL	0.4	0.5	0.5	—	0.5 (18m)	0.5	Year ending Dec.
KG KHOSLA	0.09 (11m)	0.07	0.11	0.02	0.02 (15m)	—	Year ending June
KIRLOSKER PNEUMATIC	(0.007)	0.0004	0.04	—	0.1 (18m)	0.05	Year ending Sept.
SS MIRANDA	0.2	0.08	(0.02)	0.009	0.12 (15m)	—	Year ending Dec.
WIDIA	0.1	0.1	0.1	0.1	0.1	—	—do—
BP&C	—	0.05	(0.04)	(0.6)	(0.8)	(0.5)	—
ELGI	—	0.1 (13m)	0.2	0.3	0.2 (11m)	0.1	Year ending April
SLM MANEKLAL	(0.11)	(0.19)	(0.03)	0.01	(0.4)	—	—
PRAGA	—	0.28	0.23	0.17	0.08	0.02	—
XLO	—	(0.2)	0.05	—	0.02	(0.12)	Year ending Sept.
HMT	—	0.06	0.03	(0.01)	0.01	0.01	—
AH	0.13	0.05 (15m)	0.04	0.02	0.02 (15m)	—	Years ending June 1984 to 1988

Appendix 5 : Percentage of Profit to Sales

Company	1985	1986	1987	1988	1989	1990	
AIR CONTROL	9.2 (18m)	(3.5)	(0.6)	—	(0.14) (18m)	1.5	Year ending Sept.
ADDISON	—	3.8	2.6	—	2.9	5.5	—
ATLAS COPCO	6.1	6.9	2.3	—	(0.86) (15m)	(0.98)	Year ending Dec.
CONSOLIDATED	5.2	9.4	8.8	—	2.3 (15m)	0.69	—do—
DAGGER FORST	—	0.5	(9.2)	(3.6)	1.6	—	Year ending June
EMA	—	—	—	9	12.2 (11m)	7.3	Year ending April
IFB	14.5	10.4	9.5	8.0	9.5	—	Years ending Dec. 1984 to 1988
INGERSOLL	10.5	11.6	12.2	—	13.2 (18m)	13.2	Year ending Dec.
KG KHOSLA	3.2 (11m)	2.5	4.0	0.8	0.6 (15m)	—	Year ending June
KIRLOSKER PNEUMATIC	(0.3)	0.02	1.4	—	4.1 (18m)	2.2	Year ending Sept.
SS MIRANDA	9.4	2.7	(0.6)	0.4	4.1 (15m)	—	Year ending Dec.
WIDIA	7.1	7.0	7.8	5.9	5.1	—	—do—
BP&C	—	1.4	(17.6)	(27.5)	(44.6)	(20.4)	—
ELGI	—	4.7 (13m)	4.7	5.6	5.1 (11m)	3.3	Year ending April
SLM MANEKLAL	(5.3)	(9.1)	(1.4)	—	0.48	(22.4)	—
PRAGA	—	10.9	8.3	6.3	3.2	1.0	—
XLO	—	(16.5)	3.3	1.4	(8.2)	—	Year ending Sept.
HMT	—	3.0	1.4	(0.5)	0.4	0.5	—
AH	2.4	1.2 (15m)	0.8	0.6	0.7 (15m)	—	Years ending June 1984 to 1988



**Appendix 6 : Profit per Employee**

(Rs. Lakhs)

Company	1985	1986	1987	1988	1989	1990	
ATLAS COPCO	0.42	0.54	0.18	—	(0.08) (15m)	(0.076)	Year ending Dec.
INGERSOLL	0.50	0.68	0.68	—	0.98 (18m)	—	Year ending Dec.
KIRLOSKER PNEUMATIC	(0.007)	Neg	0.033	—	0.16 (18m)	0.06	Year ending Sept.
BP&C	—	0.03	(0.37)	(0.43)	(0.86)	(0.41)	—
PRAGA	—	0.124	0.157	0.110	0.063	0.02	—
HMT	—	0.036	0.021	(0.007)	0.008	0.011	—

**Appendix 7 : Sales per Employee**

(Rs. Lakhs)

Company	1985	1986	1987	1988	1989	1990	
ATLAS COPCO	6.81	7.82	7.61	—	9.40 (15m)	7.79	Year ending Dec.
INGERSOLL	4.80	5.83	5.56	—	7.43 (18m)	—	Year ending Dec.
KIRLOSKER PNEUMATIC	2.31	2.06	2.38	—	3.86 (18m)	2.80	Year ending Sept.
BP&C	—	2.16	2.11	1.58	1.93	2.03	—
PRAGA	—	1.14	1.66	1.74	1.97	1.99	—
HMT	—	1.21	1.44	1.56	1.86	2.14	—

**Appendix 8 : Value Added per Employee**

(Rs. Lakh)

Company	1985	1986	1987	1988	1989	1990	
ATLAS COPCO	1.81	1.89	1.56	—	1.84 (15m)	1.33	Year ending Dec.
INGERSOLL	1.58	1.68	1.67	—	2.42 (18m)	—	Year ending Dec.
KIRLOSKER PNEUMATIC	0.52	0.56	0.61	—	1.14 (18m)	0.81	Year ending Sept.
BP&C	—	0.66	0.34	0.28	(0.03)	0.50	—
PRAGA	—	0.419	0.480	0.511	0.607	0.638	—
HMT	—	0.444	0.467	0.495	0.592	0.682	—



# Kirloskar Electric Route Map to TQM

S Ramesh & Virupaksha Gowda

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*One of the four units of Kirloskar Electric Co. Ltd., Unit III at Peenya, Bangalore engaged in the design and manufacture of DC Machines (0.5 kW to 3000 kW) and AC Generators (100 kVA to 1000 kVA) decided to go in for the Total Quality Management in 1985. In this paper the company shares their experience in adopting and practising Total Quality Management. This is the first of a series of corporate highlights on productivity that we propose to publish.*

*S. Ramesh is Associate Vice-President & Virupaksha Gowda is Dy. General Manager of Kirloskar Electric Co. Ltd., Bangalore-560 058.*

## Need for TQM

- \* The Products and Services which were good yesterday barely meet the requirements of today and will be inadequate tomorrow. The needs of the customers are continuously increasing. There is keen competition in the domestic market and with the entry of multi-nationals we also face formidable competition globally. The competition is also continuously improving the products, services and lowering the prices.
- \* In the age of electronic communication, the customers expect a speedy response to their queries. Historically our response time was high which was not acceptable to the customers, thus it was very essential that the response time to customers be reduced.
- \* The Inventory Turnover rate was less. We had materials in stores and work-in-progress locked up, to the tune of 105 days of production. It was necessary that we reduce the Inventory and increase its turnover rate.
- \* The quality defects were high. The defects occurred in all manufacturing areas. Though we were aware that the defects were occurring in non-manufacturing functions also we lacked data regarding these serious defects which caused product and servicing defects.
- \* The product delivery time was high. The customers liked to place orders with shorter delivery periods and insist upon the adherence of delivery schedules in view of their own commitments to their projects.
- \* Historically we believed that "QUALITY COSTS MONEY WHEREAS WE SHOULD HAVE BELIEVED "QUALITY MAKES MONEY". It is the attitude of the management and employees that needed to be changed to orient towards quality improvements and customers.
- \* There was an atmosphere of indifference prevailing in the Company. This attitude produced indifferent results and this needed correction.



- \* We were satisfied with the prevailing levels of quality. This satisfaction arose out of comparing our performance with the previous year's performance instead of performance expected by the customers. This satisfaction with the prevalent quality levels meant stopping the improvement process. We needed to develop a constructive level of dissatisfaction where quality was concerned and had to instill a belief that we can do better.
- \* The employees involvement in quality improvement was not to the desired levels. There was resistance to change in the people to suit the changing business environment. This resistance needs to be reduced in order to ensure better employee involvement.
- \* Suppliers, dealers and trade unions were not considered as our partners in operating the business. We had to create an integrated network of the Company involving customers, suppliers, dealers and trade unions.

There was a need that we should lower our manufacturing costs, increase profit margins and obtain higher market share. In this direction we set about not only meeting customers requirements but also to raise the level of product performance and the working standards of the employees.

**We set about not only meeting customers requirements but also to raise the level of product performance and the working standards of the employees.**

### Management Strategies

The route taken by us towards TQM is schematically shown in fig 1. The Management established a Quality Council in the year 1985. The Quality Council addressed itself initially to the following three areas :

- (a) To the measurement of present quality status.
- (b) Plans for future quality improvements.
- (c) Involvement and participation of all the employees.

The Management adopted the following strategies for quality improvements :

- \* **Management Leadership**—to bring about cultural changes.
- \* **Strategic Planning**—for quality and communication.
- \* **Process Improvement**—for establishment of processes, procedures, and systems. Many of the administrative processes were as complex as the manufacturing processes themselves. Most of the non-conformance occurred because of lack of process in the non-manufacturing areas like Design, Quality Assurance, Materials Management, Marketing, etc. It was the strategy of the Management to have the process control at all manufacturing and non-manufacturing process.
- \* **Product Improvements**—improvements to product technology, safety manufacturability, useability and maintainability.
- \* **Human Resource Development**—improvement, training and motivation.
- \* **Customer Orientation**—customer oriented manufacturing and non-manufacturing processes horizontally integrated in all the functional departments. A concept of internal and external customers was also brought in.
- \* **Supplier Improvement**—policy and plans to improve the suppliers to obtain conforming materials at the required delivery schedules.
- \* **Improving Tools**—the usage of basic 7 tools of SQC and planning tools like Quality Policy Development, Quality Function Development and Quality Operating System.

The Management in the year 1988 revised its earlier Quality Policy. It also brought about the Mission, values and Guiding Principles (MVGP) to be followed by the Company to meet the objectives specified in the Quality Policy. The emphasis has been on people, products, employees involvement, continuous improvements, and partnership with dealers, union and suppliers. A long range plan for 5 years on quality improvement has been drawn up.

### TQM Philosophy

The Company adopted a 5 point TQM philosophy to be followed by every function. The five elements of TQM Philosophy are :

1. Process Oriented Thinking
2. The Deming Cycle of Continuous Improvement (PDCA)



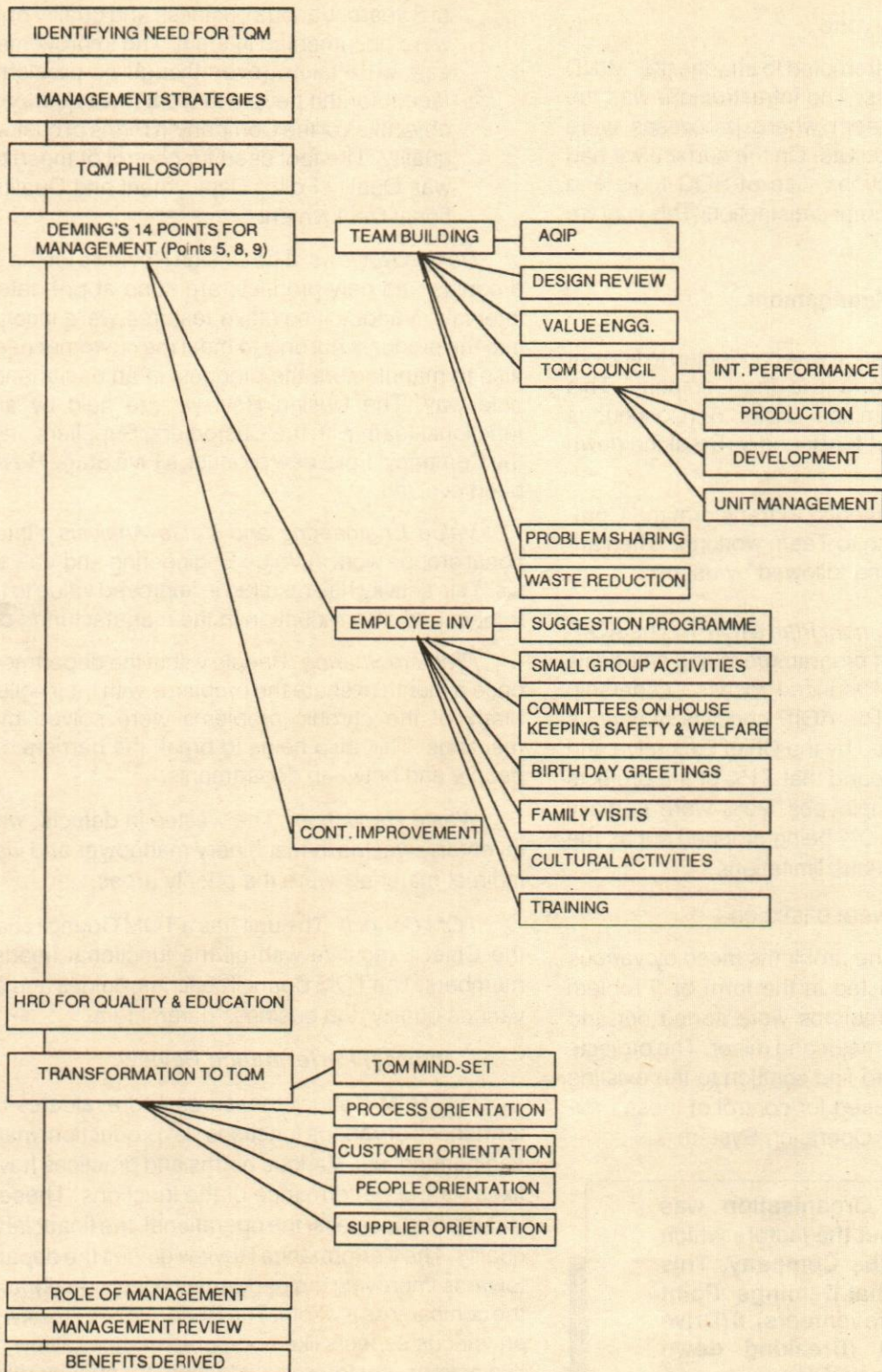


FIG. 1: TQM ROUTE MAP



3. Manage with Facts
4. Management Priority
5. Participation by Everyone

The TQM Philosophy attempted to change the "MIND SET" among the employees. The infrastructure was the modified management system where processes were managed to produce the outputs. On the surface we had activities like corrective actions, use of SQC tools and actions to improve the customer satisfaction. This way we evolved a "TQM BUILDING".

### Demings' 14 Points for Management

A survey in the Organisation was conducted to find out the factors which are important to the Company. This Survey indicated that Demings' Point 5 (Continuous Improvements), 8 (Drive out fear), and 9 (Breaking down barriers) were the priorities.

**Team Building** : We needed to transform the Company from Individual working to Team working. The various activities in team building followed by us are :

**Annual Quality Improvement Plan (AQIP)** : The AQIP is a structured improvement programme laying emphasis on Customer Orientation, Produce/Process Leadership and Resource Utilisation. The AQIP consists of various thrust areas and is monitored by the Chief Executive and audited every month. We found that 71% of the projects were completed by the employees, 20% were partially completed and the balance 9% being dropped out as the work progressed due to various limitations.

The Projects of AQIP were based on :

- (a) **Reactive Type** : All the problems faced by various departments were listed in the form of "Problem Directory". These problems were sorted out and classified as critical, major and minor. The projects were then taken up to find solution to the existing problems. The tool used for control of these projects was the Quality Operating System.

**A survey in the Organisation was conducted to find out the factors which are important to the Company. This Survey indicated that Demings' Point 5 (Continuous Improvements), 8 (Drive out fear), and 9 (Breaking down barriers) were the priorities.**

- (b) **Pro-active Type** : The Company has an Annual Operating Plan (AOP) and Long Range Plan (LRP) of 5 years. Various business and quality objectives were documented in them. The improvement projects were taken (even though no problems were faced) for the people to work towards meeting the objectives of the Company in terms of business and quality. The tool used for control of these projects was Quality Policy Deployment and Quality Functional Deployment.

**Design Reviews** : The Design Reviews for the existing products and new products are done at pre-determined intervals. Various innovative features were incorporated into the products not only to meet the customer needs, but also to manufacture the products in an easier and profitable way. The Design Reviews are held by an Inter-functional team with the Customers, Suppliers and within the Company. For a new product, a Five Stage Review has been evolved.

**Value Engineering and Value Analysis** : Inter-functional groups work in Value Engineering and Value Analysis. This activity has resulted in improved value to the customers and also reduction in the manufacturing costs.

**Problem Sharing** : People within the department meet once a month to share the problems with their colleagues. Many of the chronic problems were solved by these meetings. This also helps to break the barriers between people and between departments.

**Waste Reduction** : The wastes in defects, wastes in inventory, wastes in machinery manpower and wastes in indirect materials were the priority areas.

**TQM Council** : The unit has a TQM Council chaired by the Chief Executive with all the functional heads as its members. The TQM Council coaches, guides and controls various quality and business parameters.

#### \* **Internal Performance Review**

The TQM Council measures and evaluates the performances of various functions like production, marketing, engineering, etc. Various norms and practices have been fixed for the performance of the functions. These norms include the business, the operational, the financial and the quality. The Performance Review guides the departments towards improving the performance individually as well as the company as a whole. The Performance Review is done on various aspects like non-conformance review, corrective actions, customer satisfaction, manpower utilisation, idle time analysis, Gauge control, etc.



### \* **Production Review**

This review is made once in a week to ascertain the level of production and sorting out any production oriented problems. The emphasis in this meeting is on the delivery schedules to satisfy the customers, third party inspectors, etc.

### \* **Development**

We have a development planning activity in the company, various stages of new product development are written down in a flow chart. The development activities originated from the Long Range Plan of the Company. The status of the product development is reviewed by the TQM Council in view of the large impact of a new product on our future market.

### \* **Unit Management**

The TQM Council reviews the way the Unit is managed. Various corrective actions required are taken to ensure that the Unit is managed in an acceptable way to all the concerned. Various welfare activities are also evolved in this forum. The emphasis of the Unit Management is to create an enjoyable and peaceful working environment in the company.

### **Suggestion Programme**

The Suggestion Programme was revised in the year 1989 to improve the participation of the operators and staff members. The programme was evolved with the intention of achieving higher productivity and involvement/attitudinal changes among the employees. The scheme has been structured well and has been communicated to all the eligible employees. With the strong support from the management, rapid processing time, faster implementation time and adequate financial awards, the scheme has been considered to be fairly successful. The Acceptance Rate of the suggestions is about 40%.

### **Small Group Activities**

Small group activities both at operators level and the staff level are working for the continuous improvement of the processes, products and services. The improvements are also done in work simplification to reduce the standard times of manufacturing and reduction of cycle time. More than 60% of our employees are engaged in the small group activities.

### **Committees on House Keeping, Safety and Welfare**

These committees have been constituted to improve the level of house keeping, safety in the working environ-

ment and for the welfare of the employees. With the active participation by everyone, we have been able to achieve third level in the house keeping. We have an ambition to reach the 5th level which is the maximum as far as the house keeping is concerned.

### **Birthday Greetings**

The employees are sent greetings on their birthdays. The Chief Executive personally hands over a packet of sweets and greets the employee.

### **Family Visits**

One of the means of involving the employees is to involve their families. We invite the family members of the employee for a visit to the company on the week ends. The family is taken round the factory by the employee himself. Photograph of the family along with the employee in the workspot is taken and handed over to the family. Mementos are also given to the family.

### **Cultural Activities**

Various cultural activities including music, drama, sports, painting, etc, are held regularly to promote comradeship among the employees. The family members of the employees also take part in these cultural activities. The Company has tried to create a family like atmosphere within the Company premises.

### **Training**

The employees are given training on job related, quality related and information related matters. Training is also imparted about new technologies and also on quality systems. Presently, the training time spent by the employees is 3.6% of their working time. We have an ambitious plan to increase the training to 5% during the coming years. We also have our Corporate Training Centre which takes care of major training programmes. The emphasis on training has been to improve the attitude of the employees and improve their knowledge/skill.

### **Contests**

- \* Annual contests are held among all the four Units of KEC in the areas of AQIP, Small Group Activities, Value Engineering and Suggestion Programmes. The best teams are awarded and recognised. The employees also take part in various contests organised by the external agencies.
- \* The Kirloskar Group annually conducts external quality audit to determine the winners for "RAVI



KIRLOSKAR QUALITY PRIZE". The Companies are divided into group A, B, and C. Based on the findings of the external audit, which is a very rigorous one, the Companies are awarded Quality Prize.

- \* A National Quality Award on the pattern of Malcolm Baldrige Award of USA for outstanding achievements in the pursuit of quality of a product, process or service has been constituted

### Continuous Improvement

The continuous improvement has become a way of work life in the Company. A process has been established on problem solving in a structured way. The Continuous Improvement implementation is done using techniques like Quality Function Deployment (for diagnosis), Quality Policy deployment (for setting goals, developing projects and cascading throughout the organisation), and Quality Operating System (for improving the processes). During 1991-92, small and incremental improvements were implemented in 300 cases. For 1992-93, about 400 cases have been indentified as a part of the Continuous Improvement activity.

### Transformation to TQM

The following orientation took place in the Company to transform itself into a TQM Company :

#### TQM Mind Set :

- \* From results orientation to process and results orientation.
- \* From task orientation to people and task orientation.
- \* From company orientation to customer and company orientation.

In this way we were able to adopt and follow the Mission Values a Guiding Principles with regards to customer, people, process and supplier orientation.

*Process Orientation* : We have modified the management thought process and management system where all functional departments take the customer needs as input with an objective of producing results to meet customer satisfaction. Various processes at manufacturing and non-manufacturing areas have been established and qualified. We use process flow diagrams, work instructions, and procedures to carryout our daily activities. The statistical process control is also an inbuilt feature to the process. SQC tools like run charts, flow chart, pareto

diagram, cause and effect diagram, control charts, are extensively used for process control. We have been able to create a new mind set with all the employees towards process orientation.

*Customer Orientation* : Customer orientation is characterised by a non-wavering commitment to improve the customer satisfaction. The customer needs are dynamic and their expectations change continuously. The emphasis has been laid on learning about the customer needs and finding various ways and means to meet the customer expectations. We are conducting application studies to all our critical machines and we also monitor the conditions of our products periodically at the customer sites. We also conduct pre-design and pre-production reviews with our major customers and major contracts. This has helped us to a large extent in understanding the needs of the customers to design features that lead to their satisfaction. After going through the process of TQM, there has been a substantial increase in the satisfaction of our customers.

*People Orientation* : One of the values in our MVGP document is people. Our people are the source of our strength. They determine our reputation and vitality. Our core human values are team work, love and respect for each other. The following transformation took place with regards to people orientation :

- \* From individual contribution to team orientation
- \* From managing tasks to leading people
- \* From one dimensional vertical relationship to multi-dimensional relationships
- \* From hierachical direction to self direction
- \* From inspection to building in quality
- \* From doing things right to doing right things
- \* From error standards to error free performance
- \* From concern for department to concern for the whole organisation
- \* From teaching to teaching and learning.

*Supplier Orientation* : Our suppliers supply us raw materials, components and services. We have a well laid

**After going through the process of TQM, there has been a substantial increase in the satisfaction of our customers.**



out policy for purchaser and supplier relations from the stand point of quality control. Our objective has been to ensure that incoming materials are functionally acceptable everytime for the smooth functioning of the manufacturing activity that reduce inventory levels. We have recognised inspection as expensive and that it cannot produce a continuous flow of defect free components. We have therefore embarked on a supplier orientation to meet the companies quality, price and delivery standards. Rationalisation of supplier, source a udit, supplier performance review, supplier quality index are the various factors used for supplier improvement. The manufacturing technology with flow diagrams and work instruction are transferred to the suppliers. The electrical and mechanical measuring instruments at the suppliers end are controlled by our Company for calibration purposes. Periodic verification of the suppliers' jigs, fixtures, tools, patterns, etc. are undertaken by us to ensure the quality of incoming material. The Design Reviews with the suppliers are also held. The staff and employees of the suppliers are given extensive training in our Company on job and quality related aspects. The training to the top personnel of suppliers are given for ISO 9001 quality systems. We also undertake Manufacturing Resource Planning at the supplier end to meet our annual operating plans and long range business plans. We have built an extremely cordial relationship with the suppliers and they have been treated as an extended arm of the Company. We have been able to reduce the defect level in the incoming material quality to 0.7%. We have also been able to reduce the inventory levels in view of the supplier orientation.

### The Role of the Management

If the TQM has to be a success, the creation of required environment in the company rests with the Management. The role of the Management changes towards :

- \* Providing leadership
- \* Creating a team spirit
- \* Creating, qualifying and managing the process
- \* Supporting excellence
- \* Coaching and guiding the people with integration among various functions
- \* Providing tools and resources
- \* Allowing freedom to the personnel in implementation
- \* Reviewing the non-conformance and corrective action systems

- \* Striving for the continuous improvement of the processes.

The Management has brought about an organisational climate for quality which will foster team spirit and improvements to quality of work life.

### Management Review

The Management reviews the various recording systems and corrective actions initiated. The Chief Executive reviews once a month all quality related aspects along with the business related aspects. The Chief Executive also reviews the improvement projects, cycle time reduction, delivery time reduction, inventory reduction, gauge control, development plans and progress, etc. The Management Review also takes place regarding the planning and product scheduling using techniques like PERT, CPM, LOB, and ABC/XYZ analysis. The Management Review helps in guiding the activities of the Company towards meeting the quality objectives and also helps proper communication to all concerned. Fig. 2. shows the systems and corrective actions covered under the review.

**The Management has brought about an organisational climate for quality which will foster team spirit and improvements to quality of work life.**

### Benefits Derived

*Tangible Benefits* : The following factors indicate the improvement that have taken place after the implementation of TQM. The details indicated provide the trend from 1987 to 1991:

- \* The efficiency of workmen with respect to standard time has increased from 130% to 180%.
- \* The men and machinery utilisation has increased from 81% to 94%.
- \* The inventory has been reduced from 105 days to 40 days.
- \* Rework as percentage of available manhours has been reduced from 4% to 0.9%.
- \* The cost of material scrapped as a percentage of raw material cost has been reduced from 0.46% to 0.06%.
- \* The sale per employee has been increased by 140%.



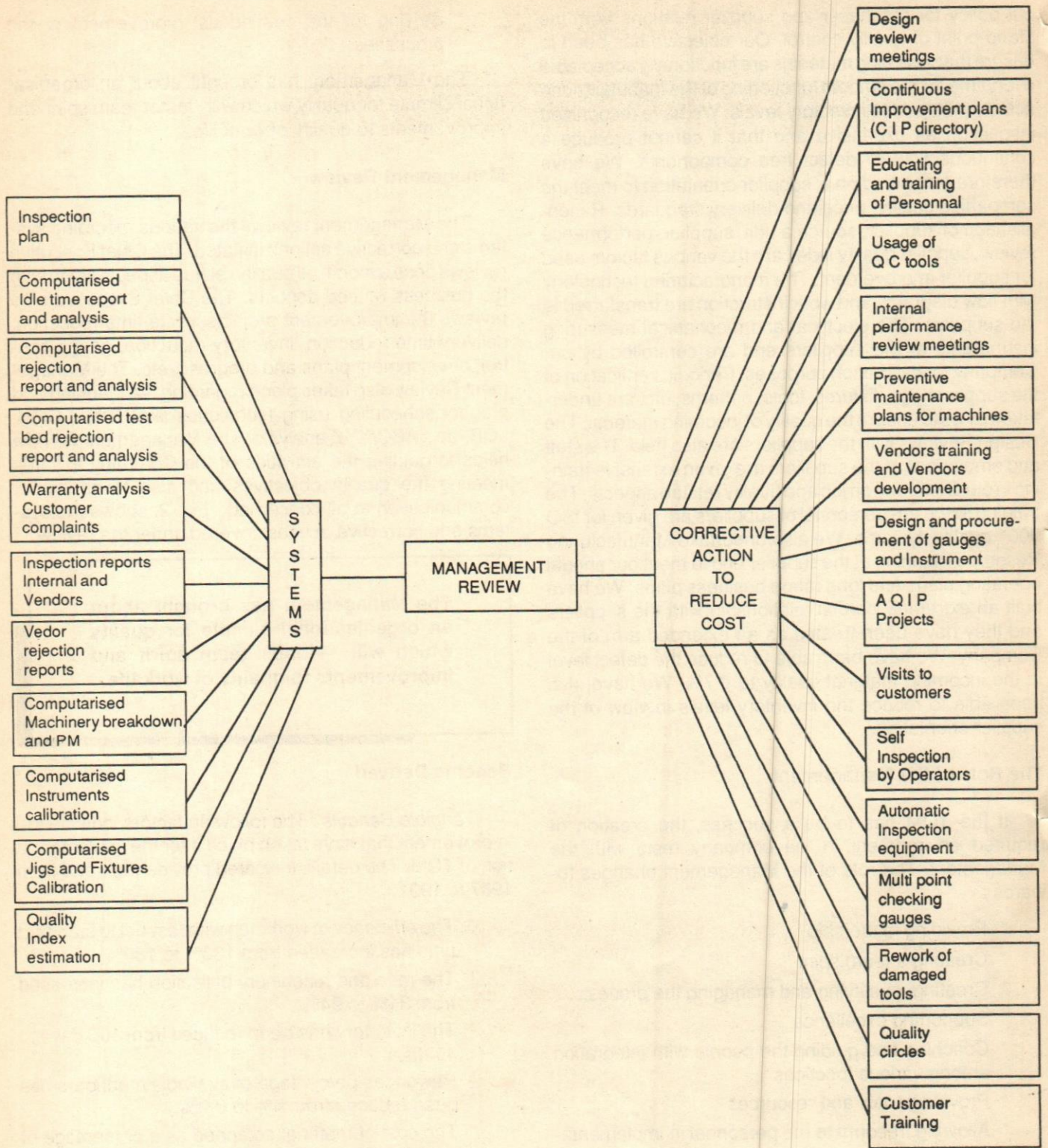


FIG. 2: MANAGEMENT REVIEW – RECORDING SYSTEMS & CORRECTIVE ACTIONS



- \* The productivity of the employees has been increased by 88.6% in terms of physical growth.
- \* The value addition per employee has been increased by 142%.
- \* The cost of energy per nett turnover has been decreased by 38%.
- \* The delivery time of products has been reduced by 80%.
- \* The quality index of various aspects have increased from 100 to 150.

Intangible Benefits : We have been able to derive the following intangible benefits:

- \* Enjoyable and livlier working environment
- \* Improved team work and communication

- \* Improved human performance levels
- \* Attitudinal change among employees
- \* Participation by trade unions in quality improvement
- \* Orientation towards customers and suppliers
- \* Continuous material flow due to supplier improvement plans.

### Conclusion

We have attempted to transform our organisation towards Total Quality Management. We have succeeded partially in our efforts and there is still a long journey to be completed. We have created a climate in the organisation for quality and have involved all the employees in TQM. We have built-in the quality of work life with our people who are our source of strength. Ours is a well knit and well motivated team continuously working for the betterment of the organisation and for satisfying our customers.



### NPC - Interfirm Comparison Project

There is a method by which companies can obtain comparative performance information. It's known as Interfirm Comparison (IFC), a scheme in which participating companies provide detailed information and get, in return, equally detailed analysis of how they measure up in every important aspect of their business in relation to the others.

The National Productivity Council (NPC) in collaboration with the German Agency for Technical Cooperation (GTZ) and other international agencies has set up a new service offering such a performance comparison.

The aim of IFC is to carry out comprehensive review of overall company performance and the factors affecting it. A comprehensive IFC is a tool to search out systematically the reasons for differences between companies in overall success.

The systematic review of the company's operations is carried out by using an integrated set of ratios which is known as Total Performance Measurement System. It is total in the sense that all aspects of performance like profitability, productivity, quality, innovation and flexibility are included.

A properly designed set of performance measures can provide a complete system for planning, assessment and control within an organisation. However, it is essential first to identify those factors upon which success depends and to devise the most appropriate measurements for monitoring them.



# Real Wages in Indian Manufacturing

NPC Research Division

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In a previous study, we had arrived at labour productivity and labour intensity ratios in Indian manufacturing industries. (Productivity, 32,4). Energy productivity in Indian manufacturing industries had also been arrived at in an earlier issue (Productivity 32, 1). In the present study annual real wages per worker in the Indian manufacturing industries has been arrived at, based on the National Industrial Classification (NIC). A total of 46 industries were selected based on their importance in terms of their contribution to the total value of output of the manufacturing sector.

The term 'wages' is defined here to include all remuneration capable of being expressed in monetary terms and also payable more or less regularly in each pay period to workers as compensation for work done during the accounting year. It includes (a) direct wages and salary (i.e. basic wages/salaries, payment of overtime, dearness, compensatory, house-rent and other allowances), (b) remuneration for period not worked (i.e. incentive bonuses, good attendance bonuses etc.). It excludes lay off payment which are made from trust or other special funds set up expressly for this purpose i.e. payments not made by the employer. It also excludes imputed value of benefits in kind, employer's contribution to old age benefits and other social security charges, direct expenditure or maternity benefits and creches and other group benefits. Travelling and other expenditure incurred for business purposes and reimbursed by the employer are excluded. The wages are expressed in terms of gross value i.e. before deduction for fines, damages, taxes, provident fund, employee's state insurance contribution etc.

By 'real wages' is meant wages at constant factor cost of 1980-81. For this purpose, the money wage bill has been deflated/inflated to 1980-81 prices using the Index No. of Consumer Prices for Industrial Workers. The Index at 1960-61 prices has been converted to a series with 1980-81 as the base year.

Workers in this study, are defined to include all persons employed directly or through any agency whether for wages or not and engaged in any manufacturing process or in cleaning any part of the machinery or premises used for manufacturing process or in any other kind of work incidental to or connected with the manufacturing process or the subject of the manufacturing process. Labour engaged in the repair and maintenance or production of fixed assets for factory's own use or labour employed for generating electricity or producing coal, gas are included. However, persons holding positions of supervision or management or employed in administrative office, store keeping section and welfare section, sales department as also those engaged in the purchase or raw materials etc., and in production or the fixed assets for the factory and watch and ward staff, are excluded.

The study is limited to 1973-88 period due to reasons of data availability from the source viz. the Annual Survey of Industries (ASI).

*Compiled by :*

Manju Kalra Prakash  
K.P. Sunny



Food Products (20 - 21)			Refining of Sugar (206)			Hydrogenated Oils, Vanaspathi (210)			Beverages Tobacco & Tobacco Products (22)			
Annual Real wage per worker (in Rs.)	Total No. of workers	Factories Covered (Nos.)	Annual Real wage per worker (in Rs.)	Total No. of workers	Factories Covered (Nos.)	Annual Real wage per worker (in Rs.)	Total No. of workers	Factories Covered (Nos.)	Annual Real wage per worker (in Rs.)	Total No. of workers	Factories Covered (Nos.)	
1973-74	2654	569536	13509	5375	95513	261	5234	11272	65	2109	200317	2357
1974-75	1793	731162	13454	2489	179048	251	4088	11204	71	1772	186913	2080
1975-76	2121	804118	14126	3112	209527	243	4676	12212	75	2039	188303	2880
1976-77	2186	880142	15306	2701	253087	261	4948	12228	79	2193	278890	6398
1977-78	2105	928795	15783	2630	249112	288	5279	11269	69	2224	321172	7307
1978-79	2670	891924	16310	3931	221667	286	6285	12760	69	2347	352095	8240
1979-80	2663	905820	16840	3576	242725	293	6565	12734	83	2353	352764	9629
1980-81	2373	1001350	17067	2466	315655	304	7746	12367	82	2318	362867	8901
1981-82	2401	1025111	18351	2837	300794	296	6532	11069	76	2133	396227	9568
1982-83	2912	985289	17111	4651	245257	308	7491	13469	90	2128	410584	8486
1983-84	3665	812467	17523	7378	160515	318	7984	13214	109	2333	426445	8188
1984-85	3809	775914	17459	7861	138618	318	7493	14213	102	2863	314933	7093
1985-86	3948	760089	17725	7979	126845	323	8065	12400	88	3292	318759	8457
1986-87	4111	742996	17299	8399	126195	328	8924	13122	97	2855	358553	7163
1987-88	4251	794920	18333	8723	144257	349	8634	13378	99	2830	401183	7951

Cotton textiles (23)			Wool, Silk Synthetic Fibre textiles (24)			Jute, hemp & Mesta textiles (25)			Textiles products (26)			
Annual Real wage per worker (in Rs.)	Total No. of workers	Factories Covered (Nos.)	Annual Real wage per worker (in Rs.)	Total No. of workers	Factories Covered (Nos.)	Annual Real wage per worker (in Rs.)	Total No. of workers	Factories Covered (Nos.)	Annual Real wage per worker (in Rs.)	Total No. of workers	Factories Covered (Nos.)	
1987-88	4251	794920	18333	8723	144257	349	8634	13378	99	2830	401183	7951
1973-74	6044	865053	5719	5227	133955	2413	5638	246571	429	4201	54675	1642
1974-75	5449	930212	5560	4808	126507	2368	5118	222979	322	3503	58777	1652
1975-76	6062	945268	5968	5462	138698	2743	5903	241315	184	3894	62197	1979
1976-77	6285	922453	6213	6030	149329	3090	6443	223545	201	4443	73547	2192
1977-78	6134	936376	6508	5749	168042	3112	6173	237098	223	4263	79214	2347
1978-79	6932	983920	6701	6699	158501	3216	6383	239353	247	4896	79947	2577
1979-80	7012	992082	7207	6812	181729	3455	7264	263475	257	4612	84174	2907
1980-81	7103	946679	7189	7142	180676	3743	7519	248685	265	4807	80523	2889
1981-82	6734	887969	7141	7064	198355	4100	7089	218955	297	4654	82101	2943
1982-83	6674	926193	6569	7064	209059	3267	6767	235076	219	4749	81525	2491
1983-84	7216	915265	6731	7568	213596	3532	6518	200906	236	4662	87104	2621
1984-85	7542	838074	6760	7478	226461	2955	7317	264986	215	4675	91202	3063
1985-86	7433	781235	7073	7524	216174	3236	8487	193528	204	4858	93700	2835
1986-87	7719	788740	6981	7562	218096	2986	8803	191436	184	4952	85997	2821
1987-88	7628	734898	6844	7369	255858	3142	7891	179372	236	4923	105382	3141



Wood & wood products furniture & fixture (27)			Paper, paper product printing (28)			Pulp, paper & boards (280)			Leather & fur products (29)			
Annual Real wage per worker (in Rs.)	Total No. of workers	Factories Covered (Nos.)	Annual Real wage per worker (in Rs.)	Total No. of workers	Factories Covered (Nos.)	Annual Real wage per worker (in Rs.)	Total No. of workers	Factories Covered (Nos.)	Annual Real wage per worker (in Rs.)	Total No. of workers	Factories Covered (Nos.)	
1973-74	2959	60744	2932	5758	194685	3779	5968	56649	560	5246	37133	594
1974-75	2524	61528	3158	5396	188423	3820	5541	59106	490	4711	37427	667
1975-76	2775	60100	3431	5786	180684	3936	5815	59738	424	4497	25373	670
1976-77	3109	57774	3573	6370	188372	4506	6338	62304	449	5614	41023	727
1977-78	3135	60440	3676	6175	199269	4439	6196	73730	538	5297	41306	762
1978-79	3459	60658	3788	6995	198719	4901	7693	70443	500	5553	48804	797
1979-80	3399	67384	3978	7148	210366	4743	7505	78798	587	6334	48720	862
1980-81	3326	64078	4033	7224	211068	4798	7627	81518	585	5882	48603	886
1981-82	3354	63531	4094	7393	221681	4890	7378	84593	672	5663	51065	899
1982-83	3676	64471	3618	7255	231722	4571	6601	92498	637	5547	52249	880
1983-84	3629	62464	3591	7445	226586	4710	7061	84851	734	5927	52458	942
1984-85	3724	61546	3847	8061	219958	4808	7486	83956	696	5980	58760	929
1985-86	3776	60114	3580	8078	211357	4870	7859	78639	802	5735	60473	999
1986-87	3989	57132	3873	8299	206383	4921	8159	80284	779	5769	59686	976
1987-88	4180	57965	3407	8602	217837	5096	8063	82530	899	5975	64448	1074

Rubber & plastics (30)			Chemicals & Products (31)			Basic & Industrial gases (310)			Fertiliser & Pesticides (311)			
Annual Real wage per worker (in Rs.)	Total No. of workers	Factories Covered (Nos.)	Annual Real wage per worker (in Rs.)	Total No. of workers	Factories Covered (Nos.)	Annual Real wage per worker (in Rs.)	Total No. of workers	Factories Covered (Nos.)	Annual Real wage per worker (in Rs.)	Total No. of workers	Factories Covered (Nos.)	
1973-74	6677	87416	1794	6951	234905	3043	7296	34581	389	8593	34795	335
1974-75	5925	88182	1952	6154	233933	3221	8039	34080	543	7638	35980	344
1975-76	6893	104000	2496	7034	250177	3732	6463	41065	639	9637	37687	378
1976-77	7259	98064	2831	7481	263581	4152	8008	41310	701	9999	38411	440
1977-78	6819	109664	2881	7144	283382	4674	8039	38911	764	9501	39924	469
1978-79	8301	101131	2350	8806	294802	4881	9457	41164	874	12329	41885	493
1979-80	7121	129785	3302	8544	330553	5328	9481	42781	883	12001	49003	503
1980-81	7450	127644	3498	8690	334994	5479	9570	47470	917	11663	50195	447
1981-82	7391	130180	3864	8713	333099	6834	9657	47522	1223	12202	46951	618
1982-83	8106	154632	3514	8761	344486	5350	9938	49972	934	11716	48269	442
1983-84	8253	139425	3778	9208	343175	5824	9683	52350	978	13345	48489	495
1984-85	8808	142501	3900	9949	346890	6032	11059	56825	1320	13664	43853	469
1985-86	9110	141350	3958	9900	372407	6402	11175	59247	1040	13036	51741	546
1986-87	9814	147819	4097	10431	357060	6335	11446	57908	1017	15022	44342	474
1987-88	9175	155490	4412	10497	378178	6578	11559	57549	1049	15520	49387	515



Paints & Varnish (312)			Drug & Medicines (313)			Non-metallic mineral products (32)			Structural clay products (320)			
Annual Real wage per worker (in Rs.)	Total No. of workers	Factories Covered  (Nos.)	Annual Real wage per worker (in Rs.)	Total No. of workers	Factories Covered  (Nos.)	Annual Real wage per worker (in Rs.)	Total No. of workers	Factories Covered  (Nos.)	Annual Real wage per worker (in Rs.)	Total No. of workers	Factories Covered  (Nos.)	
1973-74	6907	20038	338	7370	55305	674	3812	237812	3757	2767	76111	1182
1974-75	6319	18656	372	6972	55303	682	3543	233615	3890	2511	75712	1223
1975-76	7050	15588	368	8176	56299	800	4069	240268	4820	3035	78023	1533
1976-77	7304	16443	403	8890	56950	865	4417	241834	5309	3163	78395	1641
1977-78	6900	18535	496	8447	63671	918	4255	248020	5558	2947	78896	1666
1978-79	9235	19806	498	10117	63318	958	4929	259527	5639	3488	83555	1727
1979-80	9247	22298	551	9952	66478	1070	4839	274292	6083	3548	92670	1899
1980-81	9723	22853	568	10304	64259	1121	4709	293575	6440	3562	102252	2159
1981-82	9621	21433	773	10129	70006	1434	4712	307640	7694	3551	107820	3048
1982-83	10947	20326	476	11541	70261	1131	4767	337901	6667	3336	130449	2495
1983-84	11068	22099	547	10964	72874	1187	4763	354378	7618	3033	151975	3117
1984-85	11915	21612	515	12033	73231	1265	5199	342547	7841	3259	143987	3146
1985-86	11606	21179	555	12075	71602	1358	5245	355259	8515	3307	148330	3421
1886-87	12463	18864	592	12436	72565	1374	5376	343989	8267	3351	143128	3247
1887-88	11447	22356	739	13022	78189	1479	5187	349525	8706	3200	143716	3445

Paints & Varnish (321)			Drug & Medicines (324)			Non-metallic mineral products (33)			Structural clay products (330)			
Annual Real wage per worker (in Rs.)	Total No. of workers	Factories Covered  (Nos.)	Annual Real wage per worker (in Rs.)	Total No. of workers	Factories Covered  (Nos.)	Annual Real wage per worker (in Rs.)	Total No. of workers	Factories Covered  (Nos.)	Annual Real wage per worker (in Rs.)	Total No. of workers	Factories Covered  (Nos.)	
1973-74	3966	46321	391	6507	35116	126	7747	349810	4132	9295	176120	942
1974-75	3476	49057	932	6703	31984	126	7853	307359	4215	10636	137941	1114
1975-76	3851	47000	414	8131	35459	205	8624	370132	4562	10873	186198	1150
1976-77	4330	46443	448	8487	35124	226	9424	360086	4988	11792	181152	1143
1977-78	4301	42920	483	8113	35623	247	8810	368428	5054	10985	192689	1299
1978-79	4785	48043	560	9222	36371	232	9566	399156	5259	11423	204169	1332
1979-80	4656	48796	573	9133	39047	271	10296	413233	5538	12932	215324	1471
1980-81	4337	48972	590	8588	42875	261	9706	437774	5779	11607	233658	1546
1981-82	4598	52300	674	8348	44671	276	9696	446839	6013	11359	244594	1714
1982-83	4633	52105	607	9163	51077	276	10210	454920	5509	12570	235799	1474
1983-84	4828	48696	601	9956	50520	328	10281	465592	5888	12423	245142	1686
1984-85	5347	44233	567	10459	52830	366	11484	499533	5901	13774	282368	1657
1985-86	5738	46791	571	10355	57217	468	10912	457770	6077	12784	256458	1764
1986-87	6049	42006	556	10174	58598	448	10627	480003	6191	12362	276799	1822
1987-88	6143	41868	570	9326	59738	517	10810	481243	6184	12635	282213	1754



Foundry for casting & forging (331)				Ferro alloys (332)			Copper manufacturing (333)			Aluminium manufacturing (335)		
Annual Real wage per worker (in Rs.)	Total No. of workers	Factories Covered (Nos.)	Annual Real wage per worker (in Rs.)	Total No. of workers	Factories Covered (Nos.)	Annual Real wage per worker (in Rs.)	Total No. of workers	Factories Covered (Nos.)	Annual Real wage per worker (in Rs.)	Total No. of workers	Factories Covered (Nos.)	
1973-74	6019	138118	2440	4545	3718	49	5824	5735	92	8263	14099	161
1974-75	5299	136472	2519	4713	3204	21	7071	5572	74	7590	13741	141
1975-76	6072	145558	2737	5070	4043	42	7379	6627	111	8241	14767	200
1976-77	6766	143191	3094	5225	4574	70	7141	6890	116	9624	13581	183
1977-78	6031	136910	2973	4969	5152	43	7055	6478	117	9001	14909	232
1978-79	7159	154797	3121	6395	4785	49	9308	6489	96	10721	16417	253
1979-80	6979	155248	3173	6446	4918	49	8265	7913	119	10147	16615	280
1980-81	7046	159632	3293	6949	5310	53	9967	7284	141	10236	19061	308
1981-82	7231	156907	3307	6593	4778	60	8740	7151	164	10379	20128	317
1982-83	7153	174585	3126	7377	5165	35	9928	5963	149	10624	19532	318
1983-84	7462	172587	3208	7251	7351	65	10774	5968	143	9955	20713	364
1984-85	7925	169414	3313	6966	7135	53	11483	6453	129	12009	20601	335
1985-86	7879	153832	3337	6759	7205	54	13595	6723	144	11739	19431	331
1986-87	7709	157199	3365	6417	9319	64	13359	5801	167	11404	17932	328
1987-88	7393	145373	3313	6797	10195	80	13597	7053	175	11823	21838	335

Zinc Manufacturing (336)				Metal products & parts (34)			Machine tools & parts (35)			Agriculture machinery (350)		
Annual Real wage per worker (in Rs.)	Total No. of workers	Factories Covered (Nos.)	Annual Real wage per worker (in Rs.)	Total No. of workers	Factories Covered (Nos.)	Annual Real wage per worker (in Rs.)	Total No. of workers	Factories Covered (Nos.)	Annual Real wage per worker (in Rs.)	Total No. of workers	Factories Covered (Nos.)	
1973-74	9281	1864	29	5146	138538	4434	6402	239329	4713	5663	19514	799
1974-75	12664	1066	11	4543	130934	4412	5754	244325	4808	5290	16995	707
1975-76	11211	1338	11	5125	132946	5260	6691	244898	5449	5342	18813	637
1976-77	15152	1419	12	5790	138734	5590	7377	247728	5881	6938	22642	621
1977-78	12188	1723	19	5629	148655	5657	7100	265354	6203	6485	24457	718
1978-79	11745	2486	20	6212	141397	5818	8112	267802	6387	7137	26539	703
1979-80	14338	2734	23	6841	154121	6230	8157	286728	6826	7542	30006	789
1980-81	12734	2772	24	6765	151028	6457	8210	285024	7011	7431	28853	786
1981-82	12419	2335	25	6557	150842	6563	8143	293394	7876	7677	26077	797
1982-83	13248	3125	21	6254	153234	5884	8658	302844	7207	9162	27089	717
1983-84	13689	3689	22	7272	144286	6054	9058	310685	7138	8708	29088	794
1984-85	14321	3687	21	7843	153528	6078	9296	302745	7168	8440	29858	734
1985-86	12863	5173	46	7629	147512	6307	8942	306089	7648	9775	28440	802
1986-87	11597	4820	33	7807	134038	5978	11161	276978	7254	9805	24457	700
1987-88	12166	5096	43	7689	155180	6390	9594	298080	7584	10879	25894	830



Prime Movers, boilers (352)			Industrial machinery for podend (353)			Industrial machinery other then for food (354)			Refrigeration & Ac (355)			
Annual Real wage per worker (in Rs.)	Total No. of workers	Factories Covered (Nos.)	Annual Real wage per worker (in Rs.)	Total No. of workers	Factories Covered (Nos.)	Annual Real wage per worker (in Rs.)	Total No. of workers	Factories Covered (Nos.)	Annual Real wage per worker (in Rs.)	Total No. of workers	Factories Covered (Nos.)	
1973-74	7090	41535	623	5465	49207	1003	6573	21544	402	6968	11710	128
1974-75	5760	45935	689	5013	48418	977	6490	24205	541	4726	12504	161
1975-76	6990	36182	732	5805	47857	1028	8004	25999	437	6942	11697	121
1976-77	7480	26112	776	6626	47435	1130	8411	27356	499	7301	12998	130
1977-78	7296	35624	757	4581	52539	1250	7731	31134	642	7324	12002	151
1978-79	8294	35361	719	7813	50685	1289	8495	31700	656	8330	13481	155
1979-80	8623	38990	782	7715	55810	1375	8478	33110	740	8434	13896	162
1980-81	8765	40082	800	12414	34928	1359	8722	26760	737	8177	14981	200
1981-82	8456	45000	1097	7462	49370	1565	8788	34810	768	7713	15350	259
1982-83	9241	45234	822	9133	54710	1250	7071	35226	718	8517	15028	164
1983-84	10182	49853	838	8295	58046	1448	9132	30739	725	9138	14938	167
1984-85	9323	47797	942	7966	53266	1266	9817	29073	715	9288	14729	165
1985-86	10862	55191	940	9399	47805	1296	9390	26263	829	9476	15323	159
1986-87	9650	45306	871	8439	40110	1240	9742	27694	835	8733	12035	173
1987-88	9419	50474	956	9080	44108	1206	9307	33211	940	9205	13091	199

Machine tools & parts (357)			Electrical machinery (36)			Electrical Industrial machinery (360)			Transport equipment (37)			
Annual Real wage per worker (in Rs.)	Total No. of workers	Factories Covered (Nos.)	Annual Real wage per worker (in Rs.)	Total No. of workers	Factories Covered (Nos.)	Annual Real wage per worker (in Rs.)	Total No. of workers	Factories Covered (Nos.)	Annual Real wage per worker (in Rs.)	Total No. of workers	Factories Covered (Nos.)	
1973-74	6860	26897	590	6735	180454	2380	6479	74384	1141	7397	308380	1600
1974-75	5897	27319	586	6793	179753	2340	7269	71858	998	6865	308998	1680
1975-76	7456	32631	827	7524	180273	2390	8368	73173	843	7979	272563	2752
1976-77	7669	29796	847	8212	184367	2596	8979	72662	837	8753	252210	2204
1977-78	7534	32504	934	8278	187236	2740	9069	73372	915	8294	261651	2348
1978-79	8625	34399	910	9552	192769	2882	10803	75793	955	9532	293650	2528
1979-80	8765	34240	949	9318	214247	3277	10371	81165	1036	9295	365410	2867
1980-81	8408	34992	1009	9283	214725	3406	10721	82006	1046	9518	370531	2815
1981-82	8378	36036	1011	8849	209646	4229	10402	80492	1062	10037	380832	3339
1982-83	9425	36900	1166	9926	231257	3641	11317	82852	1138	10488	381508	2816
1983-84	9249	34373	1075	10075	228855	3661	11215	81685	1105	10478	374840	2815
1984-85	8738	32560	1027	10543	238393	3831	12440	86641	1148	10652	393709	3041
1985-86	10148	40284	1076	10565	234367	4066	12263	81952	1129	11366	361366	3267
1986-87	10512	36872	1032	11060	221778	3888	13672	76658	1071	11774	364671	3120
1987-88	10247	30937	975	11070	244912	4241	13587	89187	1304	11925	365919	3318



Locomotive parts (371)			Railway Wagons (372)			Motor Vehicles (374)			Motorcycle, Scooter (375)			
Annual Real wage per worker (in Rs.)	Total No. of workers	Factories Covered  (Nos.)	Annual Real wage per worker (in Rs.)	Total No. of workers	Factories Covered  (Nos.)	Annual Real wage per worker (in Rs.)	Total No. of workers	Factories Covered  (Nos.)	Annual Real wage per worker (in Rs.)	Total No. of workers	Factories Covered  (Nos.)	
1973-74	7291	25002	25	6822	111182	109	8474	88468	523	6464	11231	114
1974-75	7600	22659	23	6825	101060	110	7778	90546	569	5934	11307	147
1975-76	8107	39063	24	8138	77005	102	8518	92190	990	6551	8869	110
1976-77	8995	30093	16	9330	62045	101	9364	92493	1021	6695	13980	146
1977-78	8635	30585	19	8872	60327	139	8852	94763	1023	6554	16874	201
1978-79	8409	30313	24	9309	77917	137	10702	100622	1113	8212	17974	215
1979-80	9598	43677	36	9008	108237	173	9648	116226	1205	7939	20569	270
1980-81	9690	43467	41	8845	112497	145	10109	118110	1297	7776	20125	235
1981-82	10675	45124	44	9136	114252	187	10928	123777	1565	8944	22127	293
1982-83	10694	44286	37	9971	109551	153	11519	130387	1334	8206	18693	255
1983-84	10196	48517	37	10465	106034	153	11726	118378	1302	9443	24875	257
1984-85	10709	60582	42	9617	110232	149	12280	122548	1529	10308	25096	287
1985-86	11000	32592	36	10817	110151	146	13704	127630	1594	10696	27197	295
1986-87	11402	37747	42	11802	116390	134	12954	127172	1567	10818	29008	348
1987-88	11544	39492	62	12547	101931	160	13440	120288	1463	10421	35993	432

Bicycle Parts (376)			Other Manufacturing Industry (38)			
Annual real wage per worker (in Rs.)	Total No. of worker	Factories Covered  (Nos.)	Annual real wage per worker (in Rs.)	Total No. of worker	Factories covered  (Nos.)	
1973-74	4911	21483	464	5642	53832	1662
1974-75	3904	20571	498	5066	49349	1566
1975-76	4469	20204	581	5797	45109	1473
1976-77	5047	19179	600	6582	44956	1871
1977-78	6110	21244	598	6245	50133	1897
1978-79	5190	20270	643	6858	48276	1799
1979-80	5908	24865	694	6742	52985	2047
1980-81	5570	20377	676	7291	51695	1956
1981-82	6070	24004	748	6472	50245	2383
1982-83	5831	23977	638	7382	52469	1475
1983-84	5595	26683	669	7461	52995	1871
1984-85	5658	27800	658	8022	50497	1509
1985-86	5556	27486	673	8140	53326	1725
1986-87	5665	23777	627	8993	54998	1573
1987-88	5744	29666	687	8895	57451	1742

Note: Figures in brackets are the industry codes according to NIC



# Air Pollution from Mini Cement Plants

## NPC Pollution Control Division

Mini Cement Plants based on vertical shaft kiln technology have occupied a prominent place in the manufacture of cement in small/medium scale sector. There are about 200 plants in the size range of 20 to 100 tons per day working in the country based on this technology. Although their contribution to total cement production is still small, due to their large employment potential, small investment and flexibility of operation these units have proved to be ideally suitable for our country. The plants are usually based on locally available raw materials and cater to the local demands, thus requiring lower transportation infrastructure.

### The Process

The cement making process from Vertical Shaft Kiln Technology is very simple. Raw material, mainly limestone, is transported by trucks from quarries and is fed manually to a jaw crusher. The material is further crushed in a hammer mill and transported by a belt conveyor/elevator bucket system to storage silo. Similar silos exist for clay, coke breeze and laterite. Depending upon the desired raw meal composition the requisite quantity of each material is extracted from the silo in a trolley mounted on a weighing machine. This forms one batch of raw mix. The batch is sent to a ball mill for pulverising. The pulverised raw meal is taken to blending silos (2 nos) where the meal is homogenized by circulation of compressed air. The blended/homogenized raw meal after quality inspection is taken to a surge silo which feeds the material to the noduliser. The purpose of the noduliser is to make 8-12 mm diameter nodules (size depending on raw meal quality, type of cement, etc) for firing into the kiln. The raw meal is mixed with water (10-12%) on an inclined rotating pan. The nodules thus formed are charged directly into the kiln through a rotary chute.

The kiln basically is a vertical shaft of 1.7 m to 2.0 m diameter and 7 to 9 m height. Compressed air at 0.2 kg/

cm<sup>2</sup> pressure is fed from bottom while the clinker travels downwards in counter current direction. The exhaust gases at 50-80°C temperature escape from the top and are vented through a stack in the atmosphere. The clinker is discharged from the bottom through a double gate system and transported manually to a clinker crusher. The crushed clinker is stored in a silo. Depending upon the clinker composition and desired cement quality a prefixed quantity of gypsum is added to the clinker. Both are weighed in batches on a trolley and the mixture is sent to cement ball mill through bucket elevators. The cement produced from the mill is blended by means of air circulation in blending silos and passed through the screw conveyor system and finally packed in bags.

### Air Pollution

The principal type of pollution from mini cement plants is air pollution. Air pollution could be further categorised into :

Source Emissions  
Fugitive Emissions

#### *Source Emissions*

The only source emission from mini cement plants is that from kiln stack. The stack, usually 30 to 40 meters from the ground level, discharges the kiln off gases into the atmosphere. The main pollutant emitted from the stack is particulate matter. In the absence of any control system, the SPM emissions lie in the range of 3000-5000mg/Nm<sup>3</sup>. In the case of improper operating conditions, small amounts of carbon monoxide is also emitted. However, this should be avoided to the extent possible as it entails excess fuel consumption. The exhaust gas temperatures, normally lie in the range of 60 - 80°C except for poking periods when it could go beyond 300°C. Typical stack emission from kiln are given in the table below:



## News & Notes

### SUN SET ON JAPANESE QUALITY ?

The Japanese are struggling with the problems caused by an ageing population and a shortage of good workers. On top of that, the concept of Just-in-Time (JIT) is in urgent need of an overhaul.

Japanese manufacturers usually insist on all high value-added parts being made in Japan. This departure from the norm suggests two possibilities :

- \* Japanese consumer electric manufacturers are having to rely on foreign-made parts in order to compete, and
- \* Some Southeast Asian countries are closing the quality gap with Japan.

Can workers who are unenthusiastic about their work create higher quality products than those who are highly motivated? The answer is, of course, no. A factor which indicates that quality may be suffering in Japan is a significant drop in the "go-straight percentage" in the electric consumer product areas.

Some of the processes had go-straight percentages of less than 90 per cent. If this is representative of Japanese industry in general, what has happened? Japanese companies seem to have lost their ability to inspire their employees. And, today's Japanese line workers appear less well trained than they used to be. Young people no longer flock to manufacturing and this has resulted in a labour shortage. Even if they do get jobs in factories, young workers don't stay long. They tend to leave for service-type jobs in Tokyo and other urban centres.

On some production lines, the majority of the workers are in their early twenties and labour turnover is high. So continuity of education and training is difficult. To counter these undesirable trends, many Japanese companies have :

- \* restructured their factories into "engineering centres" giving technical guidance to overseas manufacturing centres, and

- \* automated as many processes as possible.

Automation and investment in plant and equipment, however, are not a panacea. For proof you need look no further than Nissan's Zama plant. However, its cycle time was probably slower than other plants. And, despite the fact that the factory has more robots than any other, it can't shorten cycle times. The reason for this may be that the Zama plant was designed as a joint venture to produce one product, a European mini-car. The most economical layout for this meant placing the robots close together. But the joint venture fell through, and the line now produces four body types. The original placement of these robots has taken its toll. It is difficult to reprogram the entire line to make it more flexible. But, the line cannot produce the desired variety of products in small lots.

So, although automation may eliminate some unevenness during manufacture, it still leaves unreasonable exertion and waste. Hence, the principle which has supported Japan's rise - eliminating unevenness, unreasonable exertion, and waste - is proving difficult to sustain.

Some paper manufacturers have also attempted greater efficiency through investment in plant and equipment. One managing director told me : "When our competitors started their investment in plant and equipment, we had to follow suit just to maintain our market share. If you come to visit us today, you will see that our facilities are a lot better. But, as we become more efficient, we produce more. The market becomes over-saturated and prices come down. I doubt that we can recover the cost of our investment."

So, over-investment in plant and equipment inevitably results in overproduction. But overproduction has now become the norm and, in that sense, the Just-In-Time (JIT) principle has been violated. JIT simply involves supplying to each process what is needed, at the right time, and in the right quantity. There is no room for waste, unevenness or unreasonable exertion. However, even JIT's founder, Toyota, is finding it difficult to uphold the principle. Here, it has been claimed that JIT benefited the manufacturer at the expense of its subcontractors by placing the burden of storing parts on suppliers. In an effort to deliver to Toyota on time they have been known to clog major highways. So



Toyota now creates storage spaces to alleviate the burden on its suppliers.

There is another trend in Japan. Many companies are contracting. So, when the current recession ends, we may see fewer Japanese companies with expansionist tendencies. This should open the door to European and American companies.

David Lu,  
*In Works Management, January 1992*

### SUCCESSFUL FIRMS IN DEVELOPING COUNTRIES

The growth of firms in developing countries is an essential component of general economic growth. On the basis of IFC analysis and experience, it is possible to make a number of general statements about successful corporations in developing countries, where "successful" should be taken to mean "rapidly growing," not "most profitable." Firms that pursue growth and do not conserve their profitability run the risk of overexpansion and collapse. The firms in the sample that have grown rapidly have done so over a reasonably long period of time; hence, any reference to successful firms does not mean firms that have enjoyed a year or two of rapid growth. Rather, it refers to firms that have recorded the best growth performance over the 1980s as a whole.

In fact, one characteristic of rapidly growing firms is that they are more profitable than slow growing ones, a finding that suggests the conflict between profitability and growth is more apparent than real. This positive correlation between growth and profitability is present in all countries in the sample, and it is a strong correlation.

Successful firms are more likely to retain earnings than less successful ones; again, this is a strong and consistent pattern. Yet this increased retention is not sufficient to finance growth. Hence there is a negative relationship between growth and internal finance ratios, and only in Turkey does this not appear to occur. It follows, therefore, that in developing countries successful firms are more likely to have recourse to external finance. It appears that successful firms are somewhat more likely than other firms to use external equity to finance growth and much more likely to use long-term debt. As a result, rapidly growing firms tend to be more extensively leveraged than other firms. To a certain extent, this arises because of different patterns in different countries, with successful Indian firms in particular being more likely to raise equity.

Even in Korea, however, where firms have been heavy users of debt, external equity has played a large role in financing corporate growth in the 1980s.

There are many important implications of these findings. Developing country corporations appear to be much more highly leveraged than their counterparts in developed countries. This means that the links between the corporate sector and the financial system are, if anything, even more important in developing than in developed countries. A financial system that allows corporations to raise external funds without impairing their balance sheets (and therefore their chances of survival) is essential to the long-term growth prospects of developing countries.

There are two components of this. On one hand, this is a strong justification for equity market development. In this respect, the sample of data on which this study has been based is biased, since only listed corporations in countries with stock markets have been considered. It is plausible to believe that, elsewhere in the developing world, debt is even more important in corporate finance. It is worth underlining, however, that even in those countries in the sample where high levels of debt are common (notably Korea), the equity market has made a significant contribution to corporate finance in the 1980s.

It is possible to increase the stock of debt being carried by a corporation without increasing the burden of debt service. Debt is the second component of external finance: the costs of debt service depend on the price of debt and its term structure. The greater the range of options available to corporations, the better they will be able to create capital structures that meet their growth needs. Corporations with the necessary financial strength can pursue access to international markets, where a wide range of options is available.

Clearly, this is not a realistic solution for firms as a whole. Moreover, given the constraints on the world capital market, developing-country firms cannot rely on an inflow of foreign funds. The solution, therefore, is capital market development. Broader, deeper and more efficient capital markets are essential to provide the funds that firms need in order to grow. Moreover, the importance of bank debt in developing countries also emphasizes how critical sound banking systems are for economic growth.

This is a powerful argument for market-based financial systems and financial institutions that can respond to corporate needs on a market basis.

*IFC Investment Review, Summer 1991*



## PETER DRUCKER ON INNOVATION

Specifically, systematic innovation means monitoring *seven sources* for innovative opportunity.

The first four sources lie within the enterprise, whether business or public-service institution, or within an industry or service sector. They are therefore visible primarily to people within that industry or service sector. They are basically symptoms. But they are highly reliable indicators of changes that have already happened or can be made to happen with little effort. These four source areas are:

- \* *The unexpected* — the unexpected success, the unexpected failure, the unexpected outside event;
- \* *The incongruity*—between reality as it actually is and reality as it is assumed to be or as it "ought to be" ;
- \* *Innovation based on process need*;
- \* *Changes in industry structure or market structure that catch everyone unawares.*

The second set of sources for innovative opportunity, a set of three, involves changes outside the enterprise or industry :

- \* *Demographics* (population changes);
- \* *Changes in perception, mood, and meaning*;
- \* *New knowledge*, both scientific and nonscientific.

The lines between these seven source areas of innovative opportunities are blurred, and there is considerable overlap between them. They can be likened to seven windows, each on a different side of the same building. Each window shows some features that can also be seen from the window on either side of it. But the view from the center of each is distinct and different.

The seven sources require separate analysis, for each has its own distinct characteristic. No area is, however, inherently more important or more productive than the other. Major innovations are as likely to come out of an analysis of symptoms of change (such as the unexpected success of what was considered an insignificant change in product or pricing) as they are to come out of the massive application of new knowledge resulting from a great scientific breakthrough.

But the order in which these sources will be discussed is not arbitrary. They are listed in descending order of reliability and predictability. For, contrary to almost univer-

sal belief, new knowledge—and especially new scientific knowledge—is not the most reliable or most predictable source of successful innovations. For all the visibility, glamour, and importance of science-based innovation, it is actually the least reliable and least predictable one. Conversely, the mundane and unglamorous analysis of such symptoms of underlying changes as the unexpected success or the unexpected failure carry fairly low risk and uncertainty. And the innovations arising therefrom have, typically, the shortest lead time between the start of a venture and its measurable results, whether success or failure.

*Peter F. Drucker  
In Innovation & Entrepreneurship,  
Affiliated East - West Press Pvt Ltd.  
New Delhi, 1991.*

## BASIC QUESTIONS FOR THE FUTURE

The future of the public sector and the private sector enterprises depends on five basic issues, namely,

- Technological upgradation
- Productivity and ICOR
- Price and profitability
- Environmental safeguards and resource availability
- Industrial relations.

### *Technological Upgradation*

Technology is the application of theoretical and practical knowledge to production through a sequential succession of techniques. Such technology does not just happen, it has to be generated within the country or has to be imported from outside. Generation of technology within the country depends on the number and efficiency of R & D cells in the private and public sector enterprises, or in bodies like the CSIR, ICAR, DAE, national laboratories, the Defence Ministry research laboratories and the few private national laboratories like SIMA, ATIRA, APL.

On this point, the future of India's public and private sector enterprises is rather uncertain, as the R & D expenditure in the country is Rs. 0.29 crores per unit in the private sector and Rs 2.95 crores per unit in the public sector. It is 0.71 per cent of the value of sales compared to four times that in other industrial countries. As a consequence, one issue of urgency for the future development of both public and private sector industry is to expand R & D programmes, and use the results more effectively and widely than is being done at present.



The other source of technology is to import from outside and this is being done on a large scale as the escalating number of collaboration agreements shows : these were less than 200 per annum before the Sixth Plan, rising to 600 per annum during the Sixth Plan, and further to 1000 per annum during the first three years of the Seventh Plan. There have been some outstanding cases of sound use of imported foreign technology. The textile machinery industry and the machine tools industry are some examples of the success of foreign collaborations, leading to absorption and adaptation of foreign technologies, developing local ancillary suppliers, and making of minor design changes to suit Indian conditions and raw materials. But these have involved a heavy drain on the country's foreign exchange resources, particularly during the so-called 'liberalisation' phase when foreign firms jacked up their fees and royalty rates; involved repetitive import of technology; more often than not leading to purchasing of out-dated technology; and tended to squeeze out the small producer, giving monopoly control to the foreign multinational. Both the public and private sector firms need technology to upgrade and modernise their production techniques and for this there should be increasing reliance on domestic R & D, which must be expanded at least fourfold. Simultaneously, the capacity to adapt and absorb imported technology should also be developed.

#### *Productivity and ICOR*

The productivity of most public sector units and private sector enterprises is low. One of the end results and purposes of technological upgradation is to increase and improve the productivity of the firms.

Productivity can be measured in two ways. One measure is in terms of output per labourer. This is done in the coal industry, for instance, whose annual reports record a very low OMS (output per man shift), 0.91 tonnes against the Seventh Plan target of 1.25 tonnes. UNIDO study reports that India's labour productivity in the capital goods industry which was half that of the neighbouring 6 ASEAN countries in 1970 (at 2018 in India and 4256 in ASEAN) had fallen to one-third in 1984 (at 2465 and 7387, respectively); and despite wages in ASEAN being about double that of India (Rs 1236 in India and Rs 2396 in ASEAN), the share of wages in the total value of output in Indian industry is higher than in ASEAN industry. One of the immediate tasks facing our public and private sector units is to increase the productivity of labour — which may involve improved machinery and capital, discipline and hardwork and reduction in the quantum of workforce equal to what the production and technology used for it requires.

Productivity also refers to capital and is expressed in Incremental Capital Output Ratio (ICOR). The target here for industry — taking both the private and public sectors together — is 3 (that is 3 units of capital to produce 1 unit of goods). This allows for some industries like electricity and gas having a high ICOR at 17-18. The Seventh Plan was drawn on the assumption of ICOR — of both the public and private sector enterprises — being 5. It is already a high level. The actual so far has been 6-7. This is because of the inefficient use of capital by the firms. Over two-and-a-half decades, the installed capacity has been increased by 6.3 percent per annum but production has increased only by 5.9 per cent. Another indication of the wasteful use of capital is the declining capacity use of enterprises from 85 per cent in 1970 to 79 per cent in 1986. A survey of 600 industries during September 1983 and August 1984 shows that 3 industries used only 30 per cent of their capacity, 41 used 31 to 60 per cent, 63 used 61-91 per cent and only 42 above 91 per cent of their capacity.

One other cause for declining labour and capital productivities is the limited domestic market (itself caused by the unequal distribution of incomes and assets, which leaves a large part of the people — some 60 - 70 per cent — out of the market) and which leads to firms being of uneconomic scale, resorting to batch production and lesser standardization. On this, a useful short term palliative is the establishment of minimum economic size for a firm to be granted a licence. The government has set such minimum economic sizes for 65 industries. This may help some firms to overcome the problem being able to obtain the economies of scale at least to some extent.

*Malcom Adiseshiah,  
in Privatisation - Options & Challenges,  
Ed. by S.R. Mohnot, New Delhi, CIER 1991.*

#### **KNOWLEDGE VS CAPITAL**

So much is written about the substitution of computerized equipment for human labour that we often ignore the ways in which it also substitutes for capital. Yet all the above also translate into financial savings.

Indeed, in a sense, knowledge is a far greater long-term threat to the power of finance than are organized labour or anticapitalist political parties. For relatively speaking, the information revolution is reducing the need for capital per unit of output. In a 'capitalist' economy, nothing could be more significant. According to Vittorio Merloni, an Italian businessman, Italy's recent economic advances



are a result of the fact that "we need less capital now to do the same thing" that required more capital in the past. This means that a poor country can be much better off today with the same amount of capital than five or ten years ago. The reason, he says, is that knowledge-based technologies are reducing the capital needed to produce, say, dishwashers, stoves, or vacuum cleaners.

To begin with, information substitutes for high-cost inventory, according to Merloni, who uses computer-aided design and shoots data back and forth via satellite between his plants in Italy and Portugal. By speeding the responsiveness of the factory to the market and making short runs economical, better and more instantaneous information makes it possible to reduce the amount of components and finished goods sitting in warehouses or railroad sidings. Merloni has cut a startling 60 percent from his inventory costs. Until recently, his plants needed an inventory of 200,000 pieces for 800,000 units of output. Today they turn out 3 million units a year with only 300,000 in the pipeline. He attributes this massive saving to better information.

Merloni's case is not unique. In the United States, textile manufacturers, apparel makers and retailers—organized into a Voluntary Inter-Industry Communications Standards (VICS) committee—are looking forward to squeezing \$12 billion worth of excess inventory out of their system by using a shared industrywide electronic data network. In Japan, NHK Spring Company which sells seats and springs to most of the Japanese Carmakers, is aiming to synchronize its production lines to those of its customers so perfectly as to virtually eliminate buffer stocks. Says one NHK official: "If this system can be implemented, we can theoretically reduce our inventories to nil."

Cuts in inventory, of course, not only translate back into the smaller space and real estate costs mentioned earlier, but also into reduced taxes, insurance, and overhead. Similarly, Merloni points out, he is able to transfer funds from London or Paris to Milan or Madrid in minutes, saving significant interest charges. Even though the initial cost of computers, software, information and telecommunications may itself be high, he says, the overall savings mean that his company needs less capital to do the same job it did in the past.

These ideas about capital are spreading around the globe. In the words of Dr. Haruo Shimada of Keio University of Tokyo, we are seeing a shift from corporations that "require vast capital assets and a large accumulation of

human capital to carry out production" to what he calls "Flow-type" corporations that use "much less extensive capital assets."

As though to underscore this shift and the importance of knowledge in the economy of tomorrow, the major Japanese corporations are now, for the first time, pouring more funds into research and development than into capital investment. Michael Milken, who, for better or worse, knows a thing or two about investment, has summed it up in six words: "Human Capital has replaced dollar capital". Knowledge has become the ultimate resource of business because it is the ultimate substitute.

What we've seen so far, therefore, is that in any economy, production and profits depend on the three main sources of power—violence, wealth, and knowledge. Violence is progressively converted into law. In turn, capital and money alike are now being transmuted into knowledge. Work changes in parallel, becoming more and more dependent on the manipulation of symbols. With capital, money, and work all moving in the same direction, the entire basis of the economy, which operates according to rules radically different from those that prevailed during the smokestack era.

Because it reduces the need for raw materials, labour, time, space and capital, knowledge becomes the central resource of the advanced economy. And as this happens, its value spurs. For this reason as we'll see next, "inforwars"—struggles for the control of knowledge—are breaking out everywhere.

*Alvin Toffler,  
In Power Shift,  
Bantam Books,  
New York 1990.*

#### DEMING GROUP RENEWS ATTACK

Merit, pay and performance appraisal destroy innovation, creativity, teamwork and customer focus, according to the British Deming Association. In a new booklet, the association lists eight aims for performance-review schemes. These emerged from an Institute of Personnel Management Survey in the 1980s. The booklet says some of these aims often combined in one scheme even though they are mutually incompatible.

The booklet reiterates the twelfth point of W Edwards Deming's 14-point improvement plant (*WM* October 1991



page 19): to foster pride of workmanship among managers and employees.

"Perhaps the most serious damage resulting from a policy of giving individual reward for achievement of results is that it destroys cooperative effort to develop [systems] which would lead to genuine and permanent improvement in the effectiveness of the whole organisation."

*Works Management,  
Jan. 1992*

## ENERGY CONSERVATION IN ENGINEERING

Engineering sector is one of the oldest industrial sectors in our country. The cost of energy is not a major part of manufacturing cost in the engineering industry. Typically it varies from 6 to 8% in case of re-rolling unit, 3 to 5% in case of the galvanised wire industry; while in a steel foundry 17% of the manufacturing cost is consumed by electricity, a scarce resource in India. But the engineering industry makes only 2 to 6% profits on its turn over and cost reduction efforts through improved energy efficiency is a welcome step as it reduces working capital requirements. In fact, profitability of an engineering industry is influenced by efficiency of energy utilisation as it infuses a good house keeping culture and improves the quality of manufacture and services provided.

Energy audit studies in engineering sector, conducted by National Productivity Council indicates that an energy saving potential of 15-20% exists in engineering sector. The broad recommendations of the study findings are :

- The possibility of implementation of simple straightforward energy saving measures having short pay-back periods to lowering manufacturing costs. An important factor has been increased awareness of energy matters among personnel and management.
- Substantial amounts of money can normally be saved as a result of an energy conservation project, but there are no short-cuts. An energy audit must always be performed and systematic methodology must always be employed.
- In order to achieve lasting benefits in the form of reduced energy costs, it is a prerequisite that factory personnel be trained in practical energy conservation techniques and that the factory management acquires the relevant knowledge of energy conservation.

- Energy conservation must always be seen in a wider perspective, than solely in terms of reduced energy utilisation. It should be studied *inter alia*, the financial, manpower and environmental aspects involved.

Experience shows that for most plants there are several energy conservation measures to be found which, when implemented, will ensure financial gains. Another reason for pursuing energy conservation projects is that technology is developing continuously, which means that an energy conservation measure which was impossible to implement sometime back for technical reasons could well be fully feasible today.

*Basic Steps* : In order to reduce energy costs in the most economic manner, it is necessary to start the energy conservation project with an energy audit of the plant in question; the way in which energy utilisation is divided among the different energy users is determined, *inter alia* with the help of measurements. An energy balance for the plant is produced.

It is possible to make energy and cost calculations for all energy saving measures on the basis of the energy balance. A priority listing of measures, based on profitability, can be made. It is important that all types of measures which reduce energy costs are evaluated, from very simple measures aimed at cutting down on wastefulness to recovery measures, process changes and changeover to cheaper energy sources.

The organisation of a company's energy activities and the training of company personnel are all part of an energy conservation project. Results accrue when one person is made responsible for company energy matters. Company management must realise the role played by this individual. The person responsible for energy might well be assisted from an energy saving committee, whose members should stimulate interest in energy issues in the various departments. The person in charge of energy matters, and indeed members of the energy saving committee, should have a practical technical background.

A careful and regular follow-up programme to ensure control of the company's energy situation is necessary if achieved energy savings are to be sustained.

### *Energy Auditing*

The energy audit is an integral part of an energy conservation project comprising the following :

- Getting acquainted with energy systems in question
- Gathering information on energy utilisation, production etc., to serve as a basis for the energy balance



- Planning and execution of energy measurement
- Gathering information on the energy systems development, to serve as a basis for designing energy saving measures.

The main objective of the energy audit is to establish the energy balance. The accuracy of the latter determines the accuracy of the calculations. If the energy balance is based on inaccurate data, then accurate estimation of the savings potential are impossible. However, the degree of accuracy required from an audit may vary from case to case and therefore auditing methods may differ considerably.

Energy audits depend on the possibilities to measure, with reasonable accuracy, flows of materials and goods, energy inputs and losses etc, also taking daily and seasonal variations into account.

Measurement needs to be well planned in advance. It is important to find out what instruments are available and whether new ones have to be installed. Some instruments are installed for day to day work and not as tools for follow-up work or energy audits, e.g. pressure gauges may be found in lines where flow measurements are required for the energy audit. Sometimes a plant may have virtually no measuring equipment at all. Whatever the measuring equipment available, planning is important. Care must be taken to ensure that the measurements obtained really are those initially intended.

*V. Raghuraman,  
in Economic Times, (New Delhi),  
1 February 1992*

## ENERGY CONSERVATION TIPS

### *Jaguar plots its energy statistics*

Luxury car maker Jaguar is using statistical techniques to control its energy consumption. Jaguar spends about £10 million a year on energy, half of it on electricity. Historically it used a formula to set a cost target based on the previous year's bills. But the final bill always exceeded the target. When Jaguar started its TQM programme some years ago it identified energy management as a possible application of TQM principles. A small team used cause-and-effect analysis to identify likely causes of changes in energy consumption.

For the last two to three years, as the bills come in Jaguar people plot the amounts manually and on the

company's CAD system. Plant maintenance people also take monthly readings from the sub-station meters in zones around each plant to correlate with the supplier board's bill readings. Jaguar has also worked out consumption of main plant and other items by noting readings as they are powered up during shutdowns and at other times. This information shows clearly any variations from the expected energy consumption pattern.

On two sites, the company's gas consumption usually follows closely the number of degree days. This is a reflection of the fact that, in a typical factory, 72 per cent of the energy used is for heating. Electricity consumption is harder to predict. So Jaguar has formulae relating electricity use to the economic cycle (inflation), current bills, the size of the area covered by the measurements, production volume, manhours, accounting periods (where these differ), changes in plant size and major economy measures taken during the period.

When variations occur, Jaguar people try identify the zone responsible, whether any changes in shift or working patterns can account for them, whether the process has changed, for example to run at higher than normal temperatures, whether process air conditioning may have been turned on early or left on late. If the change is a planned change, Jaguar accepts it. If it is someone leaving lights on then management takes action to make sure it doesn't happen again. Jaguar plant engineering manager Fred Hiscock says plant directors take responsibility for the energy bills run up in their part of the plant, because they know energy costs come off the profits they make. They have pushed responsibility down to operators and the rest of the workforce, which have become adept at spotting unneeded lights or machinery.

Jaguar is reducing energy consumption by moving away from central coal-fired boilers on some sites to smaller gas-fired boilers distributed nearer where they are needed. Compressors, on the other hand, the company seeks to centralise and make regular checks for leaks. The company also uses task lighting, which means dividing lighting into separate lighting zones which can be shut off when no work is needed in those zones. Jaguar is now using the Monitoring and Targeting technique and is using software supplied by NIFES to help with this.

### *Energy saving at Cyanamid*

John Morris is energy manager at the Gosport plant of Cyanamid. The plant is a by-word in energy efficiency, even though energy represents a small slice of the plant's total costs: Morris says energy costs are two per cent of production costs. The company has a text-book combined



heat and power (CHP) plant which produces annual fuel savings of £600,000. Cyanamid has gone on to extend energy monitoring and targeting (M&T) to billing as well.

Monitoring, targeting and billing (MTB) means that Cyanamid has a programme of metering all its utilities—electricity, gas, oil, water, steam, compressed air and so on—as near as possible to the point of use. It then sets the managers around the plant individual targets for reductions in consumption of those utilities. Each department is then billed for its energy use.

Morris sees MTB as Cyanamid's means of ensuring that everyone in the plant takes responsibility for energy efficiency: "Meter targets are easily understood, and the aim of this is to make all production departments from little teams and get out there and do it. If you relate all the actual consumption of electricity to a bill that they get—for example, meters one, two, nine, 10 and 11 all belong to the pharmaceuticals division—then the money they save will come back. It's another incentive to get consumption down."

Water was one of Cyanamid's first MTB programmes. Few companies realise that they can cut costs by cutting down the amount of water they use. This is not just because they have to buy the water or pay for its discharge back into the system. Users often waste energy by heating up a large volume of water and using only a small amount of it. And huge amounts of energy are used to pump water to where it is needed, and then back as effluent. The company has cut consumption by one-third, or 400 cubic metres a day out of its total consumption of 1,400 cubic metres a day. How? Most of the savings came simply by tracking down leaks and wastage. Morris cites another target: "Compressed air is really expensive. Usually a large quantity of electricity is going into compressors and a lot of the air is wasted. We are metering it to cut down leaks and wastage."

Overall, Morris believes the MTB programme will cut Cyanamid's \*1.46 million energy bill by about 10 per cent, giving a two-year payback. But he describes the use of payback periods in the energy context as "Simplistic".

*John Dwyer,  
in Works Management,  
November 1991.*

#### **COMPETITIVENESS : INDIAN STEEL INDUSTRY**

How far is India's steel industry competitive in terms of domestic prices. India (as opposed to the USA, Japan and

West Germany) had a substantial price competitiveness in 1977, not only in wire rods and plates, but also in hot rolled sheets, cold rolled sheets and galvanized sheets. However, in 1989, it lost price competitiveness in all items except wire rods. The price competitiveness of India's steel industry got eroded around 1981 and 1982.

In India, more than 20 per cent of the domestic prices of steel are accounted for by levies such as excise duty, transport cost, Joint Plant Committee Cess, Engineering Goods Export Assistance Fund and Steel Development Fund. India was the fourth highest after Brazil, Korea and Italy in 1973, but it became the costliest in 1984. During the same period, the cost of steel production per ton decreased from US \$ 400 to US \$ 237.5 in Korea, while it increased from US \$ 375 to US \$ 487.5 in India.

What are the main factors responsible for the high cost in India? First, wages as well as employment are downright rigid in such organized industrial units as integrated steel plants. Labour unions resist the introduction of modern technology if it leads to the curtailment of employment. In 1988, the production of crude steel per productive worker was as low as 50.7 tons in India, compared with 759.4 tons in Japan, 415 tons in the United States, and 242.2 tons in Brazil, indicating overemployment in India's steel industry. However, as the data of the World Bank show labour cost per ton of steel production in India was US \$ 80 and the share of labour cost was 16.4 per cent in 1984, both of which were much lower than the averages of major developed countries. This is also the case with financial cost. Financial cost per ton of steel production in India was US \$ 47.5 and the share of financial cost in the production cost was 9.8 per cent, both of which were a little higher than the averages of major developed countries, but they were considerably lower compared with Korea. Accordingly, in the case of India, it is the material cost which occupies the most important position in the cost of steel production. Material cost per ton of steel production in India was the highest among the major 16 countries in 1984, and the share of material cost in the production cost was 73.8 per cent which was the second highest after France.

The components of material cost are iron ore (including pellet and sinter), submaterials (limestone et al) and energy (coal and coke, heavy oil and power). What calls for special attention here is the energy cost. Energy consumption per ton of crude iron in the major developed countries was 6 billion calories in 1980, while that of India still amounted to 9-15 billion calories in 1986-87. Energy cost accounted for as high as 30 per cent of the operating cost per ton of crude iron in the Indian integrated steel



plants in 1984-85. Moreover, the share of energy cost in the production cost tended to increase during the period 1976-87.

Material cost is composed obviously of (1) price per unit of material input, and (2) consumption of material input. First, consider the price per unit of material input. As for iron ore, India is well endowed with it, and its quality is quite high. The domestic price per unit of iron ore in India is lower than the international level. In contrast to iron ore, the quality of the Indian coal is not satisfactory (ash content is 20-30%), and India is dependent on imported coking coal (ash content about 10%) for about 15 per cent of the total availability. The domestic price of coal in India is higher than the international level. Therefore, the impact of consumption on the production cost is quite substantial especially in the case of coal and coke. The share of coal and coke in the operating cost per unit of crude steel was 21-22 per cent in 1984-85.

Iron-making by blast furnace consumes nearly 70 per cent of the total energy input. Coke ratio (coke consumption per ton of pig iron at blast furnace) has declined to as low as 450-500 kg in the developed countries, while it remains high in India, from 666 kg in Bokaro to 1,023 kg in IISCO in 1988-89. Comparing process-wise, net energy consumption between the Indian steel plants and the British Steel Corporation (BSC) during the period 1983-87, energy consumption at each process was higher in the Indian steel plants than in BSC, except for L.D. converter at Rourkela. Energy consumption of the Indian steel plants was greater than BSC by 1.20 to 1.68 times at sinter plant, by 1.32 to 1.51 times at coke oven plant, by 1.29 to 2.18 times at blast furnace, by 0.84 to 1.43 times at L.D. converter, and by 1.02 to 1.43 times by continuous casting.

Two factors can be pointed out as the reason for high consumption of materials per ton of steel in India. The first relates to the area of material preparation. In the preparation of iron ore, it is necessary to organize the size of iron ore suitable for use at blast furnace through crushing and screening and to process iron ore into pellet or sintered ore. The preparation of materials is not satisfactory in India. For example, IISCO has not yet installed any crushing or screening plant for sizing or any sintering or palletizing plant. In 1986-87, the proportion of iron ore and sintered ore charged into blast furnace was 2:8 in the developed countries, while it was 6:4 in India.

The second factor is the problem of technological lag, especially in steel making process. India has been highly dependent on open hearth furnace which is not quite efficient in terms of energy consumption. It was not until 1987-88 that the production of crude steel based on L.D. converter outstripped that of open hearth furnace. Only at

Rourkela and Bokaro, L.D. converters had been introduced from the start. It was as recent as 1983 and 1984 that L.D. converters were introduced in TISCO and Bhilai, respectively, L.D. converters have not yet been introduced in Durgapur and IISCO.

Another problem is that India lags behind other countries in the production of continuous casting process. Continuous casting process is quite energy-saving, consuming only 1/2-2/3 of electricity and 1/18-1/5 of gas compared with the conventional casting process. In 1987, the share of continuous casting in the production of crude steel was 93.3 per cent in Japan, 45.5 per cent in Brazil; with the world average being 55.2 per cent. It is as low as 26.6 per cent in India.

A factor which results in higher cost of steel production in India is the efficiency of plant facilities. Given that 50 per cent of production cost is fixed cost, the increase of steel production by 30 per cent under the existing plant facilities would decrease production cost per ton of steel by 15 per cent. Take the example of efficiency of blast furnace (daily tapping of pig iron per m of blast furnace working volume). It is low in India, from 640 kg in Durgapur to 1,260 kg in TISCO, compared with 1,890 kg in Japan. The low efficiency of blast furnace in India can be accounted for by many factors, such as a high coke ratio unstable supply of coke, the ageing of blast furnace, and the chilling of blast furnace due to power failures. The efficiency of plant facilities has much to do with capacity utilization.

*Makoto Kojima*  
in "Privatisation - options and challenges"  
Ed. by S.R. Mohnot, New Delhi, CIER, 1991

## ENERGY CONSERVATION PAYS

Energy Conservation Pays; pays fabulously. This is what the data brought forward by the Department of Power (Government of India) proves. According to the Department of Power, some of the industrial sub-sectors such as steel, cement, chlor-alkali, textiles, ceramics, glass etc. are highly energy intensive. Even though the overall energy efficiency of Indian industry is far below from that of world standards, there are some shining examples of industrial units who have purposefully and methodically done excellent work in improving their end-use energy efficiency. To extend a national recognition to these efforts the Department in 1989 instituted the "National Energy Conservation Awards." As a part of the scheme of awards the Department collected detailed information on the energy conservation efforts carried out by the companies from energy intensive sectors. The data, thus, collected are summarised in the following table :



Sector	Company	Period	Energy Conservation Investment (Rs. Lakhs)	Energy Savings			
				Rs. Lakhs	Unit	From	To
Textiles	Madura Coats Ltd. Bangalore	1986-89	265.0	140.0 (Cumulative)	Percentage of energy costs to total turnover	8.25	6.78
Textiles	South India Viscose, Sirumugai	—	163.0	114.0 (per year)	Percentage of total manufacturing costs	17.0	12.0
Petrochemicals	Petrofils Co-operatives Ltd., Vadodara	1986-89	34.0	10.6 (per year)	Million K.Cals per tonne	6.20	5.50
Refineries	Hindustan Petroleum Corporation Ltd., Bombay	1980-89	11000.0	462.0 (per year)	M.BTU/Billion Barrel/NRGF	145.0	131.0
Refineries	Bharat Petroleum Corporation Ltd., Bombay	1986-89	9200.0	—	M.BTU/Billion Barrel/NRGF	189.2	139.2
Pulp & Paper	Bhadrachalam Paper Boards Ltd., Andhra Pradesh	1986-89	1870.0	(Saved 49.7% in Thermal Energy and 9.46% in Electrical Energy)			
Pulp & Paper	Rohit Pulp & Paper Khadki	1986-89	78.00	(Saved 37% in Thermal energy and 8% in Electrical Energy)			
Fertilizers	IFFCO Ltd., Phulpur	1986-89	768	-	U.Cals/ton of amonia (Energy savings of 6.36% in amonia Plant, 3.36% in Urea Plant and 7.03% in Power Plant)	10.26	8.42
Fertilizers	Gujarat Narmada Valley Fertilizer Co. Ltd., Bharuch	1986-89	107.0	(Energy Savings of 5.9% in Ammonia Plant and 5.48% in Urea Plant)			
Chemicals	Shri Ram Foods and Fertilizers (India) Ltd., New Delhi	1986-89	7.00	108.5	—	—	—
Chemicals	Diamines & Chemicals Ltd. Vadodara	1986-89	28.0	32.00	—	—	—
Steel	Tata Iron & Steel Co. Ltd., Jamshedpur	1986-89	390.0	1176.0	G.Cals/Ton for the period 1973-90	1.6	0.79
Aluminium Sector	Hindalco Industries Renukoot	1986-89	5500.0	(14.5% energy savings in reduction plant)	KWH/MT/(AC)	16300	15000
Chlor-Alkali	Andhra Sugars, Kovvur, Andhra Pradesh	1986-89	200.0	(6% saving in electricity)	KWH/T (Caustic Soda)	—	2630
Chlor-Alkali	Chemicals & Plastic India Ltd, Mettur Dam, Tamil Nadu	1986-89	530.0	(Saved 730 Units per ton of Caustic Soda)			

Source : Based on Department of Power (Government of India), National Awards for Energy Conservation in Industrial Sector, National Energy Conservation Day, 14th December 91.



## INTERNATIONAL R & D COOPERATION

IMS—the trilateral cooperative R & D program in “intelligent manufacturing systems” proposed by Japan in late 1989—brings the United States face to face with two fundamental policy challenges. Internationally, IMS underscores an already unsettling reality; technology from abroad is at rough parity with what originates at home. Domestically, IMS calls into question the tenets and modes of interaction long characteristic of U.S. technology policy. Although neither challenge is before us for the first time, IMS places them in unique coincidence, and offers a unique niche for progress.

### *Evolution*

The Japanese Ministry of International Trade and Industry (MITI) unveiled the IMS project in the fall of 1989. Envisioned as a trilateral effort among the United States, Europe and Japan, the original proposal foresaw \$ 1 billion in funding over 10 years, derived from public and private sources and split 20%, 20%, 60% among the regions respectively. Its goals were to systematize knowledge about manufacturing, standardize future technical approaches, and promote international cooperation. Early on, an IMS Promotion Center enlisted Japanese members, a number of private American institutions proposed participation, and the Society of Manufacturing Engineers was designated U.S. secretariat.

The spring of 1990 saw American concern coalesce about the speed, style and substance of events. Two major issues took hold: fear that Japan would quickly acquire leading U.S. technology, and the need for a government-negotiated international agreement on IMS. Invoking the U.S.-Japan Science and Technology Agreement, the U.S. government imposed a moratorium on IMS, designated the Department of Commerce (DOC) as lead agency, and began a consultation process with the private sector about how to proceed.

Throughout the following year, progress moved in two coordinated directions. While governmental representatives pursued formal international negotiations, DOC managed a continuing dialogue with the private sector. A unique institution devoted to IMS, the Ad Hoc Industry Group, was formed. By November it had become clear that the first step toward IMS would be a two-year feasibility study. In April 1991, when U.S. drafted Terms of Reference for the feasibility study were unveiled, Japan, the United States, the European Community, Canada, Australia and the European Free Trade Association were all slated as participants.

Over two years, IMS has evolved substantially from MITI's original proposal. With the addition of participants, it now enlists the entire highly industrialized world. Issues of project governance, advanced principally by the United States, are likely to remain at center stage during the feasibility study. Although substantial, albeit cautious, enthusiasm for IMS is manifest, its realization is by no means assured. In the United States, the remarkably productive dialogue about IMS has tended to obscure almost-schismatic underlying divergences of opinion about America's position in the international technical community and the roles of public and private sectors in defining a domestic technology policy.

### *Interpretations*

At its most straightforward, IMS is research. Many researchers and industrialists can envision a portfolio of generically applicable projects uniquely amenable to international cooperation.

The political dimension of IMS looms large. IMS represents both Japan's response to criticism of its “free ride” in science and technology and a step toward internationalization. For the United States, IMS may be a step toward recasting external technical relationships, especially with Japan. Internally, it is an important element of an overall evolution in business-government relations.

Some have labeled IMS a “Trojan Horse”: a Japanese effort—putatively research—to access U.S. technology, particularly software and systems development. Undoubtedly, selfish motivations are ubiquitous and natural—among Japanese, Europeans and Americans alike. The more pressing problem for Americans is how to exploit IMS as a window on technology development abroad.

Because cooperative research and technical standardization are IMS' main goals, the project opens a pathway to market access, particularly in the United States and Europe. In Japan it is intended to open doors for foreigners to the indigenous technical community. Participation in IMS is imperative among foreign companies whose goal is effective integration into the Japanese economy.

Given a lengthening period of discussion, IMS has become as much a process as a substantive project. In the United States, it augments technology policy dialogue, having pioneered new forums—notably the Ad Hoc Industry Group—that bear further attention. IMS represents a bright spot in U.S.-Japanese relations, in which realism and flexibility may be displacing rhetoric.

Historically, IMS is a logical step in an evolving Japanese posture toward technology development. A possible



prototype for the future, it bespeaks a larger Japanese voice in international agenda setting. New participants and changes from the project's original charter raise the possibility of a new worldwide format for cooperative R & D.

#### *Policy Issues*

In Japan, MITI exercises leadership, public capability is significant, few players define agendas and policy is consistent over time. The U.S. policy climate is at once open, dynamic, and plagued by halting inconsistency. If international projects represent a proto-type for the future, one questions whether the resources and patterns of responsibility in the U.S. government are adequate.

Long characterized by formalism, legalism and antagonism, government-business dialogue in the United States has turned—at least in the IMS context—toward more productive, informal interaction. The DOC's IMS workshops and the Ad Hoc Industry Group offer examples whose wider applicability should be evaluated.

IMS can significantly augment U.S. access to foreign sources of technology in Europe and Japan. Turning this potential into reality should be a paramount task for public and private participants.

Historically asymmetrical, the bilateral technical relationship between the United States and Japan needs to be put on a more equal footing. IMS may abet this process if Americans learn from Japan and Japanese society assumes a more natural internationalism.

IMS intensifies other domestic issues: foreign participation in publicly supported technology programs, and antitrust treatment for inter-firm cooperation beyond research.

#### *Principles*

- \* Cooperative international R & D should be undertaken and designed to augment the U.S. international technical position and domestic technical capability.
- \* International cooperative efforts require adequate domestic technology policy.
- \* International and inter-firm competition pervade cooperative R & D. We should accept and accommodate this reality, not rue it as an impediment to the design of such programs.
- \* The ability to design cooperative institutions approaches a definable professional capability, from which international cooperative R & D ventures should benefit.
- \* Cooperative international ventures should recognize

the asymmetry of national goals and capabilities and seek diverse beneficial out-comes.

- \* Symmetrical control of international R & D agendas should be assured for each nation's activities.
- \* Foreign participants in cooperative R & D should be guaranteed reciprocal integration in host country activities.
- \* Adequate, mutually acceptable protection of intellectual property is essential.
- \* International cooperative R & D is a long-term undertaking. Quick or dramatic technical outcomes should not be expected.

#### *Conclusions*

The early history of IMS revealed unsurprising but avoidable misunderstanding between the United States and Japan. Beyond the specifics of this case, the United States has farthest to move: Americans need to be much better acquainted with technology and policy abroad in order to exploit international opportunities.

IMS has thus far muted acrimony and fostered productive exchange between the private and public sectors and between the United States and Japan. Partly, attitude and style among individuals involved account for this. Partly, it results from well used communications forums. These patterns need to be preserved.

IMS counterpoises the evolving industrial structures of America and Japan in a potentially profitable partnership. Failure to capitalize on it would represent a major missed opportunity. Particularly for U.S. based companies in Japan, non-participation would frustrate long efforts to integrate into the indigenous technical and economic community.

A paramount design criterion for IMS is to ensure that it opens windows accurately on the international—particularly Japanese—technical enterprise. If the IMS project emphasizes manufacturing technique without linking it to the entire process of technological innovation, it will be too narrow. If it channels Americans primarily toward assimilating the Japanese technological past—e.g., lean production—without anticipating the Japanese future, then it will do a disservice.

American public policy airs conflict easily but rarely resolves it effectively. In the IMS context, conflict lurks below surface consensus: vendors and customers for intelligent systems, universities, new firms, professional



societies, and the international operations of U.S. firms all represent significantly different interests. Government's most appropriate stance may be to facilitate diverse private goals rather than forge a well-defined national viewpoint.

*George R. Heator Jr.  
Manufacturing Competitiveness,  
Frontiers, July 1991.*

## SECOND CENSUS OF SMALL SCALE INDUSTRIAL UNITS

Out of the 10.55 lakhs small scale units registered with the state Directorates of Industries (DIs) as on March 1988, 582368 units were working and 301390 units were closed, the remaining being either non-traceable, non-responding or having duplicate registration. This was revealed by the Report on the Second All-India Census of Small Scale Industrial Units—Summary, recently released by the Development Commissioner of Small Scale Industries, Govt. of India. "The figure on closed units represents the cumulative closure since 1973 Census, and some of them may in fact, be potentially viable and call for attempts at revival" according to the Report. "A number of units, though working, were ineligible for registration, due to the fact that they were functioning in non-conforming areas", added the Report.

The Survey found that the 5.82 lakhs working units had a total investment of Rs. 9296 crores (book value) in fixed assets of which plant and machinery accounted for Rs. 3502 crores (Rs. 5,543 crores in terms of original value). With a total employment of 36.66 lakhs and working capital of Rs. 7,148 crores, these units produced 7449 products (as per 9 digit NIC) and rendered jobbing/repairing services, the total value of goods and services being Rs. 43,219 crores in 1987-88. Goods worth Rs. 2499 crores were exported by 4554 units. Food products, chemicals and chemical products basic metal industries, metal products, rubber and plastic products machinery and parts (except electrical), hosiery and garments and nonmetallic mineral products accounted for 68 percent of employment and 74 percent of investment as well as production. 64.5 percent of the units were in the employment slab 1-4 workers. These units accounted for 22% of employment, 21 percent of fixed investment and 12 percent of production. 50% of the units were engaged in manufacturing/assembly only. Another 8 percent had taken up manufacture/assembly along with processing, job work and/or repairing servicing activity. 6.8 per cent of the units belonged to the scheduled castes entrepreneurs and 1.7% to scheduled tribe entrepreneurs. Woman entrepre-

neurs managed 7.7 per cent of the total number of units.

42% of the registered small scale units were functioning in rural areas. The urban and metropolitan areas accounted for 48% and 10% respectively. The units in the rural areas accounted for 33% of the employment, 29% of the total investment in fixed assets and 27% of the production. 11.6% of the employed belonged to scheduled castes and 4.5% belonged to the scheduled tribes. Women constituted 12.2% of the total employment. 1.1% of the total employed were ITI trained. 32% of the employees were in the casual/contract category. About 19% of the employees were self employed.

Production in SIDO sector increased from Rs. 2603 crores in 1972-73 to Rs. 43219 crores in 1987-88 (Rs. 13233 crores when reduced to 1972-73 prices) the compound annual growth rate was about 11.45%. Production under reserved items increased from Rs. 463 crores in 1972-73 to Rs. 11926 crores (Rs. 3810 crores at 1972-73 prices) in 1987-88, in other words at the rate of 15.1%. Employment also increased from 16.53 lakhs in 1972-73 to 36.66 lakhs in 1987-88, the annual compound growth rate worked out to 5.46%. Employment elasticity worked out to be 0.48. There has been a six fold increase in real terms in exports from Rs. 127 crores in 1972-73 to about Rs. 798 crores in 1987-88 at 1972-73 prices.

## LABOUR COSTS IN THE IRON AND STEEL INDUSTRY

The European Iron and Steel Industry has undergone profound changes in the last 20 years, including restructuring of the labour force, implementation of new technology, nationalisations bankruptcies, and mergers. Traditionally considered as a pillar industry for many countries, these changes have had dramatic impacts on many regions whose economy was mostly based on the Iron and Steel industry reveals a recent study.

The aim of the study, commissioned by a Belgian steel producing company, was to compare the labour costs of the Iron and Steel Industry in Belgium, France, Germany and the United Kingdom. Among these four countries and for the 1980-1990 period, the hourly labour costs per employee were similar in Belgium and Germany, a fraction lower in France, and substantially lower in the U.K. Looking at the labour productivity, it has increased between 1980 and 1986 at the same rate in Germany, France and Belgium. In the UK, the average productivity has remained at a considerably lower level, but has started to increase after 1983 at a faster rate than in the three other countries, the gap disappearing at the end of the 1980s.



## WORLD CHAMPIONS OF THE 90s

Japan, USA, Germany and Switzerland again lead the pack of industrialized nations in the 1991 World Competitiveness Report. Their counterparts in the newly industrialized economies are Singapore, Hong Kong, Korea and Taiwan, while the "rising stars" this year are Austria and Malaysia. The report evaluates country competitiveness through a multidimensional approach using 326 criteria. All aspects of competitiveness, infrastructure, internationalization, finance, R&D, workforce and, of course, management - are assessed to produce a high-definition picture of each nation's competitiveness. In addition, the report features a "country competitiveness balance sheet" for each of the 33 countries, summarizing the assets and liabilities to show at a glance how a country is faring. The report makes a distinction between a nation's "attractiveness" and "aggressiveness", explaining that misuse of the two concepts has often confused the very notion of national competitiveness. Hence, Ireland is competitive because it attracts a number of foreign enterprises, although few Irish companies are really aggressive on international markets. Korea, on the other hand, is very aggressive internationally, but unattractive to foreign companies. The 1991 World Competitiveness Report shows how each of the 33 countries measures up in terms of both attractiveness and aggressiveness.

However,, the challenge is not only to describe, but also to explain, what is behind the notion of competitiveness. In the report's Business Confidence Survey, executives were asked to consider which factors are at the core of their countries' competitiveness. Their answers—quality, technology, skilled people, business freedom and economic growth are the focus of this year's report. Moreover, world renowned CEOs highlight their own priorities, including contribution from Akio Morita of Sony, George Fisher of Motorola, Stephan Schmidheiny of Anova and Lord Younger of Cable & Wireless.

The big revolution in the 80s was to realize that competitiveness meant more than having a correct strategy, for most strategies fail in the implementation process. The Japanese showed the world that excellence in business practices, quality and speed were just as vitals as strategy. Among these factors, as the report indicates, quality ranks first in the minds of business leaders today.

The Japanese also showed the importance of mastering processes throughout the company. In the 80s, major achievements were made at the production level—one speaks now in defect rates per million. The story of the 90s

As an overall assessment, that the mutual competitiveness of the Iron and Steel industries in the four countries, with respect to labour costs and labour productivity, is limited.

The favourable position of Germany in the early 1980s with respect to the balance in the costs of labour and labour productivity has been altered during the 1985-1988 period in favour of France and the UK. However, labour costs in these four countries can be a competitive burden with respect to the relatively low labour costs in the newly industrialised countries and Eastern Europe. But the most important difficulties the European Iron and Steel Industry has had to face in the last 20 years lie in the decline in traditional steel products in Europe and the dependence on the world steel market.

*European Centre for Work & Study, Oct. 1991.*

## WOMEN IN SCIENCE AND ENGINEERING

Why aren't women going into and staying in science and engineering as much as we might hope? We should consider the possibility that the young women who "leak out of the science and engineering pipeline" are behaving more intelligently than those who want to recruit them but refuse to provide adequate incentives, such as reasonable working conditions and promotion opportunities. The pipeline metaphor in itself is a clue to the problem: It suggests a factory - management attitude that treats people as raw material to be made into products, without regard for their own wishes or well-being. The reason that women are not rushing into technical fields may be that other professions, newly available to them, are more attractive. This is generally admitted to be a major reason why fewer women are choosing careers in teaching. Is the same thing happening in science and engineering?

Much effort has been devoted to recruiting women, but much less has been done to prevent them from dropping out of educational programs and professional careers at later stages. Universities and corporations have not dismantled and structural barriers that effectively deny rewards to women, ranging from the SAT to promotion systems that conflict with family life or allow women to rise no further than a glass ceiling. If those leaders who are now trying to push women into science and engineering would devote the same energy to creating conditions that would pull them into technical careers, everyone's interests would be better served.

*Peter J. Denning  
in American Scientist (Sept.—Oct. 1991)*



will be to move this revolution to the office, where one task out of three still has to be redone - that is, a defect rate of 33%! Some of the same techniques that worked at the factory level can be used in the office. Motorola's accounting department, for example, found that balancing the books requires 1.3 million different operations each month. Between 1988 and 1991, Motorola reduced by 16 times the number of mistakes which occurred in the process. What used to take eight days now takes four.

Applying these techniques will also improve speed. The average company is speedy at the production level, only to bog down in marketing or sales. In 1981, Toyota was already producing a car in two days. But it still took five weeks between order and delivery. Something is wrong, if producing a car takes two days and delivery five weeks. So Toyota fired its marketing staff and replaced them with production directors who used the techniques they had used in the factory to control quality and speed. Now, Toyota cars can be delivered in one week in Japan. Such rethinking is occurring in other corporate activities. Indeed, every major aspect of company policy today - the management of speed, diversity, globalization, localization, etc. - feels the impact of this revolution in productivity which started in the factory and is now moving up the organization. In the 90s, the name of the game is excellence in business practices at all levels, including the office. Countries which have mastered the implementation process—Japan, Switzerland, Germany—may now find that it's not enough. It may be that those companies which were excellent in implementation will not be strong in the imaginative skills which are needed now.

With quality a given, consumers will be looking for other things, notably a more emotional relationship with products. Satisfying these desires requires imaginative marketing - a fact not lost on the Japanese automobile industry. For the Miata sports car, Mazda recorded 100 combinations of exhaust sounds, because their research showed that consumers want a sports car with the "right" sound. A Nissan model popular with women has a special trunk that can be opened and closed with one finger. Imaginative marketing means, of course, that you have to spend more and more time listening to customers. Again, the Japanese are out in front, spending a tremendous amount of time trying to find out what motivates consumers.

Competitiveness, the report explains, goes beyond economic analysis to more social issues such as education and values. Companies need not only an elite but a broad dissemination of knowledge at every level. Competitive companies will need people who have the ability to

understand the logic of the business even if they are rather low in the hierarchy. In the West, knowledge is too often concentrated at the top, whereas in Japan it is much more spread out. Yet, it seems to be more important to have excellence at this very middle level than to have a small elite which is very qualified. The elitist structure of France and the UK is in contrast with the situation in Germany, Switzerland and Japan where there are extraordinarily qualified people at the middle level because of the apprenticeship system.

The 1991 World Competitiveness Report emphasizes the importance of the human factor in competitiveness. Education, skills, sociopolitical activities, values, etc. are given a lot of importance in the analysis. Some believe that at the core of competitive performance is a competitiveness of values. Koreans, for example, work an average 24 hours per week and have a collective set of values. In Europe and the United States, on the contrary, values are more individualistic and leisure time is increasing. This difference in values shows that it is obviously harder to compete with Korea. Europe and the US also had a set of values based on effort and persistence 100 years ago, these values were the basis of the Industrial Revolution. Korea, Japan and Taiwan are probably also moving toward a more individualistic and leisure-oriented society, but it will take a lot of time. Meanwhile, this imbalance in values creates an imbalance in competitiveness.

In a defect-free world, countries and companies must react quickly if they want to stay at the top. It means dealing with a number of taboos and drastically changing work methods. This process is going to be more painful than we think. The 90s will be an unforgiving decade.

*Sarah Veal  
World Link, July 1991*

## TOYOTA'S SUCCESS

Since the 1960s, Toyota has had one of the highest productivity levels in the automobile industry. As early as 1965, even after adjusting for differences in vertical integration (Japanese auto makers have lower levels of vertical integration compared to American auto makers), each Toyota worker was producing 70% more vehicles per year than his counterpart in General Motors, Ford, or Chrysler. By 1980, a Toyota worker was producing four times as many vehicles as his American counterparts.

How does Toyota do it? It pioneered the concept of "lean production" (a term coined by IMVP researcher John



Krafchick), which combines the advantages of craft and mass production. "Lean producers," write James P. Womack, Daniel T. Jones, and Daniel Roos in *The Machine That Changed the World*, "employ teams of multiskilled workers at all levels of the organization and use highly flexible, increasingly automated machines to produce volumes of products in enormous variety." In 1990, Toyota offered consumers as many products as General Motors—which is twice Toyota's size.

What is even more significant is that, almost from the start, Toyota linked its production system and the consumer. Its dealers became the first leg of Toyota's production process, sending orders for presold cars to the factory for delivery to specific customers in two or three weeks, relate Womack, Jones, and Roos. This allows the company to produce only the products required in the volumes required.

The result of this unique approach to productivity, as is high profitability. Toyota reported a net income of \$2.6 billion in 1989. Furthermore, Toyota enjoys the highest operating margin in the world auto industry, and generates so much cash, writes Alex Taylor III in *Fortune* magazine, that it can buy both Ford and Chrysler at current stock prices.

*World Executives Digest, Dec. 1991*

### WORLD-CLASS VS. CONVENTIONAL PRODUCTIVITY

The universal definition of productivity is OUTPUT/INPUT; the higher this ratio, the better. It is a measurement of how efficiently you convert inputs or resources into useful outputs, products, or results. Another way of looking at it is RESULTS/RESOURCES. Mathematically, you can increase the ratio by raising output, decreasing input, or both. But in terms of operating decisions, what you really change are: (1) the amount of input; and (2) the process that converts input to output. Output is not actually manipulated; it is just a result of your decisions in (1) and (2). In practice, productivity is raised by improving the process rather than by adjusting the input quantity. Only after the process is improved are input requirements eventually reduced or output increased. Productivity calls for finding ways of doing things smarter and better. It is not as simple as adjusting input quantity or achieving economies of scale by operating at high volumes to increase input yields.

Two schools of thought on how to improve productivity have emerged:

#### CONVENTIONAL:

"Getting the most output from the available input"  
or  
 $\text{MAXIMUM PRODUCTIVITY} = \frac{\text{MAXIMUM OUTPUT}}{\text{AVAILABLE INPUT}}$

#### WORLD-CLASS:

"Getting the required output with minimum input"  
or  
 $\text{MAXIMUM PRODUCTIVITY} = \frac{\text{REQUIRED OUTPUT}}{\text{MINIMUM INPUT}}$

Let us see what we really mean by "output". As the term deceptively connotes, it is something that is "put out" by any process—man or machine. Not surprisingly, "output" is part of the engineering mind-set; as far as the engineer is concerned, anything that comes out of his machine is an output. Output/input is the engineer's definition of machine "efficiency". The concept was borrowed by businessmen and renamed "productivity".

The problem starts when the concept is transplanted into the business setting where not all outputs are useful or have value. How is this so? In business, an output has value only if it is a saleable or usable product, finished or in-process. All products are outputs, but not all outputs are products. An output acquires value if and only if it is used or bought as an input by—another process - another worker, machine, or customer, whatever the case may be.

Therefore, we have to increase productivity in the context of coming out with outputs or products which a particular user desires. In short, it is making the right thing the right way. The next process, an internal customer or external customer, will accept an output of a preceding process as an input only if it is of the right quality and quantity, and if it arrives at the right time.

While conventional productivity is production-oriented, the world-class approach is market-oriented. It starts with the requirements of the customer—output quantity and quality—and then works back to improve all processes and minimize all inputs. Since the productivity program started with the user or customer in mind, all outputs are guaranteed to be usable. Nothing is wasted. The world-class productivity philosophy is consistent with the just-in-time, or JIT, manufacturing system which requires any process to produce only the quantity to be withdrawn or used by the net process.

*Rene T Domingo*  
*World Executives Digest, Dec. 1991.*



## POLLUTION LIABILITIES

There are basically three schools of thought in dealing with contaminated land—the American, British and Dutch—with the British being regarded until recently as relative laggards in the matter. A few years ago it was the Dutch, who live in a small country that is particularly country that vulnerable to groundwater pollution, who were the leading lights in this field. The Netherlands boasts the toughest standards anywhere, but today they are finding that enforcing those standards is putting a severe strain on the national economy, to the point where they can hardly live up to their own environmental expectations. In the spectrum between what is feasible and what is desirable, Dutch requirements go so far as to insist that cleanup return contaminated land to its natural state, as though the pollution never happened, which is a very difficult and costly procedure when carried out on a large scale.

The danger of a sweeping solution to such vast problems is that they only look good on paper. Everyone argues about the language while the real problem worsens. Pollution should be cleaned up; but in the absence of a revenue wind-fall, it is easier said than done. Financial resources are scarce, and the problem of proving liability for pollution makes them difficult to get.

In many cases, cleaning up pollution requires funding mechanisms and finance that basically do not exist. Consider, for example, that in Eastern Europe the ecological crisis is so acute as to require the energy and investment of many generations just to get up to present-day Western European standards, which would be nothing to brag about. Should the Poles, Hungarians and others devote 25 years to rectifying a disastrous environmental situation at the expense of everything else? Clearly, they cannot afford to do so, and necessity dictates that the environmental problem be treated in the context of other challenges they face. Solutions will have to be parceled out according to the degree of urgency.

Western Europe's environmental problems are far less acute, but its citizens' current expectations are considerably higher. We have to realize two basic points. One is that eliminating toxic waste sites altogether is not feasible, unless we are willing to draw so many resources out of the economy that it ceases to function. The second is that we should set our sights on eliminating the more nefarious consequences of past pollution. This is possible, but only with a realistic and pragmatic approach.

What does a pragmatic approach entail? It means that decisions to clean up sites have to be based on carefully

elaborated, qualitative risk assessments of the whole system. Toxic waste sites, like men, are not all equal. Some are much more noxious and dangerous than others. And small ones can often do more damage than large ones. Resources should be deployed according to the extent to which a given situation poses risks to the community and the environment.

What degree of cleanup is necessary given the future use of the land? A site running over an important groundwater reserve and which is going to be turned into a vegetable farm obviously requires a more thorough cleanup than a site where no groundwater is at risk and where the owner plans to build a parking lot. Determining risk and establishing variable standards linked to subsequent use would eliminate the most dire hazards and save money as well. This is the practice in Britain, and it has considerable merit in the light of the Dutch and American experiences, both of which get hung up on liability, funding and rigid strict standards.

A pragmatic approach to past pollution also means that communities and societies should be prepared to pay for the cleanup themselves if and when the polluter cannot be identified and brought to justice, which unfortunately is most of the time. There is little alternative to paying. Pollution may be a poisoned legacy of reckless progress, but so are poverty, underdevelopment, illiteracy and a host of maladies with which mankind must cope as a result of past wrongs. Living societies have always paid for the sins of the past; and the average person has not much choice over the legacy he inherits.

Every effort should be made to allocate responsibility fairly. Cleanup in Britain and throughout the EC could be funded through direct taxes or surcharges on certain types of consumption and production. I do not, however, think that an across-the-board approach to all sectors of an economy is a fair concept. Some sectors—petrochemicals, autos and so on clearly pollute more and pose greater risks to the environment than others. A fairly conceived environmental surcharge, national trust fund or tax system would have to take account of this.

A lot of pollution was and still is caused by old-fashioned malice and greed; but a lot was caused by a lack of understanding or simple technical incompetence. With the law, public opinion and improved technologies bearing down relentlessly on environmentally unsound business practices, polluting industries are in the twilight of their years. The legacy we pass in need not resemble the one we inherited.

*David Barry*

*World Link, July 1992*





## Book Review

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**Productivity & Growth in Indian Manufacturing** by Isher Judge Ahluwalia. New Delhi, Oxford University Press, 1991.

This book "Productivity & Growth in Indian Manufacturing" is a painstaking research document which addresses fundamental issues so relevant for achieving an efficient economic base in India. Through a study of the past and an analysis of the present economic realities. Isher Ahluwalia provides some rare insights on the development path of Indian industry.

In the fifties India was considered the tenth largest industrial power in the world. This rank has gone down perhaps to 20th position. Why? Ahluwalia's study provides some answers. Analysis and conclusions drawn by the author very effectively and convincingly lead us to accept the need to consider productivity as a resource no less important than capital on which alone our development plans have been based. While our industrial base has become larger, our development model and policies did not aim for productivity, quality, cost reduction in manufacturing etc. We might have lost considerable time in reducing the gap between us and the developed economies. But we can't afford to waste any more in realising that inputs of larger capital and over employment of 'cheep labour' with low levels of productivity do not make an economy internationally competitive.

As a practicing manager I have been a witness to the success of some of the highly viable and financially profitable enterprises with relatively less manpower, high productivity and systems management orientation. I can also recall the disappointments of attending seminars where one after another economists talked of our inability to achieve higher growth rates because of the lack of capital resources or on account of having reached the limits of domestic savings and external borrowings. Even the shift from the so called "Hindu rate of growth" to higher levels during 1980s have rarely been attributed to better productivity levels. Isher Ahluwalia has, therefore made a significant contribution by analysing the data and arriving at an important conclusion about the phenomenon of a

turnaround in the first half of eighties. According to her findings, productivity growth was the dominant source of the acceleration in the growth of value added from 5 per cent per annum during the period of industrial drift" (1965-66 to 1979-80) to 7.5 per cent per annum during the first half of eighties. Apart from comprehensively tabulating interfirm comparisons in manufacturing industries, the book refers to comparisons of India's productivity growth performance with that from other developing countries. This part of Ahluwalia's work is very revealing. It shows that the Far Eastern Tigers and many other economies including Argentina, Chile, Egypt and Indonesia have done much better than India's negative/negligible growth in factor productivity over the two decades of the sixties and the seventies. All these are pointers to our weaknesses and since the comparisons are based on actual data, the conclusions carry weight.

According to her findings, improvement in total factor productivity growth in 80s was largely due to improvements in labour productivity. Further, capital productivity, though showed neither an increase nor decrease, the absence of a decline in itself was important because the earlier record was characterised by a declining trend. At the same time Ahluwalia points to what she calls "another side of the picture which is somewhat disturbing". Correspondingly the trend of employment in the organised manufacturing sector also showed a decline in the first half of the eighties. Though disturbing, it may perhaps be a natural corollary to the challenge of competitiveness and improvements in productivity and efficiency particularly because most of the manufacturing industries in India suffer from over employment. In fact, during the transition period towards globalisation presently being aimed at, we shall have to learn to live with this phenomenon for some period of time. Further there is some sort of a "statistical illusion" in the employment data as also pointed out Ahluwalia. To reduce the cost of conversion of raw materials to a product, the wage element being an important consideration for its competitiveness, good managements resort to shifting from the simpler and more labour intensive operations to a more capital and technology intensive



operations. This at the same time provides them with flexibility in hiring and firing workers which is otherwise not possible in India under the legal restrictions imposed by the Central and State Governments. The study takes in to account the likely effects of the labour market and other domestic distortions. It also takes into consideration the nature of the trade regime and the fiscal regime. All of these policy parameters reinforce the tendency towards a higher capital-labour ratio.

Findings of the study by Isher Ahluwalia are not only important but also timely in the context of the current debate and recent government initiatives to create an environment of "liberalisation" aiming at competitiveness and globalisation of our economy. The knowledge generated by this book should not remain only a subject of discussion among a small number of academics. It should also be debated and absorbed by managers of our economy and our enterprises, politicians and bureaucrats and trade union leaders. It is in this context that organisations like the National Productivity Council can play a vitally important catalytic role in creating a new environment and culture of productivity but for which India will neither globalise nor would the economic standards of its people rise to reasonable levels. I am sure the author would get greater satisfaction in that instead of finely worded book reviews alone.

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**Industrial Relations and Labour Management Consultation : Asian Experiences, Tokyo, Asian Productivity Organisation 1991, 438 p.**

The book under review is a compilation of survey reports collected from eight member countries of Asian Productivity Organisation (APO). The study was commissioned in 1988. About a decade ago (1980), the APO commissioned a similar survey in 10 countries. The rapid and profound changes that occurred in the 1980s justify the second round of survey.

As Nagao Yoshida writes in the Introduction to the volume, "Among Asian countries, three types of governmental attitude towards labour-management relations could be discerned. The first type is seen in a country where, after gaining independence from colonial rule, the government, as part of its nation-building programme, provides

the legal framework which gives the workers the right to organise themselves and to take industrial action. The second type is where the government deliberately suppresses the organisation of labour to ensure that its industrialisation programme is not undermined by industrial unrest. Later, as a result of either political changes or the need for further economic development, the government allows the labour movement to emerge, and pays more attention to workers' interest and aspiration. The third type is where the government adopts a non-interference attitude to management and labour to resolve differences among themselves and to forge new ties of cooperation."

The eight country reports appropriately fit into this typology. The Indian example, along with that of the other erstwhile British colonies, Hong Kong and Pakistan, resembles the first type mentioned above. But, to paraphrase the renowned sociologist, Summer, 'State-ways alone cannot change folk-ways'. Jerome Joseph observes that while there was no dearth of mechanisms for labour-management consultation, those which were in operation were mostly voluntary arrangements while statutory mechanisms remain, by and large, dormant. He notes that centralised, bureaucratic systems do not nurture participative climate and provides evidence to suggest that labour-management consultation is generally seen in operation in firms which report high unionisation rates and low dispute rates. Which means, labour management consultation could often reflect the nature and style of management characterised by open door policy and greater commitment to the concept of participation.

The Korean example, and to an extent even the Thai one, falls into the second category described above while that of Japan and Singapore may belong to the third category. Besides life-time employment and enterprise level unionism, social climate too had been identified to be a major factor supportive of labour management consultation. The Japanese case study raises the dilemma about participation in a period of rapid changes : Consultative processes take time and managers are weary of the costs and consequences of delays in decision-making even if the need for consultation and cooperation is more in a rapidly changing environment. Therefore, it was apprehended that the main factor that could hinder labour management consultation could be the rapidly changing environment than adversarialism due to ideological and other differences.

In Singapore, the nature of labour management has been largely determined, almost driven by the need for coherent and orderly change and compulsions of consen-



sus than confrontation. The consensus-building ethos was fostered by the promotion of tripartite consultation on important issues, reorganisation of trade unions as a social-cum-labour organisation and encouragement to workers participation in plant-level decisions affecting quality and productivity through quality control circles and work excellence committees.

The country report on China too makes interesting reading though one might wonder whether a post-script would have been appropriate to update the picture, post-Beijing massacre. Djang notes that after the cancellation of the 38-year old emergency decree and over all social liberation many "taboos" of the past have been lifted and "workers have become more willing to unite, to negotiate or even to contend to protect their rights. This change in attitude has resulted in numerous labour-management disputes. It appears that majority of workers prefer profit and stock sharing systems to be developed in their plants even though the transition to market economy continues to alude China.

All in all the eight country reports provide interesting insights into a subject that never wanes in its significance. Sociological research points to the need for management to share their power at the workplace, lest they may lose it. And, as Alwin Tofler points out in his recent book, *Power Shift*, "information is power."

There is considerable scope for editing the country reports, whose coverage and quality of presentation is not necessarily uniform. Comprehensive introduction and comparative assessment would have greatly added to the value of this compilation. Notwithstanding this, the book contributes to mutual learning among member countries on labour management consultation, which is a key factor for the good of our organisations and its constituents.

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**Entrepreneurship Development in Public Enterprises**  
Edited by Joseph Prokopenko & Igor Pavlin, *International Center for Public Enterprises in Developing Countries, Management Development Series No. 29, 1991, 208 p.*

In all countries—both developed and developing—public enterprises are going to stay. But in some countries which are ideologically committed to public ownership of enterprises, the public sector has assumed more significance. Ours is a mixed economy wherein both the public

sector and the private sector have their own roles to play. Our Government was making heavy investment in Public Sector enterprises. But unfortunately the performance of Public Sector is not as per the expectations. And recently there has been a move towards privatisation. But there are fears expressed by some experts who envisage that privatisation may lead to concentration of wealth by a few and problems like massive unemployment, underemployment may remain unattended and these may lead to other social problems. So one starts re-thinking and wonders whether there are any possibilities of improvement in the performance of public sector enterprises. The contention of these authors is that it is possible to achieve this. They have also given evidence from some countries wherein some public enterprises have achieved success, even outstanding success. Our planners and policy makers can draw some valuable lessons from this book and try to implement some of these ideas.

The book has an introductory chapter which brings out the reason for the dismal performance of public sector enterprises. They have rightly pointed out that — paternalistic attitudes towards public enterprises, together with absentee ownership, soft budget constraints, weak financial discipline and ineffective reward/punishment systems, a lack of competition — are some of the contributors. The vast resources made available to them provide ample scope for the corruption of the state bureaucracy. Any discerning observer would agree with this diagnosis. The authors then suggest that there is scope for improvement here. Their suggestion is that promotion of entrepreneurship development should be given a high priority in the national policies of countries with large public sectors.

Then the authors have elaborated the concept of 'entrepreneurship. They suggest that entrepreneurship within the public sector will have to take two forms :— (i) the establishment of new enterprises and (ii) entrepreneurship within the public enterprises. They also make a distinction between entrepreneurship and small business. The former is concerned with the act and process of creating a new business and the latter refers to companies already established and in operation. The two are interrelated but different. Good entrepreneurs are not born but made. It is certainly possible to develop entrepreneurial talent. And they would need support and encouragement from the industrial policy. The chapter discusses the details of such a policy.

After this excellent exposition of 'entrepreneurship' and the feasibility of its development the next section



presents seven cases of successful entrepreneurship. These are from the developed countries like U.K. and U.S.A. as well as countries like Czechoslovakia, Yugoslavia, Algeria and India. The case study of the National Small Industries Corporation in our own country can serve as an eye-opener to many sceptical thinkers in our country that our country lacks such talented people and organizations. In the concluding chapter the authors have summarised their conclusions.

The book is useful to our planners and policy makers who can get the relevant message and can implement the ideas.

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**Forestry Resources Management, Tokyo, Asian Productivity Organization, 1991, 364p.**

This book is a compilation of the papers presented at the Symposium on Forestry Resources Management organized by Government of Japan from November 7-14, 1989. The book contains the summary of findings, two reports of the resource persons specially engaged by Asian Productivity Organization (APO) and the country's reports of the Republic of China, Fiji, Hongkong, India, Indonesia, Republic of Korea, Malaysia, Nepal, Pakistan, Philippines and Thailand. These reports have been written by the professionals working in their fields. The data presented in these reports are based on publications of the respective governments. They, therefore, indicate official statistics.

The reports have specially discussed the Social Forestry Projects, their impacts and the directions in which these should be led. The relevant observations of these studies are that "the fuelwood consumption is the major cause of forest degradation and destruction, contributing to over 80 percent of the total roundwood removed from tropical Asian forests. The situation is most critical in South Asia". The second important finding of these studies indicate that "the farm households in South Asia depend on tree fodder and forest grazing to feed their livestock for at least part of the year. The demand for tree fodder can be nearly as great as for fuelwood in parts of the region". The report also points out that "the largest part of forest encroachment is by poor, landless rural families and this has contributed to rapid deforestation". The study also indicates that "few of the expected beneficiaries greet

social forestry programmes with enthusiasm. The Social Forestry programmes designed only to produce fuelwood or to meet the other household needs will rarely succeed. Despite successes in specific areas, social forestry has shown no noticeable deterrence to the massive problem of deforestation and forest degradation. Even where few forests remain, as in most of India and Bangladesh, the forests continue to disappear at an alarming rate. Extensive rural poverty will remain, and the degradation and deforestation will continue as the growing population seeks more farmland, fuel and fodder".

In the Indian context the report states that "the process of desertification in most parts of the country is not an exception but a rule. Indiscriminate felling of trees has caused serious problems of land erosion. The water table is being depleted in most areas at an alarming rate". The report clearly points out the lack of data on the state of land, the planning activity and its monitoring. The forestry research is mostly neglected in the country and is not in tune with latest technological advances to meet the gigantic task of afforestation. Applied research in forestry is lacking. Input of research is very insignificant in terms of men and material. The programme also lacks extension support. The technology developed is not easily transformed to the field. The existing gap in knowledge of the forestry sector has proved to be a serious constraint.

Overall, this is a truthful report on the situation of forestry in the countries covered in the report. The situation is stated to be grim all over. It should be widely read by the professionals, administrators and the general public interested in saving forests and environment.

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**Agricultural Diversification, Tokyo, Asian Productivity Organization, 1991, 446p.**

The Asian Productivity Organization (APO) organized a study meeting on 'Agricultural Diversification' in 1989. In all, there were 24 participants in this study meeting in which 13 country reports and 6 resource papers were presented and discussed. All these papers are documented in this publication.

The agricultural diversification is defined as one of agricultural production, marketing and processing activities from the major cereal sector so that it could contribute



significantly to both, growth and equity, in developing economies. With a view to gain useful insights and draw lessons from the experiences of member countries on agricultural diversification, the objectives of this meeting were to :

- (i) Undertake a general assessment of the current status of agricultural diversification in member countries ;
- (ii) Identify and appraise the major problems and constraints and suggest appropriate measures/approaches towards the effective implementation of diversification programmes; and
- iii) Exchange useful experience and information on the subject among the participants.

The publication highlights the major presentations of resource papers and country reports and the discussions held.

The publication has made a relative comparison of agriculture in member countries on the basis of share of agriculture in GDP and in total exports; employment in agriculture; and growth in agricultural production, etc. These comparisons are based on the statistics provided by member countries in their reports.

The programmes of diversification of agriculture differ in different countries due to difference in agro-climatic and socio-economic conditions. Though these programmes were different, they had the following common objectives :

(i) The need to increase food production and farm income; (ii) Import substitution; (iii) Export orientation; and (iv) Employment generation. Several cases of crop diversification have been given in the country reports. It is, however, interesting to note that Iran, has intensified the efforts to boost the production of wheat, barley and rice and has also promoted the cultivation of fruits (both fresh and dry) and vegetables for export. On the other hand Republic of China and Republic of Korea have diversified into the production of livestock, vegetables and fruits.

The diversification programmes have been supported in the form of prices, tax exemptions and credit subsidies for inputs and outputs. The agricultural cooperatives have played an important role in the distribution of inputs and in the marketing of outputs leading to unprecedented success in the agriculture of Republic of China and the Republic of Korea.

The publication also brings out clearly the following factors which emphasise the need for diversification in agriculture :

- (i) The increasing demand for food and fibre *vis-a-vis* the decreasing area of available arable lands;
- (ii) The need to improve the welfare of farmers;
- (iii) The changing pattern of consumption of agricultural goods;
- (iv) The need to mitigate the effects of fluctuating prices; and
- (v) The need to earn and save foreign exchange.

The potential for diversification in agriculture has also been brought out clearly in the publication. It has been stated that the possibility of this is due to :

- (i) The importance of diversification is recognised by all those who are involved in it, therefore, it has become one of the strategies for development.
- (ii) The technologies for diversification, and the required research and extension systems are available.
- (iii) The efforts are being made to develop and/or improve necessary infra-structural support for it.
- (iv) The export of agricultural products is going to continue as an important item in the member countries for earning foreign exchange.

The country reports also indicate the important problems and issues that are likely to hamper agricultural diversification in different countries. The possible solutions have also been identified in the publication.

The keynote paper provides a historical perspective of agricultural diversification and experiences of Britain, Denmark and Japan. The papers on double cropping of rice and winter cereals, and rice diversification programmes, give details of the experiences of Japan in these two areas. The experiences of livestock production in the context of diversifying agricultural activities in Republic of China are given in detail by Chung PO, in his resource paper. The other two papers have discussed the basic requirements for diversification in terms of alternate crops and cropping systems, and the role of agro-based enterprises in promoting agricultural diversification.

The publication also gives a summary of the open discussion which enlists the issues identified in the discussion. A brief summary of the field studies conducted as a part of the meeting are also presented in the publication.

This publication, on the whole, is very informative and will prove to be a useful reference for policy-makers,



planners and the development agencies concerned with agricultural development in general and agricultural diversification in particular.

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**Effective Business Management** : by N. Gopalswamy,  
*New Delhi, Oxford & IBH, 1991, 718p, Rs. 54.*

"The Book Effective Business Management introduces selected management concepts, management trainings, principles, practices and procedures". This line presented as a theme of the book is of particular interest to Indian business students, and managers at a time when Indian business environment is changing fast not only to complete in the Indian market but also to find a place in the international market.

N. Gopalsamy has tried to bring out in this hand book almost every management function relating to business organisations for developing the personnel, informational and decision making rolls of the business managers. The book is lengthy and complex, which the author believes, is necessary to be of economic value. The set up of the book into key areas (a) General Management & (b) Administrative functions is necessary to classify various management disciplines and procedural aspects of the administration. It appears that in an attempt to cover wide areas, the depth of information and application aspects have not been given due emphasis. Today what business needs, are more specialists rather than generalists having top gross information but no indepth knowledge of a particular subject. Gopalsamy ascerts that his book is an attempt to prepare business managers in their persuit towards corporate objectives more effectively. This objective will not be fully appreciated by the readers of this book. Behavioural implications connected with the effective leadership, motivation and communication need to be dealt in more detail. The book does not include case studies, illustrations and real business problems which probably will be more useful for the practising managers.

In the 17th Chapter of the book, the author deals with Public Sector Management. He has given briefly special features of Public Enterprises, deficiencies and suggestions for improvements. According to the book, "decision making procedures in the government and in the enterprises must be an expeditious profligacy in the capital expenditure must be contained, operational anatomy must be respected, business like procedure for buying and

selling must be promoted and accountability enforced". All these lead to present day topic of privatisation about which the author has not given any reference. The subject is inviting serious public debate these days in the press as well as on the television.

Management of material as given in chapters 130 and 131 of this book covers important areas of changing role of integrated materials concept which is based on a synthesis of various related functions like planning, procurement, store-keeping, inventory control, packaging, transportation, value engineering etc. Coming revolution in materials management suggests that this important activity of business must take into consideration the principle of cooperation more than the principle of competition for developing new supply sources. It should also give more emphasis on developing MIS of its own for bring its contribution to the profit pool of the company. Material function should become more of a profit function and less of a service function.

The author seems blind to the reality of invariant changes due to globalisation, one market world and dramatic decline in the role of central planning. Latest economic policies of the Government of India on liberalisation and announcement by the Reserve Bank of India of fiscal and financial measures also need special mention in the book. Perhaps, scanning of socio-economic environment and establishing trends of change and empowering people to manage the changes are important challenges for the author to incorporate in the book in order to make more useful both for practising managers and teachers of business management in the colleges and universities.

Part 3 of the book covering various aspects of auditing have been given due mention. Chapters on management audit and social audit deserve special appreciation. There is growing appreciation of the total quality management (TQM) and certification of quality under ISO 9000. It might be beyond the scope of this book to describe all the sub-systems of quality management, but a special mention of this subject will give a good coverage of the latest happenings in the manufacturing world. The whole world is seeking change, India should not remain static. We must ask ourselves, when will "made in India" become a system of world class quality through business. We can leave behind a better and stronger India for our future generations.

The book gets worked out with so many concepts which it does not explain in order to present a coherent hypothesis. As a result the nexus which the book seeks to establish between various management functions and managers remain loose and undefined. The author could



have accomplished what he set out to do as he looked on every details of relevant and related functions and worked out how each one will help managers to analyse or reorganise various functions thereby increasing productivity and efficiencies. Conversely the book could have examined the effect of every rationalisation drive on company's performance—economic and non-economic. However, the book had included basic knowledge of the legal provisions, rules frame thereunder and the procedural aspects relating to various functions of management. In that sense the book is a valuable contribution.

The book does break new ground and offers a fresh look at, as otherwise less interesting subject. The simplicity of the book should also prove an asset as many of its intended readers may not be quite comfortable with new changing business environment. The only problem is the text book format in which the volume has been designed making its appearance less than interesting.

Part 3 of the book on accounting is very valuable. Gopalsamy has extended his scope by including accounting and administrative functions like cash and bank balance, purchase and creditors sales and debtors and assets and investments. This definitely will be of valuable use to readers. Chapters on accounting for inflation and cost accounting are also very relevant particularly in the present business context. While talking about functional management, the writer should have taken care of industrial sickness in more details and revival of sick companies—their identification, plan preparation and implementation. Knowledge of these has become far more important these days.

The book is definitely a welcome addition to the sparse literature on effective business management.

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**Sardar Sarovar Project—Promise for Plenty; Edited by Mahesh T. Pathak, New Delhi, Oxford & IBH 1991, 114p, Rs 75.00**

In recent years giant multi-purpose projects like Sardar Sarovar Project [SSP] and Tehri Project in particular have come under adverse criticisms from various quarters—often unjustified. Critics have raised issues because of unhappy experience regarding rehabilitation and resettlement [RAR] at big irrigation projects.

This book is a compilation of five study reports on the Sardar Sarovar Project with a foreword written by Dr. YK Alagh, former member of Planning Commission, who was also the Leader of Narmada Planning Group (NPG) as a reply to the burning issues raised by critics mainly on RAR and environment. SS Mehta, Vidyut Joshi and BB Patel are eminent Professors from Gandhi Labour Institute, Ahmedabad while Prof. B.N. Viswanath is from Centre for Environment Planning and Technology, Ahmedabad and Mr. VM Patel Former Director of Perspective Planning, Govt of Gujarat and Adviser, NPG. All of them were associated as experts with the planning of the SSP under the NPG and their papers give planning details of SSP as formulated in 1982. Mr. Mahesh T. Pathak, Editor of the book is also the Executive Member of the NPG. The book contains wealth of researched information and relevant tables of data on the SSP mainly on RAR, environmental aspects/socio-economic benefits and is indeed very topical. Every critic must read this book to come to terms with the SSP.

Sardar Vallabhbhai Patel mooted the idea of harnessing the Narmada waters in 1946 (hence the name SSP) and since then most elaborate planning, both technological and socio-economic with detailed examination of every conceivable aspect, has been done by many professional research organisations, select international consultants, committees, institutions, tribunals, departments and also the World Bank, the International Financial Agency for the SSP.

The Narmada Valley Project (NVP) is one of the biggest inter-state, multi-purpose river valley project ever undertaken anywhere in the world. It envisages the construction of 30 major dams (10 on the Narmada river and 20 on its tributaries), 35 medium and 3000 minor dams. Two of the biggest dams are :

- (a) Sardar Sarovar Dam across the Narmada river at Kevadia Village in Gujarat State under the SSP and
- (b) Narmada Sagar Dam in Madhya Pradesh under the Narmada Sagar Project (NSP) in Khandawa district.

The execution of the works have been delayed for many reasons including strong opposition from tribal population/other activists. Construction began only in 1987—and the work schedule is lagging by one year even by the revised plans.

SSP promises plenty for Gujarat, Madhya Pradesh, and Maharashtra where shortages of water supplies, particularly in areas of Saurashtra, Kachchh, Banaskan-



tha and certain areas in Rajasthan, arrested all development plans for centuries. The chief beneficiary is Gujarat and the State Govt considers SSP very critical for far-reaching improvements of the State. Technological and socio-economic studies of SSP are by far the most exhaustive ever carried out for such a project. The projected cost/benefit ratio of 1 : 2 is indeed attractive but this is doubted by the critics with cost escalations. The projects, as these are implemented phase-wise, will bring in lot of benefits in terms of augmentation of water, land, hydro-electric power, employment, agriculture including fishery resources upgrading the whole quality of life in these states. Advanced studies have also brought out for the first time in details the penalties that will be arising. These are :-

- (a) Rehabilitation and resettlement of the oustees from the affected villages.
- (b) Environmental effects.
- (c) Waterlogging in low lying areas.

It has rightly been brought out in the book that SSP is not an irrigation project only—it has been conceived and planned as a multi-purpose development project. Central Govt cleared SSP in 1987 subject to adherence to the Forest (Conservation) Act 1980 and the Environment Protection Act, 1986. The project was also cleared by various expert agencies and the World Bank.

The Central Government has directed Project Authorities again to integrate provisions of these Acts during work execution. The book explains the systematic assessment studies that have already been carried out covering all relevant areas for proper controls as follows :-

- (i) Catchment areas treatment
- (ii) Flora and Fauna aspects
- (iii) Health aspects
- (iv) Drainage aspects

The land under submergence at SSP is 1.9% of the land getting water—this is one of the best in the world and better than many other projects in India. Critics claim that the Dam height of 138.68 metres must be lowered to reduce submergence further. Some engineers from a Pune based environmental organisation also think so and they have offered alternate proposals to reduce submergence from 34,860 to 12,720 hectares. This is worth reviewing with due concern. However, the designers argue that it will beat the very purpose of it as then adequate water will not flow into remote draught prone areas.

The most controversial aspect of RAR of about 67,000 oustees/PAPs after a house to house survey was studied in depth by Prof. Vidyut Joshi. However, critics estimated this to be 1.3 lakh persons, over 30,000 of them Adivasis. Prof. Joshi admits RAR to be not a "mere administrative problem but a complex human problem of happy resettlement over wide areas and still retaining the tribal culture". Finance had never been an issue as Gujarat has allocated 316 crores—Rs. 264 crores for Madhya Pradesh, Rs. 24 crores for Maharashtra and Rs. 28 crores for the Gujarat oustees which works out @ Rs. 2.5 lakhs per family and every major son was considered a family unit for RAR. Every major oustee regardless of his land status would be given two hectares of land and subsistence allowance for one year to compensate for the loss of employment. Such a comprehensive rehabilitation policy is the most liberal yet in the Third World.

The book contains only the details as worked out by the NPG in 1982. However, the construction work started late only in 1987 and estimated costs of Rs. 6406 crores are more likely to be staggering Rs. 13,500 crores. The critics have many other apprehensions and they dispute many findings of these studies. The problems and the extent of displacement are grossly underestimated and that secondary displacement has not even been identified, enough land is just not available to resettle all the oustees, World Bank guidelines for RAR grossly violated even in so called resettled families etc. Recent reports say that the World Bank had declined to advance \$ 200 millions to Madhya Pradesh Govt for the Indira Sagar Project (ISP)—the SSP without ISP is worthless. Japan has also withdrawn funding of 2.8 billion yen for the project.

SSP planning studies had envisaged a role of NGOs/voluntary agencies while evolving comprehensive RAR Policy and the World Bank has emphasised the same. No doubt they have helped to achieve the most liberal rehabilitation package so far. Many critics thought these projects as secret and thus even today adequate data are not known to the various agitating groups for meaningful discussions. Thus some unfounded fears are also taking deep roots, particularly amongst the critics and tribals alike. All data have now been promised by the Central Govt to resolve all related issues. State governments also have been advised to do so. Narmada Planning Group has published details of the SSP in a book of 566 page entitled "Narmada Planning Group, Planning for Prosperity; Sardar Sarovar Development Plan, Gandhinagar, NPG, 1989." There are several other publications also on the SSP. These should be made readily available to all critics to resolve the issues through negotiations. The editor should



have on his own added an additional chapter to discuss all these developments/changes taking place to update the five papers written before 1982 as the book is published in 1991.

The present book under review duly updated with all the developments/clarifications to date should in fact be supplied free to all public libraries, institutions etc. for wider understanding and public knowledge. Part of the funds meant for ad agencies will thus be well spent. The printing, get-up and indexing of the book are good. The publishers have done a good work but rather belated!

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**Management of Change through Human Resource Development: Ed. by B.L. Maheshwari & Dharni P. Sinha. New Delhi, Tata Mc Graw-Hill, 1991, p. 303.**

The ultimate goal of an organisation has been defined as survival. Survival as an organisation objective has never been so significant as in the present day environment. The organisations have to learn, to adopt and to transform so as to be able to manage the change effectively. The organisations require to formulate strategies, build systems, bring in technological changes and foster a creative environment amongst its human resource to meet the emerging threats and to capture the new opportunities. It is in this context that human resource development assumes importance. The challenges of change, emerging opportunities and competition can be met through a competent and trained human resource prepared to manage the change.

This forms the theme of deliberations and papers selected for presentation at the Fifth Convention of National HRD Network and compiled in a book form. The organisers identified four major challenges for management of change for the convention. These represent (i) Globalisation, (ii) Growth and Turnaround, (iii) Technological change and (iv) Quality and Productivity for Competitiveness. Each of these challenge themes has been divided into related themes for exploration.

Management of Change : New Responses for Old Challenges by B.L. Maheshwari and Human Resource Development : The Indian Challenge by Dharni P. Sinha set the pace. Maheshwari has made a forceful plea for a 'more rapid adaptation' to the emerging situations. The organisations require innovation, leadership with vision and strategic direction for implementing plans for the

changes. Managers require to be developed to become agents of change, imbibing styles of transformational leadership, shedding various fears and free from the haunting memories of past failures. Dharni P. Sinha recognises HRD as the 'greatest challenge'. He identifies areas of unwillingness to face competition, to improve quality, to export and to prefer buying technology as some of the problems standing in the way of Indian development. HRD in operational terms, as the author rightly points out, means building capability, commitment and culture. The paper is lucid in style, rational in approach and thought provoking.

There are three papers on the theme of Research and Development. Dharni P. Sinha in his paper, referred to earlier, has made critical observations on Indian scientific and R & D establishments having acquired the reputation of 'white elephants' and caught in the brahminical dilemma of 'purity and pollution'. There has been hardly any worthwhile contribution in the fields of development of technology and application of science towards industry or in replacing a technology from abroad. One looked forward to an analysis of this situation and an empirical evidence as to what contributed to the dismal performance in R & D at SAIL and BHEL and S & T in the three papers devoted to each of these organisations and contributed by S.K. Gupta, K.C. Lahiry and Gopal Prasad Mahapatra, A. Sudhakar Menon respectively.

On the theme of labour-management cooperation, five papers have been contributed. Subharao depicts detailed scenario of industrial relations at work at Tata Steel and the work mechanism of various worker involvement programmes. The paper is laced with facts and figures, is analytical and is thorough in all facets. The contribution is recommended to those of the serious minded managers who are open to fresh breeze of rationality and to whom labour unions are not words synonymous with low productivity. Jinnosuke Miyai's is another significant paper which underlines the importance of harmonious labour-management relations in the Japanese Productivity movement. It would surprise many an Indian reader that annual business performance is the 'most widely discussed subject' in the Joint Consultation System of Japan. Suri's paper 'Union-Management Cooperation for Higher Productivity and Technological Changes' is another excellent contribution and presents a case study of consultative mechanism to resolve employee related problems arising out of introduction of technological changes in a large steel enterprise in India. The paper has examined the issues in depth and analysed the implications of measures adopted.



The Paper by Manab Bose and PK Natrajan is only a preliminary attempt on the subject and does not throw enough light as to the methodologies adopted to obtain higher productivity. Khwaja Amjad Saeed's paper lacks in-depth analysis and provides only a theoretical framework to improve productivity.

These are three contributions on the theme of technology transfer. B. Bowonder and T. Miyake's paper is an excellent analysis of technology transfer, problems involved in its absorption, assimilation and diffusion. It brings out the significance, importance and desirability of competence building and organisational development. Citing empirical evidence the authors make one aware of the systematic work carried out at Nippon Steel to build core competence. Nippon's experience in this sphere is one for emulation by many of our organisations which have remained unprepared for this challenge. A fitting contrast is S.R. Jain's paper on experiences at SAIL. When SAIL started its modernisation work in 1989, it found itself in a peculiar situation : it could not recruit people from outside as it had enough manpower within. This peculiar situation arose as SAIL, as an organisation, was unprepared for the technology transfer. Nawaz Sharif's paper on this theme is of a theoretical nature : it details more about the components of technology transfer and less about the role of HRD in bringing about the change. As a matter of fact quite a few of the papers are theoretical in nature and are a departure from the title of the book. M.S.S. Varadan's contribution on ZOPP, S. Prabhala's paper on strategic Alliance, M.V. Subbiah's exploration on family business and Francisco Vilahur's presentation on 'Excellence' fall in this category.

Joseph M. Putti's paper on 'Merger Conflicts' in two MNC's is exploratory in nature and provides interesting insights into conflicts of different cultures, ethos, commu-

nication practices, accounting policies, strategic approaches etc. Many promising managers and engineers suffer the agony of uncertainties arising out of these conflicts. The author has categorised the occurrence of these conflicts at the anticipation, transition and post-merger stages. There is a wide scope of further work in this area.

R.N. Kanungo's paper focuses on the charismatic leadership role of managers in the context of transnational management. One cannot agree with the author that the issue is entirely unexplored. P. Singh and Asha Bhandarkar (Corporate Success and Transformational Leadership. Wiley Eastern, 1990 : refer review in 'Productivity' Oct-Dec 1991) have examined these traits. Nevertheless, the contribution is a good addition on the subject and provides a conceptual framework for further work by researchers.

B.R. Shah's contribution on 'Turnaround Strategies' is interesting. The author has referred to the success story at Andhra Pradesh Paper Mills and states that there existed no discontent amongst workmen over wages and living conditions. One, however, cannot find any explanation for observation as to why 'no attempt to trim the manpower' was made, which was 800 employees surplus. Shah's paper on the same theme also leaves the reader searching for more information and analysis. The author points out that turnaround success at Lipton was achieved by inculcation and nurturing of 'necessary beliefs' in the management team as a first task. What indeed countenanced these beliefs, which were initially missing in the management team of this professional organisation, is not clear.

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# Productivity Management & Analysis : A Select Bibliography\*

- ACHARYA, PROFULLA K : Role of quality circles in productivity movement. *Personnel Today*, April—June, 1991, p33-38.
- ALLISON, PAUL D AND LONG, J SCOTT : Departmental effects on scientific productivity. *American Social Review*, 55(4), Aug 1990, p469-478.
- AMERICAN PRODUCTIVITY & QUALIT CENTER : The master measurement model of employee performance. New York, Site Foundation, 1990, 36p, \$1.5.
- APPA RAO, G V : Productivity Improvements through technological innovation—case of machine tool industry. *Journal of Institute of Public Enterprises*, 13(1), March 1990, p15-37.
- ATTARAN, MOSEN & HAUT, JOHN, : Using economic principles to improve worker productivity. *Information Executive*, 2(3), Summer 1989, p20-25.
- BHADRAYYA, K : Improvement of standards is the key to improve productivity in process industry. *Udyog Pragati*, 14(2-4), April-Dec, 1991, p31-41.
- BHATTACHARYA, BISWA N : Concepts and trends in productivity and effectiveness—A study of Indian banking industry. *Manpower Journal*, 24(4), Jan-Mar., 1989, p1-12.
- BIRD, ALLAN & DUNBAR, ROGER : Getting the job done over there—Improving expatriate productivity. *National Productivity Review*, 19(2), Spring 1991,—145-156.
- BLASI, JOSEPH RAPHAEL : The productivity ramifications of Union buyouts. *National Productivity Review*, 9 (1), Winter 1989/90, p17-34.
- BLUMBERG, DONALD F : Improving productivity in service operations on an international basis. *National Productivity Review*, 10(2), Spring 1991, p167-180.
- BOHLANDER, GEORGE B : Where personnel and productivity meet. *Personnel Administrator*, 33(9), Sept.1988, p122-130.
- BOYETT, JOSEPH H & CONN, HENRY P : Maximum performance management - How to manage and compensate people to meet world competition. Macomb, Glenbridge Publishing, 1988, 323p, \$24.95.
- CAMPBELL, JOHN P : Productivity in organisations. San Francisco, Jossey Bass, 1988, 451p, \$31.95.
- DE BETTIGNIES, CHARLES W : Improving organisation— wide teamwork through gainsharing. *National Productivity Review*, 8(3), Summer 1989, p287-294.
- DRUCKER, PETER F : The emerging theory of manufacturing. *Harvard Business Review*, May-June 1990, p94-102.
- DRUCKER, PETER F : The new productivity challenge. *Harvard Business Review*, Nov-Dec, 1991, p69-79.
- DUPUY, JOHN : Flexible jobs - Key to manufacturing productivity, *Journal of Business Strategy*, 11(3), May-June, 1990, p28-32.
- FUKUDA, RYUJI : CEDAÇ-A tool for continuous systematic improvement. Cambridge, Productivity Press, 1989, 88 p. \$49.95.
- GAYNOR, GERARD H : Achieving the competitive age through integrated technology management. New York, Mc Graw-Hill, 1991, 300p, \$46.50.
- GITLOW, HOWARD S : Planning for quality, productivity and ocmpetitive position. Homewood, Business Ore Irwin, 1990,172p,\$34.95.
- GRANT, REBECCA : Monitoring service workers via computer - The effect on employees, productivity and service. *National Productivity Review*, 8(2), Spring 1989, p101-112.
- GREY, RONALD J: The people side of productivity - Responding to changing employee values. *National Productivity Review*, 9(3), Summer 1990, p301-312.
- HARMON, ROYL & PELERSEN, LEROY D : Reinventing the factory - Productivity break throughs in manufacturing today. New York, Free-press, 1990, 330 p, \$35.

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- HERRICK, NEAL : Joint management and employee participation. San Francisco, Jossey-Bass, 1990, 429, p, \$33.95.
- HILL, F CECIL : Generating ideas that lower costs and boost productivity. *National Productivity Review*, 8(2), Spring 1989, p157-164.
- HOLZER, HARRY J : The determinants of employee productivity and eaning. *Industrial Relations*, 29(3), Fall 1990, p403-422.
- IBIELSKI, DIETER : Productivity must not be inhuman. *National Productivity Review*, 10(2), Spring 1991, p127-128.
- ISLAM, AFM MAFIZUL : Measurement and analysis of labour productivity—The case of cotton textile industry in Bangladesh. *Indian Journal of Industrial Relations*, 26(1), July 1990, p89-99.
- JAPAN HUMAN RELATIONS ASSOCIATION : The idea book - Improvement. Cambridge, Productivity Press, 1988, 217p, \$49.95.
- JHA, HARSH & WAKHLU, BHARAT : Productivity through data-based HRM. *Management Review*, 16(4), 1989-90, p19-22.
- KANG, T W: Gaishi - The foreign company in Japan. New York, Basic Books, 1990, 279p, \$19.95.
- KARASEK, ROBERT & THEDRELL, TORES : Healthy work : Stress, productivity and the reconstruction of working life. New York, Basic Books, 1990, 381, \$29.95.
- KHADEM, RIAZ : One page management : A unified approach to productivity. *National Productivity Review*, 8(1), Winter 1982/89, p45-58.
- KONRAD, ALISON M & PEEFFER, JEFFREY : Do you get what you deserve? Factors affecting the relationship between productivity and pay. *Admn. Science Quarterly*, 35(2), June 1990, p258-285.
- KUMAR, PARMOD : Machiavellinism, productivity and ingratiation among workers. *Management Labour Studies*, 16(1), Jan 1991, p33-39.
- LERSON, JAMES RJR & CALLAHAN, CHRISTINE : Performance monitoring—How it affects work productivity. *Journal of Applied Psychology*, 75(5), Oct 1990, p530-538.
- LAURIE, DENNIS : Yankee Samurai and the productivity of Japanese firms in the United States. *National Productivity Review*, 9(2), Spring 1990, p131-140.
- LINK, FRANZ JOSEF & FROHLICH, HANS-PETER : East Germany's race for productivity growth. *National Productivity Review*, 11(1), winter 1991/92, p113-124.
- MARTINEZ, MICHELLE NEELY : In search of a productive design. *HR Magazine*, 35(2), Feb.1990, p36-39.
- MASKELL, BRIAN, H : Performance measurement for world class manufacturing : A model for American Companies. Cambridge, Productivity Press, 1991, 389p, \$45.
- MASSIMILIAN, RICHARD D : Back from the future - Gearing up for the productivity challenge. *Management Review*, 79(2), Feb.1990, p41-43.
- MERLI, GIORGIO : Total manufacturing management - Production organisation for the 1990's Cambridge, Productivity Press, 1990, 348p, \$39.95.
- NAKAJIMA, SEIICHI : Introduction to TPM. Cambridge, Productivity Press, 1988, 129p, \$39.95.
- NEIZER, NORMAN : The Arthur D.Little forecast on information technology productivity, NY, John Wiley, 1991, 272p, \$32.95.
- NOMIKOS, GEORGE E : Managing knowledge workers for productivity. *National Productivity Review*, 8(2), Spring, 1989, p165-174.
- OSHRY, BARRY : Finding and using a manager's power to improve productivity. *National Productivity Review*, 10(1), Winter 1990/91, p19-34.
- PORTER, MICHAEL E : The competitive advantage of nations. New York, Free Press, 1990, 855p, \$35.
- PRITCHARD, RD : Measuring and improving organization productivity - A practical guide. New York, Praeger Press, 1990.
- PRITCHARD, ROBERT D : Measuring organisational Productivity with Promisc. *National Productivity Review*, 9(3), Summer 1990, p257-272.
- PRITCHARD, RD : The effects of feedback, goal setting and incentives on organisational productivity. *Journal of Applied Psychology Monograph Series*, 73(2), 1988, p337-368.
- PRITCHARD, RD : The évaluation of an integrated approach to measuring organisational productivity. *Personnel Psychology*, 42(1), 1989, p69-115.
- PRYOR, LAWRENCE S : Benchmarking - A Self-improvement strategy. *Journal of Business Strategy*, 10(6), Nov.12, 1989, p28-32.



PSAROUTHAKIS, JOHN : Better makes us best. Cambridge, Productivity Press, 1989, 79 p, \$16.95.

QUICK, THOMAS L : Managing for peak performance. New York, Executive Enterprises, 1990, 380p, \$59-95.

RAO, K CHANDRA SEKHARA : Productivity and operating efficiency in public enterprises - A study. Prejanan, 9(1), Jan-March 1990, p5-29.

REID, PETER C : Well made in America. New York, Mc Graw-Hill, 1989, 226p, \$19.95.

RIVEST, GERALD : Make your business more competitive. CMA magazine. May 1991, p16-19.

ROBSON, ROSS E : The quality and productivity equation - American corporate strategies for the 1990s. Cambridge, Productivity Press, 1990, 338p, \$29.95.

ROSENBAUM, MARK : Partner in productivity consensus in labour - management relations : National Productivity Review, 8(4), Autumn 1989, p337-364.

ROTH, PHILIP P : Implementing feedback system to enhance productivity. National Productivity Review, 10(1), Winter 1990/91, p57-68.

SANDY, WILLIAM : Forging the productivity partnership. New York, Mc Graw-Hill, 1990, 224p, \$19.95.

SHETTY, YK & BUECHLER, VERNON M : Competing through productivity and quality. Cambridge, Productivity Press, 1988, 527p, \$39.95.

SHETTY, YK & BUECHLER, VERNON M : The quest for competitiveness - Lessons from America's productivity and quality leaders. Westport, Quorum Books, 1991, 448p, \$45.

SINK, D SCOTT : Planning and measurement in your organization of the future. Norcross, Industrial Engineering and Management Press, 1989, 331p, \$46.25.

STITT, JOHN : Managing for excellence - A systematic and holistic analysis of the process of quality and productivity improvement. New York, Quality Press Quality Resources, 1990, 222p, \$35.95.

SURI, GK & AKHTAR, SYED : Quality of worklife and productivity. New Delhi, National Productivity Council, 1991, 429p.

SURI, GK & KUMAR, JAGDISH : In search of productivity. New Delhi, National Productivity Council, 1989, 206p.

SURI, GK & MONGA, RC : Linking wages with productivity. New Delhi. National Productivity Council, 1989, 247p.

TAKAHASHI, YOSHIKAZU & TAKO OSADA, TAKASHI : TPM - Total productive maintenance. Tokyo, Asian Productivity Organisation. 1990, 336p, \$46.

THOR, CARL G : Getting the most from productivity statistics. National Productivity Review. 9(4), Autumn 1990, p457-466.

TIMPE, DALE : Productivity - The art and science of business management. New York, Facts on File, 1989, 371p, \$27.95.

TOWE, LEE A : Survey finds employees involvement a priority for necessary innovation. National Productivity Review, 9(1), Winter 1989/90, p3-16.

VARNEY, GLENN H : Building productive teams. San Francisco, Jossey-Bass, 1989, 150p, \$20-95.

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