Special Report

Benchmarking in India: A Survey

NPC-IFC Group

The present survey is the first of its kind to profile the perception of Indian management about the application of interfirm comparison and benchmarking. The paper enumerates the major findings of the study. No attempt has been made to provide any interpretation of the results, except the obvious ones.

NPC-IFC Group was established by the National Productivity Council, in 1990 to implement an Indo-German technical cooperation project on Interfirm Comparison. The Group consists of S.N. Nandi, Director and Team Leader, R. Welter, German Coordinator, C.V. Rao, Director, C. Ravindran, P.V.S.P Prakasham, V.V. Murthy & N.R. Beura, all Assistant Directors

Benchmarking is learning by comparison. The earlier strategy of Interfirm Comparison which was introduced in 1960's covers measurement and comparison of overall business results in terms of financial performance. But the increasing emphasis on improvement and innovation as an emerging strategy for achieving sustainable competitive advantage necessitated a search to develop and promote evaluation and comparison of process performance measures (Nandi, 1993). This led to three kinds of benchmarking:

- Product benchmarking
- Process benchmarking
- Strategic benchmarking

Product benchmarking compares competing products and services on 'attribute by attribute' basis thus identifying important aspects of a product and the associated process or function to be improved upon. It is more than 'Reverse Engineering'. It covers all the aspects of products, services and corporate/brand images that have influence on customers' buying decisions.

Process benchmarking essentially compares work practices among analogue work processes and facilitates introducing best practices in critical work processes.

Process benchmarking essentially compares work practices among analogue work processes and facilitates introducing best practices in critical work processes. Xerox Corporation, USA has been the pioneer in introducing process benchmarking, which enabled them to not only turn around but also increase their market share at a faster rate. This comparison goes beyond the industry boundary. A classical example of this approach is how Xerox improved its delivery performance by studing L.L.

Bean, a catalogue mail order company and noted leader in logistics and delivery performance, rather than analysing its competitors.

Strategic benchmarking operates at the business unit level. It is by concentrating on business units that valuable comparisons can be made across private and public sectors and national boundaries. Keeping in view the market characteristics, existing competitive position and value adding structure, it compares performance of a specific business unit with a simulated business and/or strategic peer having the same strategic characteristics. The latter is worked out on the basis of a complex business model and real time data of 3000 businesses. This approach was developed by Strategic Planning Institute, USA and subsequently promoted by PIMS (Profit Impact of Market Strategy) Associate Inc.. PIMS approach has been found to be considerably useful in strategic planning especially for business portfolio analysis. Consultancy studies by PIMS show that strategic benchmarking is very effective in evolving the strategic changes which can reposition the business to win. One of the recent cases relates to a "turn-around" planning process in a printing and publishing company in Germany. A Key step in this turn around process was a strategic audit of 70 business units. PIMS was used to evaluate the potential of each unit; based on this evaluation, action programmes were developed and carried out. Within 3 years, the group's profitability improved dramatically.

Depending upon the requirements of the individual organisations, benchmarking of any kind could be undertaken. Infact benchmarking could be a very practical tool for a continuous improvement process within the total quality management revolution.

As benchmarking is at the infancy stage in Indian industry, it connotes different meanings and entails application of different methods. The existing usage of benchmarking concept ranges from Interfirm Comparison based on financial ratios through product comparison, process comparison to strategic comparison. To evolve an appropriate strategy for proper implementation of benchmarking in this context, NPC-IFC Group undertook a survey on benchmarking in India during the last quarter of 1993.

Survey Methodology

The approach was based on a mailed questionnaire survey followed by interaction through personal discussion in a limited number of cases. A questionnaire was sent to 600 leading organistions in India. A total of 70 organisations responded to the survey, which constitutes a 11 per cent response rate.

Of the survey participants, almost all belong to large companies. The questionnaire was filled in by senior management personnel belonging to TQM, Finance and Corporate Management areas.

Industries represented are Electronics/Computer, Auto Components, Automobiles, Machine Tools, Basic metals, Fertilizers & Chemical including Pharmaceuticals, Paper, Sugar etc. Textiles, Refineries, Finance, and other Engineering Industries. A list of participating companies is given in the Appendix.

Major Findings

Increasing Attention on Total Quality Management

As a result of increasing competitiveness both in domestic and foreign markets, Indian organisations have taken many initiatives to bring about new management thinking based on Total Quality Management (TQM). More than 84 per cent organisations have already initiated steps towards total quality management. However, there have been differences in the emphasis on various aspects of TQM. Distribution of initiatives of various organisations is given in Fig. 1. Introduction of Quality Assurance through ISO 9000 is the most popular approach towards TQM, followed by continuous improvement programmes. Measurement and comparison of

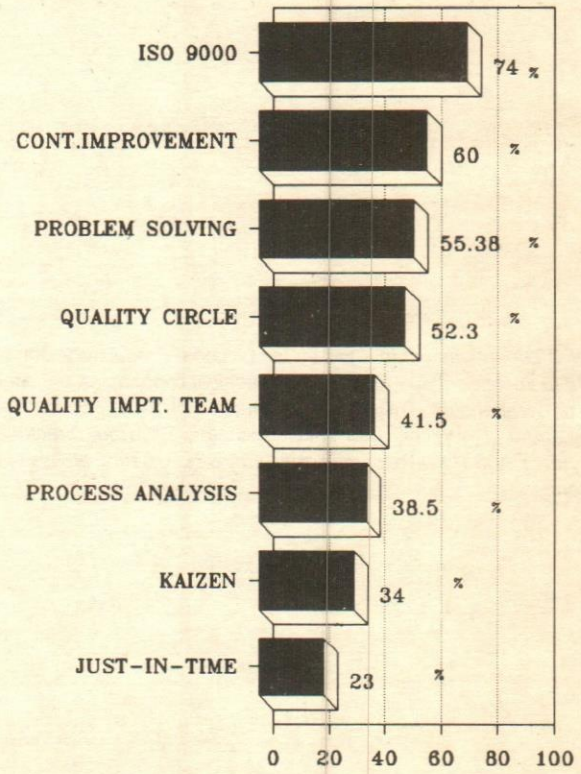

Fig. 1. Organisations involved in various TQM activities.

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Comprehensive Performance results comparison

About 60 per cent of Indian organisations are at present carrying out Interfirm Comparison in one way or the other. However they consider that all the three aspects i.e. financial, marketing and operational performance results should be covered during such comparisons. Among operational aspects the top priority is on measurement and comparison of productivity and innovativeness. (Fig. 2).

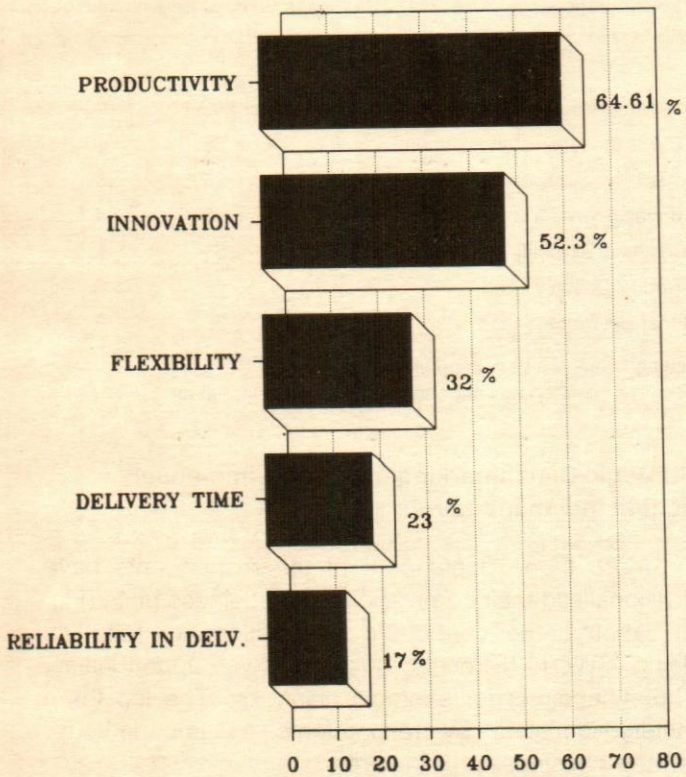

Fig. 2. Priorities in areas of operational performance for measurement and Comparison.

Overall Customer Perception about Products & Services

Around 80 per cent of the respondents claim that they capture the customer's perception about their products and services against their competitors (Fig 3). However what they are actually capturing and comparing has been found to be the perception mostly in terms of overall product/service features, price and corporate image rather than the details (Table 1). The existing practices of comparison are mostly aimed at facilitating the formulation of appropriate marketing approaches. This kind of a limited perception analysis is nor sufficient for formulating detailed action plan for improving quality of product/services. Moreover, this is also inadequate for identification of critical activities for Process benchmarking.

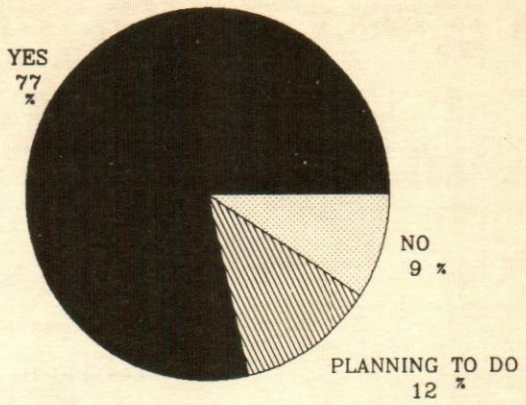

Fig. 3. Customer's Perception comparison

Table 1: Features for Comparison

Item	Mean	Always Considered
Price	2.62	79%
Overall product feature	2.59	78%
Corporate image	2.34	63%
Overall service feature	2.08	57%
Detailed product feature	2.05	46%
Promotional activities	1.99	40%
Detailed service feature	1.64	34%

Rating Scale: 3: Always considered, 2: considered sometimes
1: Plan to consider 0: No Idea.

Process Benchmarking — Diversity in Areas of Application

Only 20 per cent of the participants are at present doing process benchmarking. More than 40 per cent have plans to do so in the near future (Fig. 4)

However, there is considerable difference in the area of application. There are also variations in the units of benchmarking, as some of the organisations use performance activities while some others use performance results as the basis for benchmarking. Among the performance activities benchmarked, the most common ones are:

- Manufacturing operations

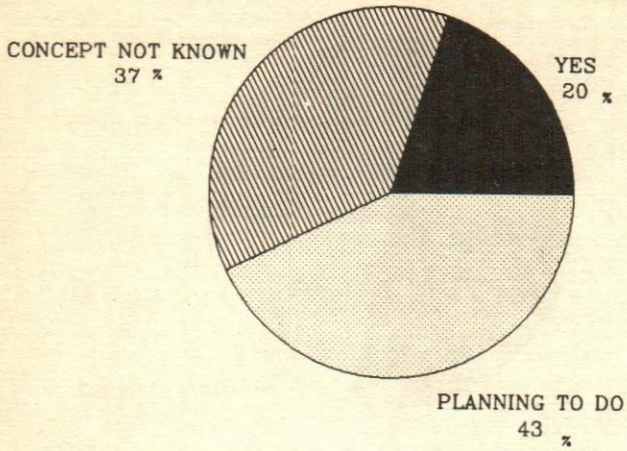

Fig. 4. Present use of process benchmarking

- Marketing
- Outbound logistics

In case of performance results, the most common parameters benchmarked are:

- Manpower Productivity
- Energy Productivity
- Machine Productivity

Similarly the top three parameters which the organisations desire to benchmark are:

- Machine Productivity
- Energy Productivity
- Materials Productivity

As found in western countries, the most common areas of benchmarking are those which are the direct sources of competitive advantage. Some of the typical ones are;

- Customer services/Customer satisfaction
- Employee empowerment/Employee satisfaction
- New product development/Time to market

This is in contrast with the situation prevailing in Indian organisations as already observed.

Another noteworthy observation relating to process benchmarking has been that more than 90 per cent of the respondents carry out or are planning to carry out process level comparisons only within their own industries.

Factors Promoting Process Benchmarking

Top management commitment, Customer services, Management awareness, Product delivery time and Financial performance are the factors encouraging firms to introduce process benchmarking in their organisations. As seen in table 2, 85 per cent of the respondents consider that top management commitment is the most important driving force for the organisation to benchmark. As per the survey conducted by American Productivity & Quality Centre (1992), among US companies, it was found that top management commitment, desire for better customer service, financial performance, product development cycle and delivery time are the driving factors encouraging firms to benchmark.

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Table 2: Importance of Factors in Promoting Process Benchmarking

Factors	Mean	Very important (%)	Not important at all (%)
Top Management Commitment	5.6	85	2
Customer Service	5.2	75	5
Management Awareness	4.9	60	4
Customer's Quality Awareness	4.7	51	5
Product Delivery Time	4.7	54	3
Financial Performance	4.7	55	9

Rating Scale: 6 = Very important, 4 = important
2 = Less Important, 0 = Not important at all

Strategic Benchmarking could now immensely benefit Indian industries

More than 70 per cent of the respondents have divisionalised their corporations into business units (Fig. 5). About 85 per cent of the organisations are regularly doing SWOT (Strength, Weaknesses, Opportunities, Threat) analysis for strategic planning. The top three factors identified by respondents as important for strategic business profiling are:

- Quality — 6.14 *
- Technology — 5.94 *
- Profitability — 5.80 *

(* measured in 0 to 7 scale, 7 being the most important one)

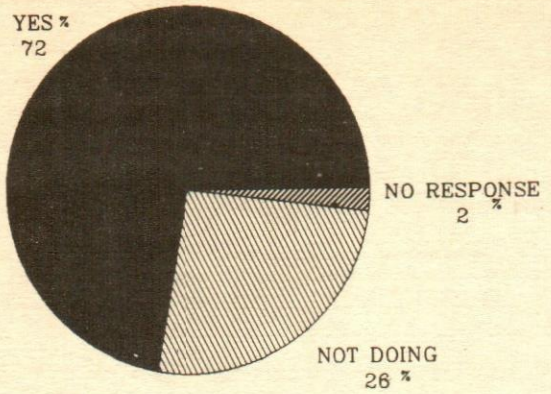

Fig. 5. Divisionalisation of the Company

These observations indicate that strategic thinking has permeated into many Indian organisations contrary to functional line thinking believed to have been dominant till now. However, the factors identified relate to 'product domain', thus showing a concern for the development of the firm's internal technological strength in response to prevalent market conditions. It is now high time that Indian organisations look both 'in' and 'out' in order to build up sustainable competitive advantage. Strategic benchmarking could be a very important tool for an objective analysis of strengths and weaknesses.

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Interest in PIMS Approach

About 50 per cent participants have been aware of PIMS (Profit Impact of Market Strategy), a wholly owned subsidiary of Strategic Planning Institute, USA. Almost all of them consider the approach of PIMS as suitable for Indian Business to carry out portfolio evaluation. Fig. 6 shows the distribution of responses. The respondents believe that the PIMS approach of benchmarking could help in strategic planning to become globally competitive as the PIMS databank maintains strategic information for 3000 business units spread over many countries. (Fig. 7). This is also evident from the fact that nearly 80 per cent of the respondents have shown interest to be compared globally. (Fig. 8)

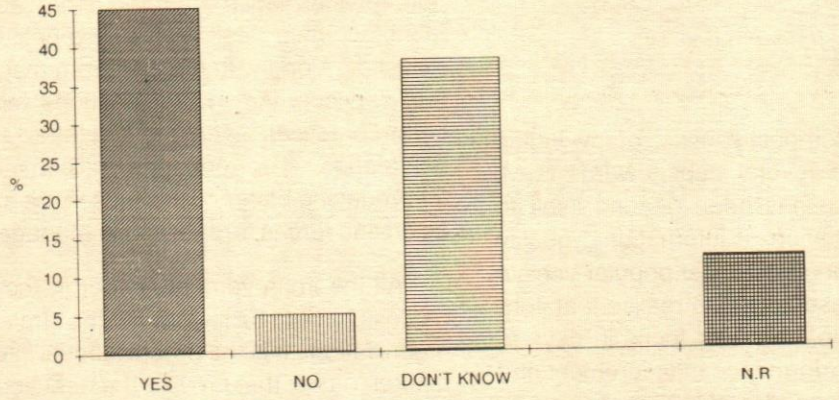

Fig. 6 Approach of PIMS suitable for business units in India.

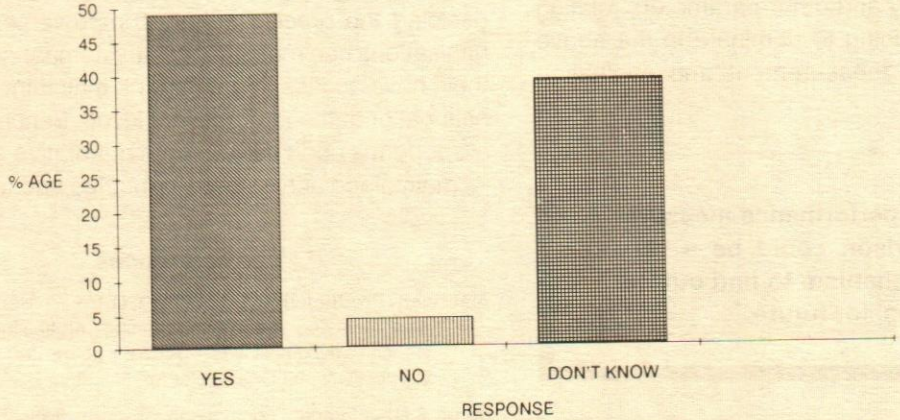

Fig. 7 Information from the PIMS databank helps in strategic planning.

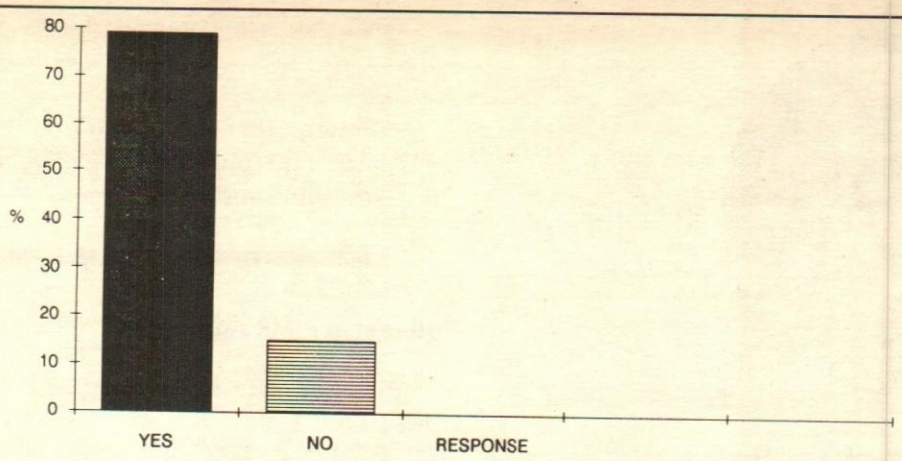

Fig. 8 Want to compare with international business units.

Database — The most important requirement in Benchmarking

Majority of the participants have perceived that maintenance of a database is highly essential for the success of Process Benchmarking and Interfirm Comparison.

Benchmarking Tool	Importance of Database*
Interfirm Comparison	3.16
Process Benchmarking	2.77

*Measured in the scale of 1 to 4, 4 rating very important

Conclusion

In order to increase competitiveness, many Indian organisations have initiated several steps towards TQM. Indian industry, as a whole has been gearing itself to accept changes and adaptation of international quality assurance standards has been the most popular vehicle to do so. But Indian organisations also realise that continuous improvement will be the major focus in days to come. A comprehensive performance measurement and comparison could be a very good tracking mechanism to find out the gap and set the goal for future. Productivity, Innovativeness, Flexibility and other parameters relating to competitiveness are going to dominate in the above mentioned performance measurement and evaluation system.

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Competition is, after all, to be tracked at the market place. Products and services as perceived by customers are the prime determinants of competition. It is not the price alone, but all the attributes of products and services which will draw the attention of customers. An organisation therefore is required to strive continuously for improving one attribute or the other. This customer-perceived-quality is yet to be fully realised by Indian organisations.

Indian manufacturers are still very much occupied with core manufacturing aspects. The importance of support services which are to be improved in order to make manufacturing itself more competitive is yet to be realised. Along with the shift from manufacturing to support services, Indian organisations will have to look for better practices even beyond their individual industry boundaries. Top management commitment and desire for producing better customer service are expected to act as driving forces for the shift in managerial priorities.

All the improvements either in the product or in the process have to be linked with the strategic aspects of the organisation. It is the organisation's internal strength and market forces, that provide the direction for improvement of products or processes. Therefore strategic evaluation based on an objective data base could be helpful in deciding the precise areas of improvement. Indian organisations can make necessary comparisons only when they have access to a databank maintained either at the national or at the international level. Benchmarking, after all, depends upon data — both quantative and qualitative — maintained across both industries and functions.

References

American Productivity & Quality Centre — Surveying industry's Benchmarking practices: Planning, organising and managing Benchmarking activities — A user's guide, 2nd Edition, American Productivity and Quality Centre, Houston, USA, 1992.

Nandi S.N. — Interfirm comparison for Productivity Improvement, APO Productivity journal, Spring issue, Asian Productivity Organisation, Tokyo, 1993.

Appendix : Survey Participants

Aruna Sugar & Enterprises Ltd.	Mahindra & Mahindra Ltd.
Ashok Leyland Finance Ltd.	Modi Xerox Ltd.
Automobile Corporation of Goa Ltd.	Munjal Showa Ltd.
Bannari Amman Sugars Ltd.	National Organic Chemicals Industries Ltd.
Bharat Electronics Ltd.	Nicco Corporation LTd.
Boots Pharmaceuticals Ltd.	Orient Syntex Ltd.
Burroughs Wellcome (India) Ltd.	Oriental Hotels Ltd.
Castrol (India) Ltd.	Parke Davis (India) Ltd
Cochin Refineries Ltd	Pearl Polymers Ltd.
Crompton Greaves Ltd.	Perfect Cycle Victor Ltd.
DCM Shriram Industries	Premier Auto Electric Ltd.
Digital Equipment (India) Ltd.	Rajendra Steels Ltd.
Facit Asia Ltd.	Ruby Mills Ltd.
German Remedies Ltd.	Seshasayee Paper & Boards Ltd.
Godavari Fertilizers & Chemicals Ltd.	Shree Rajasthan Syntex Ltd.
Greaves Ltd.	Sirpur Paper Mills Ltd.
Gujarat Propack Ltd.	Sona Stebzings Systems Ltd.
Gujrat Heavy Chemicals Ltd.	Special Steels Ltd.
Harrisons Malayam Ltd.	Standar Batteries Ltd.
Hero Hona Motors Ltd.	Straw products Ltd, J.K. Paper
Hindustan Dorr-Oliver Ltd.	Straw Products Ltd, Lakshmi Cement
Hindustan Photo films Manufactures Co. Ltd.	Sudarshan Chemicals Industries Ltd.
Housing Development Finance Corp. Ltd.	Sundaram Abex Ltd.
India Glycol Ltd.	Tamilnadu Petro Products Ltd.
Indian Aluminium Company Ltd.	Tata Robins Fraser Ltd.
Indian Rayons & Industries Ltd.	Textool Company Ltd.
Indo-Gulf Fertilizer & Chemicals Ltd.	The Manik Lal Harilal Mills Ltd.
Ion Exchange (India) Ltd.	The Tata Iron & Steel Company Ltd.
Ipitata Sponge Iron Ltd	Triveni Engg. Works Ltd.
ITC Bhadrachalam Paper Boards Ltd	Universal Cables Ltd
Jain Group of Industries	Usha Martin Industries Ltd
Jay Shree Tea & Industries Ltd	Voltas Ltd
Khaitan Hostombe spinels Ltd	W.S. Industries (India) Ltd
Kiloskar Pneumatics Company Ltd	West Coast Paper Mills Ltd
Larsen & Tourbo Ltd	Widia (India) Ltd

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"I believe that at the end of the century... general, educated opinion will have altered so much that one will be able to speak of machines thinking without expecting to be contradicted."

— *Alan Turing*, 1950

Special Report

'Kyosei' with Asia: Japanese Corporate Strategy towards the 21st Century

Eiji Ogawa

In the existing climate of open trade policies, corporate strategies assume great significance. The author elaborates on the Toyota production system and presents the various strategies relevant to the Indian industry in the present day context.

Eiji Ogawa is Professor in Nagoya University, Japan. Paper presented at the APO-MITI-JPC Top Management Forum on the same subject; Feb. 28-March 4, 1994.

After the Second World War Japan recovered quickly and achieved high economic growth joining the band of leaders. Since 1991, however, the Japanese industry has suffered serious economic recession triggered off by the burst of the bubble economy. Various macro-level measures taken for economic recovery have yet to show desirable effects due partly to the policy priority shifted to the political reform. However, the economic restructuring, which has appeared successful in the USA, has also shown positive initial effects upon the Japanese industry and economic recovery is expected to be in the offing in a couple of years.

Several reasons can be cited to support this somewhat optimistic view. First, the Japanese workers possess a high degree of educational qualifications and are well disciplined and highly skilled. Secondly, consumers have still maintained a high propensity to saving and hence their financial liabilities are relatively low. Fiscal deficits of the government are not so large. Thirdly, Japanese manufacturing industries practise sophisticated technologies in downsizing, automation, and quality control. Fourthly, the total R & D expenditures are still high although they have recently shown a downward trend. And fifthly, the trade surplus with Asian countries, which have shown a dynamic economic growth, has been expanding to the level of 120 billion US dollars (Business Week, 1993.)

Japan's foreign direct investment in Asia has also been growing rapidly and products made in Asia — notably textiles and apparel goods — have been reimported to Japan. Training courses and seminars have been conducted by many organizations in Japan with a view to accelerating transfer of technology and managerial skills. Linkages with Asia are not limited to economic activities but have been expanded to university education. Many students from other parts of Asia have

joined Japanese universities to obtain Masters and PHds particularly in the departments of engineering.

The basics of Japanese business management have been under review. In Japan, firms are not considered as machines which simply raise profits but as human-based organizations. Labour management relations, team work and workplace-first management have eliminated class distinction so that president and new employees become equal partners in the organization. The Toyota group which created the Toyota production system represents such an organization.

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Toyota Production System

The Toyota production system started with the introduction of the marketing technology of supermarkets in the USA in the 1950s, but its original concept was developed by Kiichiro Toyota who was the first president of Toyota Motor Corporation. The idea was to supplement items to the extent they are sold just like goods in the supermarket. This is the famous 'pull system' whereby parts, components, and products are made in exact correspondence with the requirement — the pull by the subsequent production process. This is order-made production and shows a remarkable contrast with the estimated production which is directed by the push of the previous production process. The 'limited volume of production' or production upon order is a characteristic of the Toyota production system.

This system does not allow an excess inventory and attempts to reduce lot size, desirably to the level of a single unit. Production system characterised by smooth flow and without stoppage is the most ideal — therefore it is far from easy to undertake a small lot or single unit production from the viewpoint of production technology. When set-up time is longer in processing and assembling different types of parts it reduces the operating ratio. Hence set-up time should be to make a small lot production economically viable. For instance, Toyota has developed the technology change moulds within ten minutes — this is the 'single digit of set-up time' in press processing. This technology has been applied successfully even to the 2,000 ton pressing machine by which small lot production was economically realized. Now this knowhow has been adopted throughout the world.

Now that mixed production of various kinds of parts and products in small lots upon order has become technically and economically feasible, the lead time from the receipt of orders to the completion of parts and components has been radically reduced. This is called the 'smoothing out - *heijunka production* which aims at the immediate implementation of small lot production thereby ultimately reducing the inventory to the minimum possible.

The Toyota production system aims at small lot production of a large variety of products by achieving high quality, low defect rate, low production cost, and reliable and short production period. These objectives can be realized simultaneously by removing all kinds of wastes which arise from excess production, excess inventory, unnecessary transport, correction of wrong actions, unnecessary motion, long waiting, and lack of coordination among production processes. Wastes can be removed by applying three methods; just-in-time, *jodohka*, and use of standard operations (Toyota Motor Corporation, 1991).

The Toyota production system aims at small lot production of a large variety of products by achieving high quality, low defect rate, low production cost, and reliable and short production period.

Just-in-time (JIT) can be realized through the implementation of the pull system, smoothing-out or leveled production, and continuous flow processing. JIT contributes to eliminate wastes arising from excess production, excess inventory, and unnecessary transport *Kanban* is used as a means to implement the 'pull system' in a rigorous manner. *Jidohka* is an automatic shut-down mechanism of production process which is controlled either by machine or by man to remove defects immediately. This mechanism eliminates the possibilities of further processing of defective parts and products or taking unnecessary actions for correcting them.

Standard operations are decided by the person in charge of the workplace upon advice of senior workers making it possible to remove wastes arising from unnecessary motion, long waiting, and unnecessary production process. However, the standard operations

are treated not as fixed but a flexible target to challenge. They are improved by incorporating new and creative ideas of all workers. Persons in charge of the workplace train and motivate workers to actively participate in this exercise.

The Toyota production system is thus an engineering methodology based upon JIT and *Jidohka* and at the same time an organizational or team movement in search of continuous improvement (*kaizen*).

'Kyosei' with Asia

The production of passenger cars and trucks in Thailand in 1964 was Toyota's first encounter with Asian countries, and by the end of 1992 its activities have been expanded to cover five Asian countries including Malaysia, Indonesia, the Philippines, Thailand, and Taiwan where more than 12,000 workers are employed. Toyota's investment in Asian countries has contributed to promoting the transfer of manufacturing technology and managerial skills. Local supporting industries that provide parts and components to Toyota's subsidiaries have been developed rapidly under the guidance of Toyota. Efforts have been made to develop trainers among the local staff who could promote and lead the *kaizen* movement. For this purpose emphasis has been laid on the training of workers in production skills, production management, maintenance, and workplace management. In the long run, it will be most desirable if product design can also be undertaken locally. For instance, P.T. Toyota-Astra of Indonesia has developed successfully a new model called '*Kijang*' which is appropriate to its local environment. Technology transfer does not complete its mission once it reaches the stage of R & D. In addition to the transfer of manufacturing technology, it is necessary to transfer managerial skills to strengthen the capabilities of top and middle management in the field of corporate strategies and policies, organizational design, personnel appraisal, etc.

Toyota's investment in Asian countries has contributed to promoting the transfer of manufacturing technology and managerial skills.

Toyota's philosophy and vision established in January 1992 is based on the following principles of ***kyosei*** through technology transfer with a view to becoming a good corporate citizen in the global society:

- Be a company of the world.
- Serve the greater good of people everywhere by devoting attention to safety and to the environment.
- Assert leadership in technology and in customer satisfaction.
- Become a contributing member of the community in every nation.
- Foster a corporate culture that honours individuality while promoting teamwork.
- Pursue continuing growth through efficient, global management.
- Build lasting relationships with business partners around the world.

(Toyota Motor Corporation, 1992)

Management of Change

The Toyota production system is a continuous *kaizen* movement. One of its prominent features being the 'management of change'. The changes started with minor improvements at workplace which were subsequently developed into large-scale process innovations or product developments. The *kaizen* movement at workplace started with the ideas and suggestions for improving daily operations. In many cases, it was the team leader who brought out new ideas and all workers in his team followed suit by making proposals for *kaizen*. Higher productivity through *kaizen* resulted in the reduction of workers, but without adversely affecting the productivity of daily operations. More often it was the team leader who shifted to other workplace since he needed different experiences at different workplaces to become a manager.

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With the passage of time, when new ideas and suggestions for *kaizen* were exhausted, industrial engineers were invited for advisory services in overcoming the status quo. The scope of *kaizen* thus expanded to influence the entire production process. Furthermore these

efforts triggered process renovations. The number of participants in the *kaizen* movement were increased while the scale of change was also enlarged. Large-scale improvement of process itself could also be undertaken by modifying the design of parts.

While carrying on *kaizen* activities geared for production process, when the team members faced another wall to break, product designers took part in the movement to modify the specifications of the product design. This necessitated the change of production processes and consequently manufacturing operations. These changes further generated new ideas for *kaizen* at different levels of organization.

In summing up, Toyota started with *kaizen* at workplace. The success at this stage was followed by another *kaizen* at the whole production process and parts-making by involving IE engineers. Once the speed of *kaizen* for QCD tapered off at the second stage, a new challenge was made for the improvement of products themselves. This was the last stage of *kaizen*. The idea running through this exercise was the need to incorporate the concept of QCD (Quality-Cost-Delivery) from the very beginning of the design stage (Fig. 1).

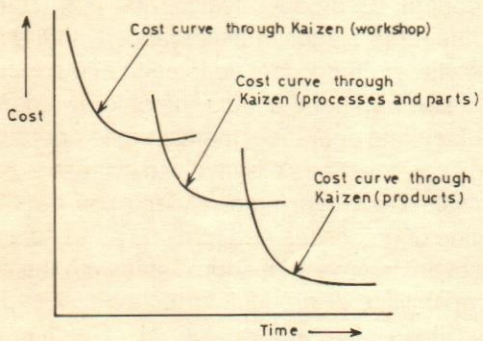

Fig. 1. Shift of Cost Reduction through the Toyota Production System

Response to changes in the Toyota production system started with minor changes at workplace which was enlarged to generate large-scale changes affecting product design or products per se. Since men tend to show resistance to change, this bottom-up approach is pragmatic and effective in creating an environment amenable to changes. This is in contrast to the top-down approach which is often applied in coping with corporate crises arising from, for example, a conversion to new business. Business process reengineering, which has invited wide attention among Japanese industries, adopts the top-down approach. Even in this case, success can hardly be achieved in the absence of active participation of rank-and-file workers.

Changes follow the process from idea generation to its implementation and dissemination. A few prerequisites to nurture a climate which could generate ideas are smooth and dynamic flow of communication and an emphasis on learning and implementation of basic knowledge. It is important to vitalize the workplace so that each team member finds joy, excitement, and challenge in his job assignment.

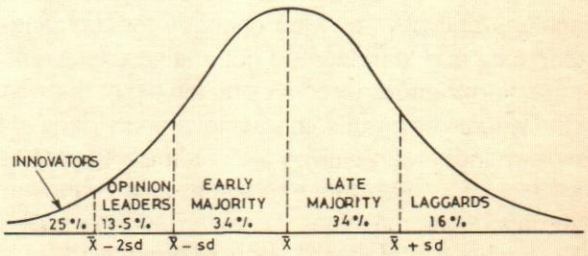

Fig. 2. Adopter categorization on the basis of innovativeness.

Many studies have been made in analyzing the dissemination of changes. Among them, the model developed by Rogers is well known (Fig. 2). The Roger's model divides persons into five groups; innovators, opinion leaders, early majority, late majority, and laggards. The change agent uses various techniques to convince the members of the society or organization. To start with, he provides information to innovators to bring about new ideas, and then approaches opinion leaders through information and incentives. Once their commitment is obtained for an intended change, it is relatively easy to persuade the early and late majorities. The most difficult part is to convince laggards to whom all possible techniques and resources are mobilized.

Management of Technology

In the Toyota production system was in fact the change of technology caused by individuals workers or work teams. Technology is a series of means that persons concerned decide to choose as most appropriate in

Technology is a series of means that persons concerned decide to choose as most appropriate in achieving a specific objective under given circumstances.

achieving a specific objective under given circumstances. Of course, the progress of science and technology and the changing market inevitably make the choice of technology obsolete. However, the preceding definition is useful for the theoretical analysis of the Toyota production system since it reveals various aspects of technology, i.e., technology as a means, the subjective choice and the dynamic nature of technology.

Assuming that technology changes, what are the other changes? Technology is a combination of man, information and materials such as raw materials, tools, machines and power. Man changes by acquiring new experience and learning and generating creative power. Information changes by conveying the experience gained by individuals or groups, the achievements derived from new learning, and creative ideas as messages to cause new actions. Substance changes by changing raw materials, tools, machines, or power and this calls for a new combination of these factors of production.

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These changes have been triggered off by the supply of external information such as market change or the progress of science and technology. Changes also require financial investment. Further they take place gradually and not instantaneously. In other words, the technological change is a process in response to action and reaction of these three factors.

Technology has two facets: science and skill. The former can be shared by others in the form of documented information and knowledge, whereas the latter which is a combination of physical and mental abilities cannot be. Engineering operators engaged in CAD (computer-aided design) can achieve high performance based upon a combination of the manual skill of key board operation and highly intelligent, creative mind. In this age when mechanization and automation have progressed rapidly, competitive advantages in technology come from a clever combination of scientific capability and skills. Skills are the strategic factors of the firm since they cannot be easily transferred.

In technology transfers it is important to transfer not only the scientific technology but also, the skills. It is far from easy to transfer this type of skills since it cannot be documented and belongs to the area of craftsmanship. A Japanese maxim says, "if you want to learn skills from your master, you have to steal them." 'Steal' means that you have to identify and assimilate the essence of the master's skill in your own way and ingenuity. How then can we transfer such skills? One of the most effective ways is to work closely with those who possess them. Compared with foreign firms, Japanese firms have shown a higher propensity to send abroad a larger number of engineers and skilled workers for a longer duration. This is due partly to the fact that Japanese firms emphasize the transfer of skills embodied in workers much more than the documented technology. Of course information should be documented to the extent possible, but it is difficult to put all operations into documentation. It requires face-to-face contact and learning by copying.

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The transfer of manufacturing technology involves six steps: manufacturing operation, maintenance operation, product control, IE, product design, and R & D. Further transfer has three stages in accordance with the degree of complexities; introduction, adaptation and creation. Introduction starts with the acquisition of knowledge about the manufacturing operation, maintenance operation and production control. The skills involved in these processes can be assimilated over time. Adaptation requires the modification of processes and parts so as to adjust them to the local environment. It should start with the acquisition of capabilities in production technology and, more desirably, those of workplace *kaizen*. Creation of new technologies based upon self-reliant efforts completes the process of technology transfer. It is necessary to acquire the capabilities of product design and R & D in this regard. Needless to say, skill acquisition constitutes an indispensable element during the last stage of transfer.

In addition to the transfer of manufacturing technology, the transfer of managerial skills is no less important. Training should be given in such a manner as to increase

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worker motivation and quality of work life. Toyota group's firms and factories are venues of learning. The role and responsibility of the top and middle management are to demonstrate that the firm is responsible for human resources development through which it contributes to the society. The successful transfer of managerial skills depends on the top management's capacity in designing corporate vision and strategy. The role of middle management is not to simply supervise the staff, but to act as workplace advisors dispensing relevant advices as and when necessary. They recommend ideas for *kaizen* and innovations to the top management based on long workplace experience. They further digest the policies and strategies designed by the top management and convey them to the staff in a specific and simple manner. Technology transfer of this nature can also be achieved by way of a learning process based on on-the-job experience.

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Management of Linkages

Basically the Toyota production system emphasizes communication linkages and cooperation. Good cooperative relationship among team members at the workplace is the crucial factor in forming the linkage. Veteran workers help freshers over their responsible areas of coverage to the extent possible till the latter get to accumulate sufficient knowledge and experience. The *kaizen* or innovative movement is initiated by the team members at the workplace. The scope of the movement is broadened with the involvement of production engineers, which is further expanded by the participation of process engineers, product planners, marketing designers as well as members of other workplaces. The involvement of workers at various levels and workplaces is to accomplish an easy way of manufacturing as well as defect-free design at the stage of process and product design with a view to achieving QCD in toto.

The need for product innovation has been increasing in the light of the changing market and technology. The automobile industry was no exception. The gestation period has been getting longer as the product itself has become more complicated. If this can be cut shorter, the firm's competitive advantages would be enhanced radically. A new model 'Neon' developed Chrysler is a case in point. Toyota was successful in cutting the lead time shorter by emphasizing linkages between various processes and involvement of R & D staff, product designers, production engineers, skilled workers and marketing staff at the initial stage of developing a new model. The shortening of lead time has led to considerable reduction of the gestation period required for R & D, quality improvement, and cost reduction. Similar approach adopted in the United States is called 'Concurrent Engineering'.

Basically the Toyota production system emphasizes communication linkages and cooperation.

Toyota has attempted to ensure the daily production of various models by using the *kanban* system simultaneously with the *kaizen* movement. The reduction of lead time through *kaizen* is crucial to satisfy the two different functions — stable, daily production on the one hand and changes through *kaizen* on the other.

Initially the Toyota production system was implemented in its own premises only. However, the automobile industry has long backward linkages thus relying heavily on a large number of affiliated and subcontracting firms. So soon it was also introduced to those firms whose cooperation was imperative to satisfy QCD. More specifically it was after the oil crisis in 1973 when the system was disseminated very rapidly among them. Indeed the firm has reaped rich dividends only after the establishment of close linkage between assembly and subcontracting firms.

Assistance has been extended not only for conventional transactions between parent and subcontracting firms, but also for the development of new models. The latter is now well known as 'design in' wherein parts and component manufactures participate in automobile production from the initial stage of design and development of new models. Linkages of this nature are not surprising since nowadays even business alliances between competitive firms have gained momentum for example, between IBM and Toshiba or NEC and Bell Research Laboratory.

Many forms of linkages have emerged in the age of technological innovation. Alliances among the firms in different lines of business are one of them. This form of linkage is dominant among small firms that challenge new ideas and innovations by sharing limited resources.

Linkages among small firms in different lines of business are initiated by many players: the small firms themselves, public R & D institutes, financial institutions, or small business industrial associations depending upon the nature and scope of cooperation. Tripartite linkages among industries, universities, and public R & D institutes have also been prevailing in Japan in which both large and small firms are involved.

Linkages are no more limited to domestic activities and have now gone beyond national borders. Joint venture is one of the cases which represents international linkages. It requires mutual understanding and cooperation between partners having different socio-cultural backgrounds. The spirit of equal partnership needs to be respected for its success.

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Technological linkages are to be synchronized with organizational and psychological ones in that inherent differences are observed between two different organizations regarding technology, corporate culture, management style, and ways of thinking. Information technology plays an important role in this regard since it expedites the sharing of information among the participants. Thus linkages in the true sense of the word can be achieved through orchestral management which encompasses the whole gamut of technology, information, and organizational culture. The formation of substantial linkages makes it possible to accomplish QRS (quick response system) and upgrade QCD performance. It appears that the Toyota production system has set the final target on these aspects.

Orchestral Management

By now linkages are no more limited to conventional business dealings or R & D activities, but also extended to strengthen relationships between industry and region or between industry and natural environment. The industry has to design a modus operandi to connect and orchestrate different functions, organizations, levels, culture and history in the global society.

Orchestral management among different functions

Different terminologies and business concepts are used even in the same firm among workers belonging to different divisions. For example, those used by production staff are different from those by marketing or design staff. Not surprisingly this could be a source of confrontation between them rather than cooperation. It is therefore important to increase the use of common language and opportunities of dialogue with a view to develop professional staff of different disciplines mutual trust and confidence.

Orchestral management among different organizations

Different organizations possess different cultures making it all the more difficult to establish cooperative relationships. Written agreement, sharing of capital, joint venture, and merger are some of the business strategies which firms mobilize to link different organizations. In this regard, highly developed linkages between assembly and part-making subcontracting industries in Japan have opened up new perspectives in orchestral management of different organizations where mutual trust and technological complement play an important role.

Highly developed linkages between assembly and part-making subcontracting industries in Japan have opened up new perspectives in orchestral management of different organizations where mutual trust and technological complement play an important role.

Orchestral management among different levels

Human relationships have been transformed from vertical hierarchy to horizontal and network cooperation in the present society. This transformation should be equally applied to each level of economy, be it macro, meso, or micro to achieve orchestral management. The macro level refers to political and economic policies at national and international levels, while the meso level points to industrial and economic policies at the regional level. Needless to say, the firm is placed at the micro level. Measures taken at the micro level become effective when they maintain good harmony with macro and meso policies. In other words, mutual tuning between different levels increases social productivity. Mutual trust, sharing of information, and close communication between different levels are the factors which should be taken into account to strengthen the extent of tuning.

Orchestral management among societies

When firms go abroad, they come across societies that possess different cultures and histories. Unless and until they understand and respect them, they can neither gain mutual trust nor establish equal partnership. Lack of careful attention to this aspect is likely to waste all previous efforts directed to establish amenable tuning between different functions, organizations and levels.

Conclusions

Developing mutual trust is the basis of orchestral management. Mutual trust is the relationship between people and cannot be accomplished overnight. The following factors should be considered in forming and maintaining partnership:

Developing mutual trust is the basis of orchestral management.

- Basic consensus should be arrived at between partners about the common vision and philosophy and the strategies to develop them.
- Mutual advantages and benefits between partners should be recognized in forming partnerships.
- Efforts should be made to keep mutual advantages and benefits valid as long as possible.
- Mutual understanding should be promoted by sharing information and deepening organizational interactions at the level of top management, middle management, and rank and file workers.
- Continuous efforts should be made to strengthen the mutual trust thus developed.
- The achievements made should be constantly appraised in relation to the vision and philosophy which were originally designed.

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What if I'm Afraid to Rock the Boat?

A participant in one of our programs — a manager in a major corporation — shared this experience:

> One day, I was sitting in a company meeting where people were discussing important policies that could have a significant negative impact on the environment. As I sat there, I came to the realization that, while I felt very strongly about these issues, I was essentially silent.
>
> "Why?" I asked myself. "Why am I afraid to open my mouth? When I was hired into this company from the outside years ago, I had no fear. I openly expressed my feelings and concerns. I was confident. I felt I could act with integrity. What's made the difference?"
>
> As I thought about it, I realized that since that time, I had acquired substantial retirement benefits. I'd bought a new home. I was making payments on a new boat. Essentially, I didn't want to do anything that might jeopardize my economic security. I realized the "golden handcuffs" held me bound.
>
> At that point, I made two resolutions: to get my financial affairs in order and build up some reserves, and to continually improve my marketability. I never again wanted to be in a position where my integrity was compromised by my dependence on a job.

Special Report

Poverty & Sustainable Development: Ecological Concerns

Deonanan Oodit & Udo E. Simonis

Generally, the relationship between poverty, environment and development is perceived as a "vicious circle." Poverty leads people to overutilize and overburden their natural environment on which, in the end, all development depends. In reality, however, there are certain structures behind the aggregates of this relationship. And structures should be studied when searching for solutions to escape vicious circles. This article structurally defines both poverty and environmental problems in order to detect options for development that may simultaneously contribute to alleviate poverty and to prevent further environmental deterioration. Both national and international options are considered.

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This article has been excerpted from a recent research report undertaken by the authors.

Sustainable development is a concept that so far has eluded a simple and precise definition. The concept arose as a reaction to certain negative experiences, both in the developed and the developing countries. In an ecological sense, sustainable development calls for development patterns that maintain the natural capital stock and overall ecological integrity. Strictly speaking this would imply that development be based only on renewable resources, used at a rate at which they regenerate, and leading to emissions and wastes that can be decomposed and digested by nature. A more pragmatic view places the emphasis on development first and on ecological integrity to the extent that it is important for sustained development.

Sustainable development calls for development patterns that maintain the natural capital stock and overall ecological integrity.

In this view, key ingredients for sustainable development are seen to be eradication of poverty so as to prevent further resource degradation, which calls for changes in the sociopolitical structures; clean or cleaner technologies to mitigate environmental pollution, which call for R & D investment and technology transfer, and for environmental impact assessment of all new projects; slowing-down of population growth, so as to relieve the pressure of population on natural resources; internalization of environmental costs, so as to reduce discharge of harmful emissions and disposal of hazardous wastes, implying a change in lifestyles that are both resource-destroying and environmentally polluting.

Such principles and respective measures, it is believed, would mitigate the negative effects of current patterns of economic growth, prevent further degradation of the natural resource base, and at the same time contribute to the alleviation of poverty, and would give a decent but sustainable development perspective for all.

Environmental Stress & The Urban Poor

Urbanization is a most dramatic social and material transformation that it taking place in the developing countries since the mid-century (World Commission on Environment and Development, 1987).

Manufacturing industries, services and commercial centers are located at the core of the big cities. Large numbers of the urban poor cluster in slums and squatter settlements around such centers or at the urban periphery, be it due to absolute shortage of land or to the high rents on serviced lands. These areas are prone to hazardous natural and man-made environmental conditions, such as flood plains, slopes, or land adjacent to industries using polluting technologies. Most of the urban poor thus live and work in hazardous exposure situations, shunned by the more affluent. They have to contend with bad sanitation, contaminated water, floord, or chemical pollution. According to WHO, an estimated 600 million urban dwellers in the developing countries live in what is termed life and health threatening circumstances.

In particular, the urban poor are affected by water pollution, inadequate sanitation facilities, insufficient collection and disposal of solid and toxic wastes, in-door and out-door air pollution. A WHO estimate for 1988 suggests that 170 million urban inhabitants lack access to safe and adequate water supply, and 330 million lack adequate sanitation. The urban poor depend on water from inland water bodies that are contaminated by human excreta, and industrial toxic wastes. Many urban agglomerations in the developing countries have no sewerage systems at all.

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While by and large quality of urban cooking fuels is better than that used in rural households, not everybody in the urban areas can afford clean fuels. Poor households still depend on traditional biomass fuels which they burn in unventilated shacks. In the large urban agglomerations increasing numbers of people (both poor and non poor) are being exposed to out-door air pollution caused by uncontrolled industrial and automotive emissions.

The problem of hazardous wastes in developing countries has been exacerbated by the import of inappropriate products and technologies from industrialised countries. In many cases it is cheaper to relocate such industries to the developing countries than to meet the increasingly stringent environmental standards and regulations at home. Officially, "codes of conduct" on environmentally sound management have been signed, but in actual life such agreements on the national and international level all too often do not reach local decision-making.

Ecological Urban Restructuring

Urbanization has put considerable stress on the natural environment and the health of the urban poor. To stop or reverse the process may well be impossible. What is needed, therefore, is a new paradigm for urban development (*urban ecology*), appropriate institutions and a legal framework conducive to environmentally sound city planning (Hahn & Simonis, 1991).

The urban poor have benefitted little if at all from the industrial and commercial activities that degrade the environment, but bear the full consequences of their adverse effects. They are the primary victims of sewage discharged in water bodies, of polluted air, of dumped solid and toxic wastes. The urban poor need to be protected from the immediate threats to life posed by unhealthy sanitation facilities, water supplies and cooking facilities. A full-scale attack on urban problems using conventional capital-intensive technology would, however, require large increases in investments. For example, to meet the WHO targets for water and sanitation in Latin America by the year 2000, a threefold increase in the levels of annual investment (some $50 billion) would be needed. Moreover, conventional techniques require large amounts of freshwater, often as much as 40 percent of the average daily water consumption. At such costs the need of urban sanitation cannot be met. There exist, however, a wide range of alternative options that are much cheaper but equally efficient, and use locally manufactured hardware — plumbing, concrete caps, etc. Labor for such activities could be provided by the beneficiaries in the form of "sweat" equity.

There exist, however, a wide range of alternative options that are much cheaper but equally efficient, and use locally manufactured hardware — plumbing, concrete caps, etc.

Both the social and the technical factors of such basic sanitation facilities have been tested in Africa, Asia and Latin America. Much headway has been made in recent years in modifying conventional sewerage designs to reduce costs. Examples are the shallow sewerage system and the small bore sewerage system. The modified systems cost as little as a quarter of conventional sewerage. What is needed, is wider diffusion of these low-cost alternatives.

Cities can encourage water conservation in water intensive industries as well as in the services and residential sectors, by ensuring that the water consumer pays a realistic price of water, and also by better maintenance of existing distribution systems to prevent leakage. A survey of 14 large Latin American cities found that unaccounted water ranged from 39 to 67 percent. These measures alone could suffice to provide safe drinking water to most of the still unserved urban poor. For instance, in the city of Sao Paolo, a program to reduce water leakages in the distribution system succeeded in reducing the unaccounted water from 35 percent in 1977 to 27 percent in 1986. The resulting water savings enabled increase in the number of home connections without the need for additional water development by 46 percent.

Solutions to in-door air pollution are more difficult to find, but several possibilities exist. For instance, charcoal or biomass when fermented to produce wood alcohol provide more energy per unit of fuel than raw bio-mass, and reduce air pollution at the same time. The impact of biomass fuels burned in-doors can also be reduced by improved cooking stove design that concentrates the heat. Another possibility is the use of solar stoves. Until now, however, such alternatives have largely failed to meet affordability criteria. While technologies to use energy more efficiently and to mitigate adverse health effects are available, their use requires financial resources that the poor often do not have. The ultimate solution thus lies in measures to quickly raise the income of the poor, or to drastically reduce the cost of such alternative techniques.

In order to mitigate the effects of out-door air pollution, in most developing countries there is urgent need for regulations on industrial and automotive emissions. New industrial plants and automobiles should be required to be fitted with state-of-the-art pollution control devices and allowed to operate only if they meet strict pollution standards. Leaded gasoline should be banned, price differentiation favoring cleaner gasoline could be introduced. Within city limits, better use of public transportation systems would reduce air pollution, cut transportation costs and save energy.

In many developing countries, the price of gasoline is already rather high. Still, a moderate gasoline tax would be useful for raising revenue which could be spent for financing public transport. In countries where gasoline is subsidized, such subsidies should be removed instantly. Vehicle tax and license fees need to be redesigned to discourage the ownership of energy-intensive and polluting vehicles. Compulsory inspection and regular maintenance of vehicles are still unknown in many countries, but could, if introduced, cut automotive pollution substantially.

To effectively deal with the growing waste problems, emphasis needs to be placed on waste prevention, minimization and reuse — and preferably in that order. There is not only the need for more stringent environmental laws, there is room also for economic instruments and, of course, many forms of local action.

Hazardous toxic materials may have to be banned outright. Solid waste minimization can be achieved through modification of industrial processes and through changes in the design and use of products. Already many options are available at the processing stage to reduce waste through raw material substitution. Additional recycling, such as the recirculation of cooling water through a closed loop, is also possible to a substantive amount. Durable packaging instead of single-use packaging can be made mandatory. Establishing strict quantitative and qualitative criteria for discharging industrial waste water into the sewer networks and enforcement of these criteria would drastically cut the cost of sewage treatment by municipal authorities.

One possible instrument to reduce waste is the application of user charges. To be effective in changing behavior, however, charges need to be sufficiently high. Various mechanisms such as "pay-per-bag," or "charge-per-can" have proved to be successful in reducing solid waste. The "deposit-refund system" for certain kinds of packaging is quite common in many countries. Concessional loan and tax incentives can encourage the application of waste minimization technologies, etc.

Generally, the environmental costs are not or not fully integrated in the price of a product. As a result, market signals do not provide sufficient incentives for waste minimization. Therefore, efforts need to be undertaken for the full internalization of environmental costs also in order to promote new technologies. Charges on the disposal and treatment of wastes can play a useful role in helping to recover the costs associated with waste management.

With regard to municipal sewage treatment plants that ensure the elimination of pathogens, technology is well developed. Cost-effectiveness and affordability, however, remain critical. An effective waste water technology suited to the climatic conditions of many developing countries is the stabilization pond system. Unfortunately, this system requires large space which is not always available in high density urban areas.

Solid waste management which includes storage, collection, transport and disposal poses different problems. The collection techniques imported from industrial countries are often not appropriate. UNCHS (Habitat) therefore promotes the use of appropriate equipment in solid waste management. In most developing countries, as much as 40 percent of the refuse can be reprocessed, the rest being primarily organic matter which may be composted and sold to the agricultural sector.

National Environmental Policy

Until recently, direct regulations were at the center of national environmental policy (Enyedi, *et al.*, 1987). Regulatory instruments aim at influencing the behavior of polluters by imposing norms or standards on products, technologies and discharge of pollutants. Their use is likely to persist, particularly as regards hazardous and toxic substances. Increasingly, however, economic instruments are being introduced, though in most cases they are used only in conjunction with direct regulations. In theory, economic instruments offer the advantages of flexibility and efficiency in inducing polluters to internalize the costs of pollution and to develop cleaner technologies.

Several major economic instruments for environmental policy have been conceived, namely charges, such as effluent charges, user charges, product charges, tax differentiation; enforcement incentives, such as noncompliance fees and performance bonds; subsidies; and deposit-refund systems. A variety of problems arise when trying to introduce such instruments. Economic efficiency can be achieved only if heavy polluters are charged more than low polluters, which calls for a scale of instruments, based on detailed monitoring. The administrative costs of enforcing such a system can be high, even in a developing country.

- The application of *charges*, particularly *user charges* is not very viable in situations of extreme poverty. The poor contribute to certain types of pollution, but they are the ones who suffer most from it. The provision of safe drinking water and sanitation facilities to the poor at low cost would be useful social function since such services give rise to positive externalities in terms of health and productivity. Charges on household water and for discharge of sewage into municipal facilities need not be based on the amount of use or discharge but could be based on the ability to pay (income).
- Regarding solid-waste management, the *deposit-refund system*, as applied to bottles and other reusable containers, seems to be a viable mechanism. The deposit-refund system makes possible lower prices for energy and raw materials. The system is already in widespread use in developing countries. *Tax differentiation or command and control measures* could be used to extend the deposit-refund system by inducing the production of reusable containers for as many products as feasible. Metallic waste reuse is not a big problem in most developing countries because it is already remunerative and provides an income to the poor. What is needed, however, is sanitary treatment, prior to collection, to prevent adverse health effects.
- Elimination or reduction of *subsidies* for products brought directly into the environment, such as fertilizers and pesticides, particularly where they are being overused, would help in reducing their impact on water quality, soil, biodiversity, and on human health.
- A major consideration as regards the application of *effluent charges* is the viability of industries. Even in developed market economies such charges are often kept low in order not to undermine the competitiveness of industries producing for the export market. The main emphasis in developing countries, as far as industrial pollution is concerned, would have to be placed on the use of *cleaner technologies*, particularly in new plants. While the provision of funds from the budget generally is not compatible with the "polluter pays principle," subsidies would be justifiable in cases where environmental problems are severe and costly, as for instance, water pollution treatment,

restoration of hazardous waste sites, and emissions from fossil fuels combustion.

- *Product charges* can be effective in controlling pollution if environmentally sounder products are available at prices that will induce polluters to switch to these substitutes, i.e., when the cross price elasticity of demand is high.

Global Environmental Policy

Until now, global warming is largely caused by the industrial countries through the burning of fossil fuels and the extensive use of CFCs (Benedick, 1991). At the end of the 1980s, the industrial countries were responsible for some 75 percent of the CO_2 and more than 90 percent of the CFC emissions. Unless preventive action is taken, however, the contribution of the developing countries to global warming will increase rapidly. So far, the largest proportion of the CO_2 emissions in the developing countries results from deforestation and burning of biomass fuels; industrialization and motorization will take over in the future. Clearly, the industrial countries have the responsibility to lead the way, both in their national policies and through bilateral and multilateral assistance, in implementing the climate convention signed in Rio de Janeiro by altogether 155 countries. How this should best be done, by direct regulations or by using economic instruments, however, is an open question.

International Mechanisms

A number of mechanisms have been proposed to deal with global warming, among them a global carbon tax; tradeable emission permits; and international environmental offset programs (Lashof & Tirpak, 1990).

The chief objective of a carbon tax is to stabilize and decrease green-house gas emissions, according to the "polluter pays principle." The tax is actually intended to alter the behavior of polluters by making fossil fuels more expensive, by inducing them to reduce energy demand, encourage energy conservation, enhance efficiency, and promote renewables. One version of the proposal advocates the levying of taxes at varying rates according to such criteria as current emissions, historic emissions, or population size. A global carbon tax could be part of a "CO_2 protocol" to implement the climate convention signed in Rio de Janeiro, 1992.

To be effective in achieving a significant reduction in energy consumption and CO_2 emissions, the tax would have to be rather high — this obviously runs contrary to certain vested interests especially in low-income countries. Moreover, a high tax rate could lead to shifts from fossil fuels to charcoal, firewood and biomass scavenging, with implications for further deforestation and deprivation of nutrients to the soil. It is here that international arrangements must come in to soften such distributional and substitutional problems.

Perhaps, a feasible use of the mechanism would be to impose a moderate but progressive carbon tax in the industrial countries (in Europe, for instance) in order to generate revenues which could be used for the transfer of environmentally sound technology to the developing countries on a preferential basis. The intent of the mechanism would be to place the greater financial burden on the wealthier nations which is where life style changes are most necessary if the threat of global warming is to be substantially reduced.

Another mechanism that has received much attention in the literature, but not so much in practice, is emissions trading. This calls for establishing markets for emission permits (quotas), to be issued (by an international agency) for transboundary pollutants based on current emissions, past emissions (for instance, 1980), levels of income or population size. Under this mechanism, the permission to release stipulated safe levels of pollutants, would be made available for a fee. Those who do not fully utilize their quotas could sell or lease the balance to third parties anywhere in the world at a price to be determined by the market (*market for emission permits*).

While practical experience with tradeable permits is limited, in principle the mechanism offers an efficient solution to reduce the levels of pollution. It runs, no doubt, against the vested interests of the heavy polluters, the industrial nations, the rich, who would have to pay for what they are doing to the global environment. Establishing markets against those (the rich) who so far benefitted most from growth and trade will, of course, be not an easy undertaking. Regarding those vested interests and the remaining uncertainties of setting targets, assessing emissions, etc., tradeable permits may not be introduced at the international level in the very near future. From the point of view of resource transfer from North to South, however, a market for emission trading would be a major break-through.

A mechanism that could be viable in the short run is an international environmental offset program i.e., realization of the *compensation principle*. In such a case, an industrial country could invest in environmental protection in a developing country whose harmful technologies would tend to undermine established global emission-reduction targets. Recently, the modernization of two nickel smelting plants in the former Soviet Union near Murmansk were funded by the governments of Finland,

Norway and Sweden. This is an interesting, though only regional case of concessional transfer of environmentally sound technology that benefits both the donor and the recipient — and the natural environment.

Deforestation is partly due to absolute poverty. Since tropical forests save biodiversity and serve as CO_2 pollution sinks to the rest of the world, they could be taken to internationally exemplify the compensation principle. To the extent that tropical forests are important for the state of the global environment, *countries* with and *people* in tropical forests are providing free economic services to the rest of the world and should, therefore, be compensated by the international community for preserving these forests. The modalities of preservation of tropical forests, through appropriate regulations and policies, be devised, once the *commitment to preservation* and the *willingness to pay for it* have been agreed upon internationally.

Other mechanisms, such as *debt-for nature swaps* and *international environmental offset programs*, have been used, but are limited in number and extent. Debt-for-nature swaps initiated by NGOs in industrial countries have been successful on a small scale but are not viable on a large scale. One major problem is the unavailability of funds for swaps, but there are others. Countries that predominantly have public debt are reluctant to sell them on the secondary market at a discount for fear that this would undermine their credit rating with the international finance system. Moreover, the mechanism is often seen as a device to force developing countries to relinquish national sovereignty on natural resources to foreign NGOs.

International environmental offset programs so far also have been limited. The financing of afforestation in Latin America by the government of the Netherlands to offset current CO_2 emissions at home is an example. To the extent that more industrial countries want to invest in reforestation and afforestation in the developing countries, this mechanism could become quite powerful. If, however, forestry measures in developing countries were financed only to offset the effects of *additional* polluting plants in the industrial countries (i.e., *future* emissions at home), this would be rightly perceived as fake.

International agreements

Because of their transboundary impacts certain air pollutants can best (or only) be controlled through concerted international action. Some efforts have been made in this direction in the last fifteen years establishing targets for the emission of SO_2, NO_x, vocable organic compounds and reduction of CFCs. There is an outright ban on dumping of hazardous wastes too.

Theoretically, at least, the poor (the poor countries) are thus prevented from falling victim to the toxic leftovers of the rich (the industrial) countries. In practice, however, "environmental dumping" is a reality, or must be expected to become reality in a quantity-oriented throughput economy.

Putting sustainable development on the agenda without increasing commitment to global environmental policy would certainly lead to serious political cleavages. However, there are no quick fixes to this endeavor.

While parts of the additional financing will represent a cost to ensure sustainability by way of curing environmental degradation, parts of it will represent investments rather than costs. In many cases, such investments will simultaneously produce economic return and environmental relief. Also, the costs of timely (*preventive*) action will be less than the eventual costs of delayed (*adaptive*) action. In a broader sense, financing for environmental protection can be viewed as an investment in maintaining the productive capacity of the global ecological system.

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The net capital inflow requested for development of the poor countries, in terms of efforts by donors, has been set at 0.7 per cent of the GNP of the industrial countries. This target, if met, would amount to approximately US$ 120 billion in 1990 prices, exchange rates and GNP levels. An estimate of the Worldwatch Institute puts the financial needs of developing countries for environmental conservation at US$ 20 to 50 billion per year during the 1990s. The World Resources Institute has also arrived at about the same estimate.

Current Efforts

Most multilateral agencies meanwhile have started to integrate environmental considerations into planning, budget allocation, implementation and assessment of their work. For instance, the World Bank now requires an environmental impact assessment for all their new projects. UNDP in one year increased its budget allocation for environmental protection activities by over 100 percent. Some 55 percent of IFAD's projects reflect concern about the environment.

In addition, several multilateral and bilateral programs have been established with an explicit environmental thrust. The largest is the *Global Environmental Facility* (GEF), established in 1990 as a pilot scheme of the World Bank, UNDP and UNEP, to provide grants and low interest loans to developing countries to help them carry out environmental programs. The UN conference in Rio de Janeiro gave a push to expand this program. Several sectoral efforts are also underway, for instance, the *Tropical Forestry Action Plan* (TFAP), the *Consultative Group on International Agricultural Research* (CGIAR), the *Metropolitan Improvement Programme* (MEIP), and the *Environment Programme for the Mediterranean* (EPM).

The TFAP, initiated in 1985 in collaboration with FAO, UNDP, World Bank and World Resources Institute to prepare national action plans for sustainable management of land and forests in 80 countries, has been criticized and is now under review. CGIAR's mandate is to carry out research on drought and stress-resistant crop varieties as well as on environmentally sound alternative farming. The MEIP, launched in 1990 with the assistance of UNDP, World Bank the government of Japan, aims at arresting and reversing environmental stress in five major Asian cities — Beijing, Bombay, Colombo, Jakarta, and Manila. The EPM, a long-term technical assistance plan financed by the EC-Commission, European Investment Bank, UNDP, and World Bank, aims at improving environmental conditions in the Mediterranean Basin.

Thus, the trend at the bilateral and multilateral levels regarding environmental protection expenditure is positive. The present efforts, however, certainly do not constitute adequate responses, given the magnitude and urgency of the problems.

In view of the substantial volume of *additional* funding required for sustainable development in the developing countries, it does not seem realistic to rely only on increases in voluntary contributions. Instead, or conjunction, emphasis should be placed on additional long-term commitment. The potential for redeployment of funds within national budgets, through reduction in military spending (the "*peace dividend*"), elimination of subsidies for activities that are environmentally destructive and for changes in the outmoded taxation systems seems to be great. Also, a number of new , innovative approaches to funding environmental protection activities have been proposed. Examples are, notably, debt relief, charges, energy or carbon tax, tradeable emission permits (Chandler, 1990; Grubb, 1989; Sand, 1990).

Debt relief through debt-for-nature swaps has been tried on small-scale basis. What is needed, however, is comprehensive debt relief for the poor countries. The World Resources Institute has proposed a "Multilateral Authority" which would purchase debt at a discount and then negotiate for phased forgiveness in return for the implementation of sustainable development programs.

Charges for the use of the global commons — like ocean fishing, use of the high seas by shipping, use of the atmosphere fro air transport and other economic activities — could yield substantial financial resources.

These charges could be levied and collected nationally or through an international taxing authority established under the United Nations (ITF-*International Taxation Fund*), and the revenues could be used for environmental protection measures, particularly to finance the transfer of clean technologies to developing countries.

An energy tax or a *carbon tax* has been proposed and is being widely debated, particularly in Europe. The primary objective of such taxes should be to alter the behavior of polluters by raising the cost of highly polluting products and technologies. Behavior modification, however, would require the tax rate to be rather high, which could make many current economic activities unprofitable. But it should not be forgotten that the willingness of implementing environmental taxation does exist in many industrial countries and has never been as high as it is at present.

Tradeable emission permits offer he potential of effectuating substantial transfer of resources from one country to another, from the North to the South. It implies establishing a market where no market exists so far. And it would be a market where the poor (countries) could gain, the rich (countries) would have to pay, and the environment (nature) would win.

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Environmental Policies & Opportunities for Waste Minimization in India

L. Panneer Selvam

To accomplish an environmentally sustainable industrial development, it is imperative to respond to the adverse environmental impacts by promoting efficient use of resources and cleaner production technologies through innovative environmental policies supported by effective economic instruments and institutional development. This paper reviews the existing industrial and environmental policies and discusses the opportunities and the enabling measures that will push the ongoing reform process towards an environmentally sustainable industrial development.

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The economic reforms and trade liberalization programs currently adopted by India are aimed at accelerating the industrial development and to progressively integrate the domestic economy with the global economy. These reforms, by promoting domestic and global competition, are expected to stimulate the industry to improve its productivity and cut down wastes. At the same time, adverse environmental impacts on account of increased pressure on natural resources; import of polluting technologies from developed nations and reluctance by the industry to invest on pollution control and waste disposal measures are the challenges to be met. Therefore, to accomplish an environmentally sustainable industrial development, it is imperative to respond to these adverse environmental impacts by promoting efficient use of resources, cleaner production technologies through innovative environmental policies supported by effective economic instruments and institutional development. This paper reviews the existing industrial and environmental policies and discusses the opportunities and the enabling measures that will push the ongoing reforms towards the ultimate aim of an environmentally sustainable industrial development.

Environmental Impacts of Economic Reforms

Government's initiatives to accelerate the pace of industrial development and boost exports create both positive and adverse environmental impacts. The positive impacts are: (i) the domestic and global competition will stimulate the industry to improve its productivity, cut down its wastes and (ii) additional stress on export industry to respond to the growing global environmental concerns on issues such as, global warming, deforestation etc., by using cleaner production methods and produce environment friendly products. The adverse impacts are: (i) pressure on natural resources to earn foreign exchange; (ii) shifting of dirty or polluting tech-

Box 1 Rise in chemical exports at the cost of environment?

India now exports 40 per cent of its iso-proturon (a wheat pesticide) production, whereas, two years ago it was importing large part of its requirement. The production of chemicals such as iso-porturon involves environmentally hazardous processes. The rise in exports of these chemicals is because, the environmentally conscious western countries are curtailing their domestic manufacturing operations. For example, the Indian chemical exports are targeted to touch Rs. 42,480 million in 1992-93, an increase of 64 per cent over the previous years. In about 40-50 percent of such exports, the comparative cost advantage has been derived from the absence of safety and environmental practices. Bichhri, a village in Rajasthan, is a vivid example — within four months of a dye intermediate, called H-acid, manufacturing factory being set up there, water supply within three kilometer radius of the factory was polluted, with its highly acidic and untreated wastewater. While the local community have to live with new environmental damages, the benefits accrued are passed on to foreign buyers. Despite having an elaborate set of rules on pollution control and safety measures, there is nothing to prevent the legal entry of dirty industries into the country. Also over 60 percent of chemical intermediates (which are more toxic than the final products) are produced by small scale industries, often using obsolete and hazardous manufacturing processes. Government's policies, to promote small scale industries, combined with lack of effective enforcement of safety and environmental standards make the problem acute. To overcome this, the Government should consider banning the manufacture of toxic chemicals and use of polluting processes by the small scale industries.

Source: 'Down to Earth', January 31, 1993

nologies from developed countries (Box 1) and (iii) with increased cost credits, industries would try and optimize their investments by reducing expenditures on pollution control and waste disposal.

Efficient Use of Resources

The growth of an economy, traditionally has been measured in terms of its materials consumption and output levels. Consumption of energy, cement, steel and freight transport levels are the four major indicators. Negative impacts of the increased consumption levels of these indicators on environment are indisputable. It has been successfully demonstrated by countries like Germany, Japan, Sweden and Norway that positive environmental effects can be realized by de-linking the economic growth from consumption.

Positive environmental effects can be realized by de-linking the economic growth from consumption.

Deterrents to Efficient Use of Resources

A programme for resource conservation, waste minimization or pollution prevention, reduces costs of production, waste treatment and disposal. Despite these advantages, resource conservation programmes among Indian industries are not as popular as one would like them to be. To learn about the deterrents for conservation, let us look at figure 1, showing the relationship between the production and waste disposal costs.

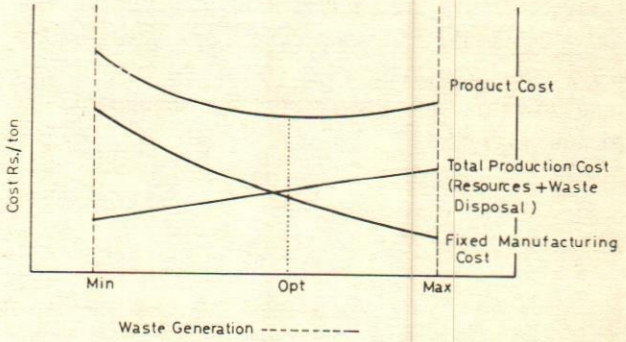

Fig. 1: Relationship between the production and waste disposal costs.

By reducing the wastage or by introducing simple efficient resource utilization techniques, one can approach the optimal condition of least product cost. However, adoption of expensive (in relation to cost of conserved resources) conservation or cleaner technologies for further reduction in waste generation will increase the overall production cost. The main deterrents that control the shift towards least waste generation conditions are: (i) subsidized price of resources; (ii) lack of supporting policies and instruments to encourage the use of Cleaner Production (CP) technologies; and (iii) laxity in enforcement of environmental protection and waste disposal regulations.

How to Promote Resource Use Efficiency?

Remove the Resource Subsidies

An increase in resource use efficiency could mean less mining, transport, and generation of wastes. Higher levels of resource productivity are better indicators of a strong economy. However, this becomes an unimportant issue, when resources are underpriced or subsidized. Neither the entrepreneur nor the consumer pay for resource depletion (the green house effect or the top soil loss) with the result, prices do not reflect the actual costs and make it appear that wasting natural wealth is entrepreneurship. For example, many industries consider water as a cheap raw material and pay little attention for its conservation. Box 2 discusses the potential water conservation opportunities.

Box 2 Industrial Water Conservation

Opportunities for Industry: Water is one of the cheapest raw materials for the Indian industry. Consequently little attention is paid to conserve water. Studies by the National Productivity Council (NPC), have confirmed wide variations in the amount of water consumed per unit of product, even under similar operating conditions. Water conservation is seldom difficult. Obvious methods such as, use of closed-cycle recirculation cooling systems instead of once-through systems, dry-floor cleaning methods, good house-keeping measures like stopping leaks from taps, valves & joints, use of self closing taps, etc., are relevant to all types of process industries. Less obvious methods like, use of counter current-rinse tanks, process control, and tertiary treatment for recycling treated wastewater for secondary applications (cooling, gardening, floor washing) etc., are industry specific.

Opportunities for Government: To complement the industry's efforts to conserve water, there is a need for a good water resource management plan, considering the inter-sectoral nature of water use. A recent analysis of a few World Bank financed water supply projects, shows that the unit cost of raw water (excluding treatment and distribution) in a new water development project, would be more than double, in some cases even triple that in 1988. Conservation and demand management in the water sector, as it is done in the energy sector, are therefore, for obvious reasons, economically and environmentally sound practices.

Water Tariff: The cost of industrial water supply in most of our cities and towns — fixed more on social and political considerations — vary from a meager Rs. 1.32 to Rs. 18 per Kilo Liter. Majority of them change less than Rs. 2.50; as a result, there is no motivation to conserve water. Therefore, it will be useful to rationalize the tariff by considering: (a) actual direct financial costs of supply; (b) opportunity cost, reflecting the additional economic benefits if the water is made available for other productive purposes like agriculture; and (c) pollution cost, internalizing the damage cost (effects of poor water quality on down stream users), by wastewater disposal.

Water-Intensive Technology Tax: Since the ground water use in India is not effectively regulated, introduction of rational water tariff may not always promote conservation. For example, if municipal water supply is expensive, industries would try to develop self-managed groundwater supplies. Therefore, it may be worthwhile to introduce tax on water-intensive technologies, particularly when alternate water-saving technologies are available. However, it is a complex process and detailed assessment of available industry specific process/technology options is a prerequisite. To begin with fiscal concessions on proven water-saving technologies such as low volume cisterns for toilets, self closing taps, cooling towers, etc., could be introduced.

Wastewater Disposal Regulations: Absence of load based wastewater disposal standards, insignificant cess on wastewater discharges, inadequate technical capacity and institutional arrangements for monitoring the discharges, and the sheer laxity in enforcing the environmental regulations, discourage the industry from conserving water. On the contrary, it will be beneficial for the industry to meet the disposal standards by dilution. A firm pollution prevention and control policy with industry specific load based standards, will motivate the industry to conserve water.

Many industries consider water as a cheap raw material and pay little attention for its conservation.

Both economic and environmental benefits could be achieved by judiciously reducing or even removing the subsidies. These reforms will require considerable political and economic will because most often these un-targeted subsidies typically benefit the rich or politically influential. The fertilizer and pesticide subsidies, for example, has encouraged chemical intensive farming, resulting in groundwater and surface water pollution, reduction in soil fertility etc., instead of extensive farming based on organic farming practices. However, this change to happen and to prevent the increase in cost of food production due to withdrawal of subsidies, it is important to link the economic instruments with technological research and planning for advanced organic farming methods. For example in Indonesia removal of pesticide subsidies (more than 80% of the retail price) in 1988, reduced excessive pesticide consumption in favour of a successful integrated pest management programme and generated budgetary savings of more than U.S. $ 120 million annually. Then why is this not possible in India? Another example is the pulp and paper industry — a recent study by the Administrative Staff College of India, indicates that the true cost of paper would double if the hidden ecological subsidies-impacts of depletion of forests and water and air pollution — are taken into account.

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Introduce 'Green Taxes'

Experience elsewhere prove that it is time to reduce ecological subsidies to sustain the development process (the worst economic performance was by the socialist countries, which heavily subsidized the use of energy and other resources) and whereas in India, neither the government nor the industry has any policy on ecological subsidies. One way of rectifying this situation would be to influence the price of energy and other resources in the form of an additional levy — revenue neutral 'Green Taxes'. Unlike pollution charges, green taxes are not earmarked and the revenue collected can be used to reduce other taxes. The overall tax burden would thus remain constant even if the government imposed fairly substantial 'green taxes'. This is likely to eliminate inefficient technologies and wasteful consumption patterns. However, this ecological tax reform should proceed step-by-step to avoid adverse impacts on producers and consumers and also to allow sufficient time, about 1 to 25 years, for technology development infrastructure and institutional development and cultural changes. At the same time, we should not fully abandon the traditional command-and-control policies.

Unlike pollution charges, green taxes are not earmarked and the revenue collected can be used to reduce other taxes.

Empower People

When there is an open access to natural resources and property rights non-existent, there is no mechanism to regulate the use of these resources. Thus, no individual bears the full cost of environmental degradation. The result is over-exploitation — "tragedy of the commons', such as over-fishing, overgrazing, and excessive extraction of groundwater. When a resource is controlled by the government, (forests for example) pressures from interest groups, often lead to over-exploitation and misuse. In the process, the government may not value the firewood-fodder-water supply function of forests, as much as the local community does. This, in pure economic terms, was the key contention of the Chipko women who refused to let the government sponsored contractors chop down their forests. On the contrary, if the natural resource is owned by the community, it prevents outsiders from over-exploiting the resource and would encourage local participation to deciding the cost of a natural resource — the Chilka lake, for instance. This would also take the economy towards prudent use of natural resources and reduce the impact of market forces that bypass the ecological and social costs of natural resource use. Irrigation water management in Karnataka is one of the success cases of common property management, wherein, the users have developed mechanisms for restricting access to outsiders, and allocating use rights among those in the group. Therefore, the starting point for any environment friendly economic reform

should be the establishment of community rights over natural resources.

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Environmental Regulations & Economic Instruments

If economic restructuring is to lead to environmental improvements, environment friendly market forces will simultaneously have to be stimulated by introducing innovative policies to penalize polluting industries and reward environmentally sound manufacturers. These instruments, should not be based on revenue considerations alone; but to modify the nation's economic behavior. Over 170 such innovative economic instruments are being used in 14 industrialized countries (Box 3) — 50 per cent of them are charges and about 30 per cent being subsidies. Experience in these countries has shown that the level at which the charges are fixed, is important in bringing about changes in economic behavior. For instance, unlike Germany or France, the Netherlands has been successful in inducing the entrepreneurs to set up waste treatment plants as a result of effluent 'charges'. Since the water pollution charges levied per capita in 1986, in the Netherlands was as high as 33 ECUs (European Currency Units) as against 2 and 4 ECUs in Germany and France respectively, it was more profitable for Dutch entrepreneurs to prevent pollution than to continue their existing practices.

The Indian regulations, on the contrary, are mainly based on the command-and-control (CAC) approach with uniform emission standards, specified for each sector. These policies are supported by financial subsidies & incentives in the form of excise and customs duty concessions and exemptions. India with several hundred thousands of heterogeneous polluters, a large informal sector and weak institutional set-up, enforcement of CAC policies is not, and indeed cannot be expected to be effective. Technical and institutional inadequacies, prohibitive costs involved in monitoring, and lack of supporting legal instruments make it still worse. Therefore, a combination of CAC and market-based-incentives approach will not only be cost effective but also easier to enforce. Moreover, the existing policies do not encourage efficient use of resources or waste minimization.

A close look at the existing financial incentives and economic instruments would reveal that they do not provide enough impetus to maximize the resource use efficiency, because they are applicable only to EOP (End-of-the Pipe) control technologies. For the loss making industries, instruments such as 100% depreciation allowance, are not attractive for known reasons. Moreover, when all tax rates are being revised downwards, it will be difficult for the government to sustain these concessions for pollution control. Therefore, to promote resource conservation and to motivate the industry to increase their investments in environment protection, it will be useful to introduce innovative market-based-incentives. For example, the Thailand Government has introduced an innovative and cost effective deposit-refund arrangement for hazardous wastes management (Box 4).

Economic Instruments & Technology Linkages

Numerous economic policies that are not directly concerned with the environment of the country, nonetheless, have an impact on the environment. The tax concessions to promote the use of agricultural residues instead of wood as raw material for paper production, by small scale pulp and paper mills, is a good example. In the absence of any techno-economically feasible solution for chemical recovery or treatment of black liquor from small pulp mills, proliferation of these mills will generate severe water and soil pollution. Whereas, the mills using waste paper as raw material, who are already in a financial crisis need to be encouraged with tax benefits, as they generate less pollution and consume less energy, to meet their increasing waste paper import bill. Several mills are in the verge of closing down their operations, in the wake of the elimination of dual foreign exchange rate.

"Not-Me-First" (NMF) Syndrome

NMF is one of the common attitudinal barriers to being the first to try any new waste minimization or Cleaner Production technologies. Therefore, the Government should use economic instruments to encourage investments in R & D and demonstration of new CP technologies. A list of economic instruments suggested by a number of environmental specialists, industrialists and economists during an interview conducted by the Center for Science and Environment is given in Box 5.

Box 3 A Summary of Economic Instruments used in Industrialized Countries

Charges: Charges are a 'price' polluters pay for using environmental services. They increase costs of production for polluting industries, so that it is profitable for industries to use cleaner processes. Various types of charges are:

- Effluent charges based on the quantity and/or quality of effluent discharged;
- User charges for collective effluent treatment by government bodies;
- Product charges are added to the price of products that, in their manufacturing or consumption stage, are polluting, or products for which a disposal system has been organized.
- Administration charges for authority services such as control and authorization fee;
- Tax differentiation is a policy by which taxes are used to bring about favourable prices for environment friendly products, and vice versa.

Subsidies: Subsidies are financial incentives for polluters to alter their behaviour, and assist them in complying with environmental standards. Subsidies are in the form of:

- Grants that are usually non-repayable;
- Soft loans at a low rate of interest; and
- Tax allowances that include higher depreciation rates.

Deposit-refund systems: A surcharge on the price of potentially polluting products. When pollution is avoided by returning the products or residuals to a collection system, the surcharge is refunded.

Market Creation: Artificial markets are created where manufacturers can trade their 'pollution rights' through:

- Emission trading, when a polluter releases less pollution than is permitted, on the basis of limits fixed collectively for a particular region, the polluter can sell or trade the difference to another firm that discharges more than its limit, thereby creating incentives to less-polluting technologies;
- Price or market interventions to facilitate the continued existence of a market;
- Liability insurance by legally establishing the liability of polluters for environmental damages or clean-up costs. Risks may be covered by insurance premiums.

Enforcement incentives: Enforcement incentives are:

- Non-compliance fees, are imposed when polluters do not comply with regulations and based on the profits resulting from the non-compliance;
- Performance bonds are payments to authorities in expectation of compliance with imposed regulations and refundable when compliance has been achieved.

Source: 'Down-to-Earth' — February 15, 1993

Government Policies & Cleaner Production

Industrial Policy

Cleaner production (CP), despite its proven benefits, has not yet become an area of focus for corporates, particularly in the Small and Medium Enterprises (SMEs). The policies themselves are not conducive to CP. The approach, if at all, has been towards making CP artificially attractive through incentives and concessions with little analysis of the causes for its limited acceptability. At the macro level, emphasis is on capital rather than resource conservation; interest rates vis-a-vis natural resource pricing would amply justify this. The SMEs are considered as employment generators and are usually built on a regime of fiscal concessions, incentives and subsidies with little credence to efficiency and economy. Their survival is dictated by the continuance of such a fiscal regime and not on genuine effort by the entrepreneur in improving his efficiency and productivity through CP.

Regulatory policy

Cleaner production is not a substitute to pollution control but only complementary. It usually has to be followed up with End-Of-Pipe (EOP) control systems in order to meet the statutory requirements. In India, the

Box 4 Regulating Hazardous Wastes: an Innovative Approach in Thailand

To control hazardous wastes from industrial sources, the Thailand Development Research Institute has proposed the creation of an autonomous Industrial Environment Fund. In line with the "Polluter-Pays' principle, the fund would be financed from waste charges that would first be estimated for each industry and later verified by environmental auditing. The charge would be set at a level that covers the cost of transport, treatment and disposal of hazardous wastes and provides a margin for running the programme. A charge of 1,000 Baht per ton on the 600,000 tons of industrial hazardous wastes projected for 1991 would raise 600 million Baht. This is only 0.3 percent of the GDP originating in the 17,000 industrial plants in Thailand that generate hazardous wastes, or 1.5 per cent of net profits.

The proceeds would be used to establish and operate central treatment and disposal facilities for hazardous wastes collected from factories. Factories would deposit with the fund their waste charges for the entire year. Plants that attained lower waste per unit of output, as verified by accredited private environmental auditing firms, would then be eligible for rebates. The operation of the treatment and disposal facilities would be contracted out to private waste management firms through competitive bidding.

The main message of this initiative is that pollution control costs can be minimized if the incentives are right. The more efficient an industry's production process, the less waste it generates and the less it pays for waste treatment and disposal. The scheme would thus give industry an incentive to reduce wastes and would encourage the development of business opportunities in hazardous waste management.

Source: World Development Report, 1992

prevailing environmental rules and regulations hardly provide any incentive for cleaner production. Except for a few cases, the emphasis is on concentration based emission standards instead of load based or output related standards. The prevailing regulations do not discriminate the extent of deviation from statutory requirements; penalty is same whether default is by a factor of 2 or 20. Thus, industries prefer to take recourse to EOP control approach to meet their statutory obligations rather than spending time and effort on CP. It is almost two years the Government of India (GOI) has pronounced its policy statements on 'Abatement of Pollution' and 'National Conservation Strategy' but the intentions listed in these statements have not yet been operationalized.

Further, in the absence of strict enforcement of the environmental laws, the waste disposal costs are almost negligible. When the enforcement is rigid, it prompts the SMEs to reduce the waste disposal costs through CP measures. A typical example is the case of tanneries at Kanpur which, unlike their counterparts in Calcutta or elsewhere in the country, are closely monitored as part of the Ganga Action Plan. The result is that the tanneries at Kanpur have now adopted chrome recovery as part of their process, whereas others are still engaged in the prodigality of dumping this recoverable resource in to the drain.

Investment policy

Often the high cost of already scarce capital results in lack of adequate funds for CP related project investments. Also the financial institutions are keen to sanction new projects or expansion schemes, rather than for replacing or modifying the plant and machineries for cleaner production. Even when the funds are available the high capital cost makes the CP investments unattractive as the pay-back is not always viable. Surprisingly there are no fiscal incentives for CP, although a lot of such instruments are available for EOP control measures. For example, EOP investments are now eligible for an accelerated depreciation rate of 100%.

Institutional development policy

There are no specific policies or concerted efforts to promote the concept of CP through the development of and support to institutions and non-governmental organizations (NGOs) despite their well established need in technical as well as educational field. For example, the efforts made in other similar areas, like energy conservation, can be extended to cover CP as well. Industry Associations and Professional bodies such as the National Productivity Council should be strengthened to provide an effective advisory service for industries. The Policy Statement of the Government of India on 'Abatement of

Box 5 Suggestions for new Economic Instruments

The following suggestions for green taxes and financial incentives include those mentioned by a number of environmental specialists, industrialists and economists during a recent interview conducted by the Center for Science and Environment.

- Entrepreneurs to be encouraged to set up companies that will operate common waste management plants on commercial basis. Financial incentives for these plants to include seed capital to set up treatment plants and to exempt their income from tax.
- Financial institutions to provide soft loans and accelerated depreciation rates for investments on 'Cleaner Production Technologies'.
- To promote the manufacture and use of 'Ecomark' products, the government to provide excie duty reliefs; preferential purchase by the central and state governments and public sector agencies.
- Industries that practice resource conservation and waste minimization measures are to be encouraged. The government to compute national norms on average consumption of critical resources for manufacture of various products, such as paper. Industries that consume less than the average are to be rewarded with tax concessions. These norms are to be periodically reviewed and scaled down progressively.
- Fiscal incentives in the form of income tax concessions are to be provided to producers of compost and bio-fertilizers.
- Water intensive flush toilets, used by the rich are to be taxed heavily. Development of water-saving and non-water consuming compost toilets are to be encouraged.
- Water cess to be made more rational and comprehensive.
- In case of industries using critical natural resources and causing significant environmental degradation, an 'Environment Cess' based on annual production or turnover is to be levied to finance eco-regeneration operations, clean-up operations, and treatment plants.

Pollution' adopts an escapist attitude by a feeble reference to the steps to be taken to strengthen governmental and institutional structures dealing with environmental management.

Conclusion

Economic efficiency and environmental management policies are complementary to each other. Experience has proved that the industrial output could be increased several times with reduced wastes. This requires accelerated investments for development and adoption of cleaner production technologies, stronger environmental institutions, supported by innovative environment policies and open trade and capital flows. The key to sustainable growth, therefore, is not to produce less but to produce efficiently.

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Integrated Waste Management

Surya Prakash Chandak

Waste Management is struggling to come out of the clutches of 'Treatment and Disposal' protagonisation. Instead of looking at wastes with disgust or fear we need to find appropriate opportunities for reducing, reusing or utilising them. The environmental emphasis needs to shift from controlling pollution to waste avoidance. The research and development need to address the problems of waste minimisation techniques and evolve, technologies of converting wastes into useful products and environment friendly wastes disposal, argues the author.

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Development today is synonymous with economic development which, in turn, is normally assessed by increase in quantum of production, be it agricultural or industrial. In his quest for development and improving lifestyles, man has consistently sought conversion of materials as available in nature into useful products. Thus, iron ore undergoes a series of processes to get converted into steel and then to a useful car. Coal undergoes another series of operations to release heat energy which is then converted to electricity to light our houses and run the motors. We even augment the natural processes through artificial inputs to either speed them up or increase the output. Addition of fertiliser helps in growing more grain per acre of land, use of pesticides helps in controlling plant diseases and so on. However, all these operations are associated with 'side effects'. The conversion processes invariably generate wastes. Manufacturing steel from iron ore generates slag. Making electricity from coal releases fly ash.

There are two basic causes of waste generation: Technical inefficiency, and managerial inefficiency. Technical inefficiency relates to generation of wastes due to limitations posed by the technology and unless the technology itself is changed nothing can be done to reduce the waste. With the present level of technology it is not possible to convert the entire heat content of coal into electricity. Managerial inefficiency arises due to inadequate operation and maintenance and waste arising out of this can be reduced.

Status of Waste Generation in India

Industries in India, in most of the cases, have a higher waste generation propensity than their counterparts elsewhere in the developed countries. The amount of waste generated by some major industries in India is given in table 1. This has the dual impact of creating higher pollution levels as well as lower competitiveness of the industry.

Table 1: Major Industrial Wastes in India

Industrial Sector	Quantity MTPY	Types of Wastes
Steel Industry	35.0	Blast Furnace slag
Caustic Soda	0.02	Brine mud
Copper Smelting	0.164	Copper slag
Thermal power Plants	30.0	Fly ash
Cement Plants	1.6	Kiln dust
Sugar, paper, soda ash fertiliser, tanneries, calcium carbide	3.0	Lime sludge
Mica Mining	0.005	Mica dust
Phosphoric acid and Ammonium Phosphate Plants	4.5	Phosphogypsum
Mining & Extraction of Alumina	2.65	Red Mud/Bauxite

Source: National Waste Management Council; (1990)

Industries in India, in most of the cases, have a higher waste generation propensity than their counterparts. This has the dual impact of creating higher pollution levels as well as lower competitiveness of the industry.

The relatively inexpensive availability of resources like water leads to their indiscriminate usage resulting in higher level of waste. The water requirement for different industries in India is given in table 2.

Table 2: Water Requirement for Different Industries in India

Industry	Volume of water used
Dairy	6-10 litre/litre of milk
Sugar	15-40 litre/kg of sugar
Distillery	20 litre/litre of alcohol
Cotton Textiles	10-70 litre/meter of cloth
Viscose rayon	1600 litre/kg of fibre
Pulp & paper	270-450 litre/kg of paper
Tannery	40-45 litre/kg of hide
Integrated Steel Mill	20-50 litre/kg of steel
Urea	6-8 litre/kg of urea

Source: Sundaresan (1993)

It could, therefore, be concluded that the problem of industrial, waste is enormous and requiries concerted effort to promote industrialisation without compromising the quality of environment.

Integrated Waste Management

Integrated Waste Management, as the name indicates, is a holistic approach which encompasses all aspects ranging from waste generation to its disposal. Instead of the conventional approach of looking at waste in a piecemeal manner—treatment, disposal, exchange etc.— the integrated approach favours simultaneous dealing with all options of waste management. These options could be categorised into three areas: Waste Minimisation, Waste Utilisation, and Waste Treatment & Disposal.

Integrated Waste Management, as the name indicates, is a holistic approach which encompasses all aspects ranging from waste generation to its disposal.

Waste Minimisation

The approach to waste minimisation refers to a set of activities aimed at reducing the generation of wastes. It is a new and creative way of thinking about products and process that make them. The reduction in waste generation is effected by application of one or more of the following strategies:

Source Reduction

- Good housekeeping
- Input material change
- Better process control
- Equipment/Technol ɔgy modification
- Product Change

Recycling

- Recovery of useful material
- Reuse

Industries in developing countries have particularly significant waste minimisation opportunities due to the following reasons:

- Continuance of obsolete, inefficient technologies
- Lack of technical expertise and skill for optimum operation and maintenance of process/requirements
- Lack of instrumentation and process control
- Emphasis on 'Production' instead of on 'Efficiency of production'
- Lack of competitive market.

Studies conducted by the National Productivity Council and other agencies have demonstrated waste minimisation potential ranging from 10 per cent to 50 per cent in India (Table 3).

Table 3: Extracts from NPC Studies on Waste Minimisation

1. The case of Misplaced Boiler Draft

Problem

In a spreader stoker coal boiler, the particulate emissions were found to be about 1300 mg/Nm^3 and the total heat loss comprising of stack loss and unburnt loss was also above 20%

Waste Minimisation Measures

The combustion air supply to the boiler was controlled by adjusting the induced and forced draft settings. Optimisation exercise was carried out to achieve lowest stack loss as well as unburnt loss in ash.

Benefits

The particulate emissions came down to 900 mg/Nm^3 and also the heat loss came down to 17.8%.

Enabling Measures

Increase in the price of coal which forced the management to take steps for fuel economy; Technical assistance in identifying the problem and implementation of solution; Training of boiler operators in efficient boiler operation.

2. The case of Unsafe Safety Match

Problem

In a safety match unit the dip solution, comprising various hazardous compounds to form the head of a match stick, was getting contaminated due to dropping of match sticks. Periodically, the dip solution was filtered and the sticks retained on the filter cloth were disposed of in the drain

Waste Minimisation Measures

Rinsing of the sticks with fresh and reuse of rinse water for making up the fresh dip solution. The washed match sticks were sent to boiler for burning.

Benefits

Pollutions and need for effluent treatment eliminated. Recovery of dip solution equivalent to US $ 6000 per year.

Enabling Measures

Enforcement of Hazardous Waste Management Act, which imposes quantity based restrictions on handling and disposal of hazardous waste.

3. The case of Missing Milk Shake

Problem

In an Ice Cream factory non-availability of space and limited funds were constraining the installation of waste water treatment plant required for treatment of effluent specially from equipment washing.

Waste Minimisation Measures

The procedure of Ice Cream Vat rinsing was modified from continuous rinse to batch rinse. A demonstration exercise was carried out to convince the management of the efficacy of cleaning and its impact on pollution load reduction without compromising on ice cream quality

Benefits

BOD load reduction by 61.5% and a capital cost reduction on Waste Treatment Plant by 43% was achieved. The space requirement for Waste Water Treatment Plant came down by 45%. The resultant rinse water was collected and found to be an excellent milk shake and sold as such.

Enabling Measures

Enforcements of regulations; Financial benefits; Technical help for process modification; Demonstration to convince the management.

4. The case of Coal Emissions

Problem

In down draft pottery making kiln, the prevalent coal combustion practices were generating thick smoke immediately after each firing and specially during the later half of the kiln cycle. This resulted in violation of emission standards (1200 mg/Nm^3 and poor thermal efficiency.

Waste Minimisation Measures

The firemen were trained in correct firing practices and combustion management. The firing practices were changed from heavy firing (4 shovels per firing) to lighter firing (more frequent but 2 shovels per firing). The induced draft fan capacity was also augmented and complemented with draft control systems

Benefits

The particulate emissions reduced from 3000 mg/Nm^3 to 1100 mg/Nm^3 thereby avoiding the need to instal and expensive Air Pollution Control system. In addition, the industry saved 28% fuel due to better combustion efficiency. The quality of wares also improved and the rejection came down by 50%.

Enabling Measures

Strict enforcement of emission regulations; Financial benefits; Training of Operators.

Source: Panneerselvam & Chandak (1992)

The economics of most of the Waste Minimisation options is usually attractive and it could be made still more attractive by appropriate resource pricing and other measures (table 4).

Waste Utilisation

Waste Utilisation refers to measures promoting the philosophy: 'Your waste is my raw material'. The industrialisation in the last 50 years has been based on

maximising the use of naturally occurring resources — iron ore, oil, coal, etc. Technology development has been treated synonymous to converting natural resources into useful products. Little attention was paid towards converting wastes; either generated during conversion process or the discarded products after serving its function.

Table 4: Strategies to promote Waste Minimisation

Rational pricing of natural resources giving due weightage to their cost of exploitation and also the 'Cost in Absence'.
Preferential purchase in the Government sector of products made in 'Low Waste Factories'
Creation and Promotion of Waste Minimisation Circles in Industrial Clusters
Promotion of technical institutions specialising in Waste Minimisation
Shift from concentration based effluent standards to load based standards.

Waste Utilisation refers to measures promoting the philosophy: 'Your waste is my raw material'.

One of the reasons for continuance of such practices was the cost and convenience of using natural resources than wastes. The abundant availability of the former and totally free disposal of the latter further propelled the attitude of 'Mine more, make more'. The times are fast changing now — the resources are becoming scarce and disposal costs are mounting. One has to start thinking in terms of 'Cradle to Cradle' approach instead of its 'Cradle to Grave' counterpart. The obvious and imperative solution is to develop products based on wastes. The possibilities are immense, a few simple ones are shown in table 5.

Developing countries have an inherent advantage-their low wage earning level also offers an opportunity. The power of the poor can be converted into a force for collection and segregation of wastes; the rag pickers and junk dealers already form an important part of our society. The cost of collection and sorting could thus be very low in developing countries thereby improving the financial viability of waste utilisation. Some of the obvious benefits of waste utilisation are:

- Reduced pressure on the natural resource extraction and consequently less adverse impacts on environment
- Prolongation of life of exhaustible resources
- Employment creation
- Reduced disposal costs
- Reduced land requirement for waste dumping

However, there could be certain pitfalls as well which need to be taken care of:

Table 5: Products Obtainable from Important Industrial Wastes

S. No.	Industrial Waste	Source Industry	Potential for use
1.	Flyash	Thermal Power	i. In portland pozzolana cement
			ii. In construction industry
			iii a. Dam construction
			b. Land reclamation
			c. Road construction
			iv. Cellular concrete
			v. Lime flyash bricks
			vi. Sintered light weight aggregates
2.	Blast furnace slag	Steel Industry	i. As a component in blast furnace slag cement
	i. Granulated		ii. As a component in binding material
	ii. Ungranulated		i. Road aggregate
			ii. Slag wool
3.	Lime sludge	Fertilizer, Sugar, Paper & Acetylene industry	i. As raw material in cement manufacture
			ii. In lime pozzolana mixture
4.	Chemical gypsum	Fertilizer industry	i. As a set controller in the manufacture of cement in place of mineral gypsum
			ii. For making gypsum block bricks
			iii. Light weight structural blocks

Source: National Environmental Engineering Institute (1988)

Product quality: Bricks from fly ash could sometimes be inferior to products from virgin natural resources unless appropriate corrective measures are taken.

The processing of waste should be environmentally benign and appropriate to ensure that the same should be built in.

Quite often the price of waste starts increasing as its demand rises and availability drops, thereby upsetting the economics of its utilisation e.g. in Northern India, in sixties the rice mills used to pay for lifting the rice husk from their premises whereas in nineties the same is being sold at Rs. 600 per tonne.

A few strategies for promoting waste utilisation are given in table 6.

Rightly do some visionaries prophesise that 'The entrepreneur of 21st Century would be the one who sets his eyes on waste'

Table 6: Strategies for promoting waste utilisation

Intensive development and promotion of technologies/products utilising wastes
Fiscal incentives viz. excise reliefs to products based on wastes as compares to similar products made from natural resources
Creation of market forces for promoting products from waste e.g. banning brick making from top soil in regions having sources of fly ash
Mandatory linkages of waste generating and waste utilisation industries in case they are techno-economically viable
Creation of market driven incentives e.g. capital subsidy for biomethanation.

Waste Treatment & Disposal

Notwithstanding the developments in science and technology since Industrial Revolution, total 'Waste Free' or 'Zero Waste' manufacturing is still a pipe dream. The manufacturing processes, despite the best efforts put in for Waste Minimisation and Waste Utilisation, still

Table 7: Liquid Effluent and Sludge Treatment System matrix

Process	Control Parameter	Industries
Adsorption	BOD, COD, Toxic compounds color	Dyes and Intermediates, Textile, paper, pharmaceuticals, pesticides, fruit canning petrochemicals, rubber chemicals, manmade fibers
Air Stripping and Stream stripping	Volatile organics	Dyes and intermediates, textile, paper, pharmaceuticals, pesticides, fruit canning, petrochemicals, rubberchemicals, manmade fibers.
Biotechnology Conventional	BOD, COD	For all industries biodegradable and difficult to biodegrade
Advanced Microbial cultures and enzymes	BOD, COD	-do-
Fixed film bioreactor package units for small industries	BOD, COD	-do-
Disinfection Conventional Ozonation	Pathogens See "Ozonation and other chemical oxidation reduction processes"	
Ultraviolet	Pathogens	
Dissolved Air Flotation	Suspended solids and oil and grease	Metal processing and finishing, petroleum refining and petro-chemicals, dairy, edible oil, textile processing, dyestuff, tanneries, food and fruit processing
Electrodialysis		Metal processing and finishing, caustic soda
Evaporation and Crystallization	Toxic organic and inorganic	Pulp and paper, distillery, metal processing and finishing, textiles, organic chemicals, and petrochemicals
Incineration (Thermal Treatment)	BOD, COD Toxic organics	Paper, distillery, tannery, Pharmaceuticals, pesticides, Petrochemicals, petroleum, dyestuff intermediates
Exchange	Heavy metals, NH_3 cyanides, fluorides	Caustic soda, fertilizer, manmade fibers, rayon, pulp and paper, distillery, pharmaceuticals, metal processing and finishing, electronics, ferrous and nonferrous
Ozonation and Other Chemical Oxidation	BOD, color, odor, refractory organics, toxic chemicals, pathogens	Iron and steel manufacturing dyes and intermediates, pharmaceuticals, paper, pesticides
Reverse Osmosis	Dissolved ignorances	For all industries for reclamation of water
Sedimentation	Suspended solids, oil, grease	All industries
Conventional Tube and plate settlers	Suspended solids, oil, grease	All industries
Sludge Handling Treatment and Disposal	—	All Industries

Source: Tropical Research & Development Inc. (1991)

generate some wastes. Attention should now be focussed on the best possible treatment and disposal of this waste to render it as environmentally benign as possible. Surprisingly, this last step in the hierarchy of Integrated Waste Management has been so far taken as the first and often the only step in most of the countries. The results have been obviously disastrous; increase in manufacturing costs, environment protection becoming a necessary evil, development of a multibillion dollar 'environment industry' without any value addition, beginning of a cat and mouse relationship between the regulatory bodies and industries etc. Strict implementation of 'command and control' approach has forced the entrepreneur to set up ventures in regions of leniency; an excellent illustration of shifting polluting industries from developed to developing countries.

Attention should now be focussed on the best possible treatment and disposal of this waste to render it as environmentally benign as possible.

The waste treatment technology is, by far, the most developed dimension of waste management. From the centuries old technology of bio degradation to modern ones like plasma degradation, waste treatment has travelled a lone way. Some of the well known treatment technologies are enumerated in tables 7 and 8.

Table 8: Air Pollution Control Matrix

Process	Control parameter	Industries
Mechanical	Particulate matter in small and medium industries	Boilers, dryers, kilns
Bag Filters	Particulate matter and some gases by dry scrubbers	Cement, boiler, chemical flour mills
Scrubbers	Particulate matter, gases	Glass, ceramic, cupolas, foundries, cement, rayon, mining, quarrying, steel
Electrostatic Precipitators (ESP)	Particulate matter limited gases	Power boilers, kilns, coal mills, dryers, coolers, pulp and paper, chemical

Source: Tropical Research and Development Inc. (1991)

Comparatively, the field of 'waste disposal' has not been developed as other areas in waste management. Landfill continues to be the predominant method specially for hazardous wastes. Using the assimilitative and dilution capacity of the environment, discharging liquid effluents into water bodies and gaseous emissions into atmosphere continues to be practised round the globe. Land treatment which exploits the natural capacity of the soil to return substances to a condition approaching the original state from which they were won by a process of extraction and purification is yet to be fully developed. Hazardous and toxic wastes which are difficult to treat are immobilised (converting the waste into a chemically more stable or immobile form), solidified (converting the wastes to a insoluble rock like material) and encapsulated (coating or enclosing wastes with an inert durable material) before final disposal. Deep sea dumping, quite often illegally, is also resorted to by many a waste generator. A common thread which runs through all the waste disposal methods is that the disposal costs are increasing while disposal sites are decreasing. The only long term sustainable solution, therefore, is to minimise the quantity of waste itself rather than exploiting new sites or alternative methods of disposal.

The only long term sustainable solution, therefore, is to minimise the quantity of waste itself rather than exploiting new sites or alternative methods of disposal.

A few suggested strategies for waste treatment and disposal are given in table 9.

Table 9: Strategies for Waste Treatment & Disposal

Treat only unavoidable and unusable wastes; waste segregation helps in reducing the quantity and volume of such wastes
Maximise use of natural methods of waste treatment; viz. bio degradation, vermiculture, etc.
Treatment technologies should preferable 'kill' the waste instead of merely changing its form; detoxifying cyanide and converting it into carbondioxide and ammonia is a better waste treatment technology than an electrostatic precipitation which simply knocks down particulate matter from gaseous stream (the example hopefully illustrates the concept although it means comparing horses and mules)
Required treatment levels to take cognizance of aspects like assimilative capacity of environment, background pollution trends, damage costs, treatment cost etc.
Preference to disposal techniques which permit reuse of disposal area e.g. land treatment instead of secured landfill.

Conclusions

The last twenty years of work in environment protection was aimed principally at 'End of Pipe Control' through

the typical command and control strategy. The strategy has failed and despite spending enormous amount, the planet continues being slowly converted into a large waste yard which eventually may turn into a grave yard for mankind. The recent emphasis on Cleaner Production and Waste Minimisation is on one extreme taken as a panacea to all the environmental problems and a mere pep-talk on the other. None of the two extremes are reasonable.

Formation of national and global environmental strategies based on a prudent blend of the components of Integrated Waste Management seem to be the best approach for ensuring sustainable development.

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Eco-management Strategies

Bernhard Meyhoefer

There are those who view the ecological crisis as a question of survival in the industrialized world, even as a 'matter of life or death', and who speak of the 'destruction of the life-sustaining ecosystem'. But there are others whose attention span for this issue is as short as for a passing fashion. A particularly popular approach is procrastination: building ever higher chimneys, moving rubbish dumps out of town, merely shunting the problem further away and just transferring waste from one medium to another. These measures may be necessary and meaningful for winning time. But we must use the time we have gained — the big problem is still out there! The author outlines strategies for trackling this massive problem.

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The currently predominant 'curative environmental protection' makes technologists largely responsible for the preservation of the environment; it is vital, however, that the role of commercial personnel is not discounted. Environmentalism must be an integral part of every level of the business enterprise. Consumers, tend to overlook the part played by the end product in environmental problems, and see themselves as somehow less responsible for damage to the environment than manufacturers. It has to be made clear that the threat to the environment is not confined to spectacular catstrophes or particular branches of industry but involves routine consumer behaviour too.

The threat to the environment is not confined to spectacular catstrophes or particular branches of industry but involves routine consumer behaviour too.

It is no longer possible for public or private sectors of economy to push the environmental consequences of their actions to the background. Since industry has created many of the problems we face, it must present the solutions too. Government cannot meet the ecological challenge alone and so the central sociopolitical role must be performed by the business community.

Eco-friendly Management

Responsible human activity is always goal oriented. Therefore environmentally oriented management and marketing should be the major goal in corporate policy. Management awareness will not be achieved overnight, but someone has to make the first move.

Since a return to the age of the bicycle would be impossible it is incumbent upon industrialists to solve the

problem or the environment before their future is negatively affected.

Four strategies for corporate adaptation are possible:

- passivity
- reactive behaviour
- confrontation
- creative transformation

A corporate policy strengthened by the awareness of ecology transcends mere considerations of profitability and can also lead to competitive advantage. Ignoring the demands of environmental protection, concealing the environmentally harmful aspects of a product and playing down environmental problems, lead to loss of image and profits as well ultimately.

The demands of ecological production and consumption do sometimes present economic threats but they also provide new opportunities.

The demands of ecological production and consumption do sometimes present economic threats but they also provide new opportunities. The winners in this situation are not the suppliers of rapidly growing environmental technology, but the manufacturers devoted to competitive, environment friendly production methods and products because:

- disposal problems are solved in favour of the producer or consumer
- integrated concepts reduce the risk of liabilities
- new product design improves sales eco-friendly segments of the market

The losser in this situation are the manufacturers:

- whose production methods, under social and legislative pressure, incur large expenses in avoiding pollution
- whose products are subject to growing criticism — ranging from pressure for substitution to a total prohibition
- whose capital is the 'damaged' environment (e.g. tourist industry, fishing industry etc.)

The following procedure can be used to set up and run environment oriented management:

- Identify the key ecological problems in the business
- Inculcate ecological concepts in the values of management and staff (transformation of business culture)
- Use the results of the current-status analysis to check and expand corporate policies
- Draw up an integrated system of objectives
- Decide on adequate strategies
- Ensure that ecological concern pervades every aspect of the business and is embedded in institutional forms by nominating supervisors, and environment committee etc;
- Instal an eco-controlling system for planning and control of environmental measures

Guaranteed success for the introduction of environmental measures depends on corresponding motivation. Not only top management but also the staff at all levels must be persuaded that the new eco-policies make sense. The following priorities should be adhered to:

- Preventive concepts — using integrated technologies to stop ecological damage happening in the first place
- Reduction strategies — using technology to minimize unavoidable damage
- Exploitation strategies — feeding waste materials into a system of recycling
- Disposal concepts — safely disposing of any waste left after running through the above procedure

Development of Environmental Strategies

It is the responsibility of strategic management to ensure the future competitiveness of a company by developing or initiating success potentials such as image, competence or share of the market. Successful management will have to expand its sphere of influence to embrace a considerable wider concept of the environment including ecological and social as well as economic and technical factors.

Companies respond to ecological concerns in basically two different ways:

- passive strategies of environmental protection — responding to governmental pressure
- active strategies of environmental protection

Proactive environmental protection is preferable to a defensive position, because:

- defensive behaviour means that chances of lowering costs and increasing turnover are missed in the long term

- defensive behaviour provokes growing pressure from environmentalism
- eco-friendly product creation can be cheaper
- many companies lose image through clumsy, defensive handling of information

Organisations can be categorised into four different groups on the basis of the strategies adopted:

- *Innovative type*: pursuing active, customer oriented marketing
- *Socially responsible*: characterised by high degree of ecological concern
- *Adaptative type*: Not having an ecologically based marketing strategy, but only as much as legally necessary
- *Ignorant type*: having neither an ecological marketing strategy nor an active environmental strategy

Ecological strategies demonstrate innovation, co-operation and communication. Innovation applies to all three environmental protection objectives: use of resources, limitation of emissions and limitation of risks. Co-operation is particularly relevant to other agents in the production chain (consumer, trade etc.).

Innovation applies to all three environmental protection objectives: use of resources, limitation of emissions and limitation of risks.

Environment oriented production

The concept of prevention sees the complete process of procuring raw materials, production and disposal as a unified whole. Optimization must embrace ecological as well as economic and technical criteria. However, even after preventative measures, industrial production inevitably produces some kind of residue. To reduce this residual burden, the ecological instruments (i.e. prevention, reduction or reuse) must be applied at two levels:

- At production level
- At the level of products themselves, at development, consumption and disposal stages (table 1)

Table 1: Waste Management at Various Stages

Production phase	Sales consumption and use phase	Disposal phase
• Use of environment friendly, low energy materials	• Minimum damage to environment and health through packaging	• Low volume of waste
• Use of readily available raw materials	• Recyclability, reusability of packaging	• Problem-free opportunities for dumping, incineration or composting
• Minimum use of resources	• Minimum production and packaging volume	• Minimum disposal volume, by means of re-exploitation (even of parts)
• Maximization of product life-span	• Safeguard to health during consumption and use	• Recycling of waste products
• Product-related contribution to emissions and energy factors in production	• No gaseous emissions or only environmentally compatible emissions during consumption and use	• With dangerous waste: Easier re-exploitation or possibility of separate collection and disposal
• As far as possible, intensification of production (and sales) not only of relatively environment-friendly products (quiet cars with catalytic converter), but also absolutely environment-friendly products (bicycles and biologically famed produce)	• No effluents or few effluents which can be removed in an environment-friendly way • Energy-saving use and consumption phase • Low-noise use and consumption phase • Facilitation of the most environment-friendly and economical use (product instructions, customer service and consultation) • Increased ease of repair and maintenance, easy replacement of parts subject to wear • Other ways of increasing life-span (style function and materials)	• Problem-free, energy exploitation by means of waste incineration

The concept of prevention sees the complete process of procuring raw materials, production and disposal as a unified whole. Optimization must embrace ecological as well as economic and technical criteria.

At the production stage, planning and implementation, prevention strategies are largely technical problems. Thinking in terms of the circulation of usable materials, we must consider the cycles of actual substances we use, paying particular attention to the protection of natural resources and limiting emissions.

An ecologically focussed research and development department offers the best prospects for improving the success rate of environmental business strategies. R&D provides the essential information for the future introduction of new, directly effective instruments of corporate environment policy. For this reason, R&D can be described as a preparatory stage to environmental protection, providing the technical know-how needed for the direct introduction of strategic goals. It provides a basis for the use of instruments of adaptation, such as new production methods or new forms of waste disposal.

There will be rising demands on all companies in the area of eco-production:

- By inspection and enforcement agencies ensuring compliance with environmental laws
- Through additional requirements in refuse and ground protection for the treatment of air and water
- Through intensified environmental liability and increased security against accidents

Ecological process development concentrates on the reduction of resources used during production, and also on reducing pollution output through efficient curative cleaning or the use of clean technologies. The production process has to be modified to minimize both resources used and residues formed. ***Even if no form of production is completely eco-neutral, the least we can do is to choose the most eco-friendly.***

The most difficult task facing engineering is to create 'closed cycles'. Residues, subsidiary materials and fuels have to be fed, through purpose-built circulatory systems, back in to the production process. The finishing departments are increasingly responsible for this type of environmental technology to manage not only raw materials but also issues of disposal which are best dealt with internally, — i.e. preventively.

Once environmentally sound production methods have been developed and are on the market, decisions on new investment should be based not only on increased productivity but also take into account any resulting reductions in the use of resources, reduced waste, pollution and so on. Since energy is vital to all industrial activities, developing efficient management of this scarce and costly resource will be of paramount importance in the design of new production processes.

An attitude of environmental awareness at work is equally important: *All processes of production and all damage to and protection of our environment depend on how individual people work. No matter how advanced the environmental technology is, its efficiency in the long run depends on the measure of environmental awareness enjoyed by those who operate it.*

Internal environmental audits

Management is not just a question of setting goals and providing the means for fulfilling them — it also implies control over the way these goals are achieved. Environmental protection is an important aspect of corporate strategy and it therefore requires efficient management methods, Thus far, supervision of environmental factors has been limited to ensuring compliances with legal restrictions and has been delegated to the environment officer. The purpose of an audit should be not simply to provide information on the efficient functioning of the relevant plant and other facilities, but to make sure that the management and the entire organizational structure of the company are serving the goals of environmental protection. This control system, therefore, assists in business decisions at all levels. The long-term ideal to be pursued in this context is the implementation of voluntary internal audits, which involve the systematic, regular assessment of internal environmental measures at all levels, culminating in a summary evaluation. This should ensure that environmental protection receives the same amount of attention as other operational areas, that a company's activities and products can be evaluated in terms of ecology, and that potential risks are specified.

Environmental audits are a very important element of management. The execution of an audit involves:

- gathering information on the current state
- evaluation of information
- deciding on measures

Management is not just a question of setting goals and providing the means for fulfilling them — it also implies control over the way these goals are achieved.

Several different types of audit can be adopted (Financial Times, 1990)

- Compliance audit, to ensure that a company is conforming to legislative regulations
- Site audits — spot checks of sites
- Issue audits — audits of distribution activities
- Full environmental audits of the whole company

For the president of the Confederation of British Industry, the potential benefits of environmental audits are as follows:

- Providing an early warning system
- Increasing employee awareness
- Facilitating insurance cover
- Providing an information base against which environmental performance can be tested

Environment oriented Product design

The marketing term 'product life cycle' is confusing from an ecological point of view because residue from production can take years or even decades to disperse. The harmful effects from a given product occur in a time scale which makes this type of residue seem like history to the manufacturer and the purchasers. Environmental simulations can be used to a great effect to gain an understanding of the reciprocity between object and environment, and to adapt a product to its environment. Environmental testing contributes to the environment of materials and the minimization of packaging by simulation of the transportation procedure, and can investigate the properties of recycled materials in new application.

Environmental simulations can be used to a great effect to gain an understanding of the reciprocity between object and environment, and to adapt a product to its environment.

'Construction constitutes less than 8 per cent of the overall cost of a product but it determines about 70 per cent of the final cost' (Stahlmann, 1988).

Disposal and usage are becoming most important decision-making factors at all levels of business from product development to choice of materials and finishing methods.

Product design operates on three levels:

- Economic: as a marketing instrument, influencing customers
- Production policy: as a direct determining factor of the production process
- Ecological: side-effects of production, use and disposal, e.g. product design for recycling and safe disposal

Decision makers must be familiar with the ecological effects of alternative product designs in order to decide where the ecological advantage lies. In a sense, the whole fate of a product, from cradle to grave, has to be considered in terms of waste. 'If the analysis is limited to one phase of production, then changes made might have effects on earlier or later stages, which override the advantages gained from the phase analyzed' (Strebel, 1981).

The whole fate of a product, from cradle to grave, has to be considered in terms of waste.

The phase of production design must be interpreted very widely, with regard to its effect on eco-management. All of the following need to be taken into account:

- Measures within the actual production phase
- Measures already taken at the product development stage
- Retrospective measures such as recycling and disposal following use of the product

Collaboration and the combined knowledge of countless experts is vital to the development of an environment-friendly product.

Two types of improvement can be made during production through product design:

- Increasing the net product per unit. This means a quantitative saving in preliminary stages or a

qualitative functional increase in the value of the products

- Reducing the effects on the environment per unit through changes in the product at the manufacture, use or disposal stage

If ecological demands are to be met by means of eco-product design, the products must have the following general properties:

- Improved environmental qualities
- 'Friendly' input of resources
- Long-life characteristics whenever possible
- Easily repairable
- Improved possibilities for reuse and harmless disposal

The cost of implementation can be a problem. The need for investment often inhibits technical progress.

The market price for ecologically scarce materials is sometimes considerably lower than for abundant materials. This causes business to opt for the scarce raw materials out of competitiveness rathar than considering their product design measures (Müller -Wenck, 1980). An example is crude oil which, although very scarce, is often sold at rock bottom prices.

If there is already an increase in environmental awareness in a given market sector, and a corresponding reaction from competitors, a company should intensify its environmental product management. According to Wicke (1990) the following issues have to be clarified in the planning phase:

- Official environmental regulations, consumer requirements, other demand factors (e.g. trade, public involvement)
- Eco-friendliness of own and competitor's products
- Alterations to research, development, production, input materials and their effect on liquidity, costs
- Price and market preparedness
- Competitior reactions
- Changes in circle of purchasers and in the sales system

Since the terms'natural', 'bio', 'eco' and 'environment friendly' are not legally protected they are often abused. For this reason, fulfilling eco-criteria set out by independent institutes can have a beneficial influence on sales (e.g. Eco-Test or 'Stiftund Warentest' in Germany).

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The Power of Goals

You can want to do the right thing,
and you can even want to do it for the right reasons.
But if you don't apply the right principles,
you can still hit a wall.

Waste Minimization Programme for Small Scale Industries — An International Perspective

Ralph A. Luken & Ritu Kumar

This paper describes a few key strategies and policy measures that should be adopted in order to better manage and reduce the pollution emissions and wastes emanating from the Small Scale Industries (SSIs). The arguments were supported by examples of policy reforms and successes achieved in some developing and developed countries.

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In many instances, a few large scale industrial sectors, such as chemicals, ferrous and nonferrous metallurgy, paper and pulp, cement and mining, are responsible for a significant share of the industrial pollution problems of both the developed and developing countries. However, and especially so in developing countries, small and medium scale industries which contribute to a major part of the productivity growth and employment also become collective sources of localized pollution loadings such as organic wastes in water effluent, as well as hazardous wastes — heavy metal sludge, solvents, waste oils, acidic and alkaline wastes, photo wastes etc. Often these wastes are disposed of in an unsafe manner and are extremely difficult to monitor. These problems are further compounded by the fact that for many of the industries the costs of control in relation to output may be too high. Often such enterprises operate in highly competitive markets and are only marginally profitable, so even a modest increase in the costs (of environmental regulations) may threaten their viability. Even though the technological solutions for pollution prevention and control may be well known and easily available, there is no guarantee that they will be adopted. Moreover, even when policy measures are in place, their enforcement and monitoring is a real problem for the small and medium scale sector on account of their large numbers and diversity. A large number of these firms are not even recorded in official surveys further aggravating the problem of enforcement. The waste management problems of SSIs require special attention and special measures and innovative approaches are needed to address their particular problems. The recommended strategies for the prevention and control of pollution emissions and wastes may be classified into three broad categories — policy,

institutional and enterprise levels. Ideally measures taken at any of the three levels should be well coordinated and harmonized.

Small and medium scale enterprises operate in highly competitive markets and are only marginally profitable, so even a modest increase in the costs (of environmental regulations) may threaten their viability.

Policy Level Actions

Assign priority to pollution prevention rather than pollution control

While the cost-effectiveness and precautionary aspects of pollution prevention are key to its advantages, it is also important to understand that urgent environmental problems often result in the use of readily available, off-the-shelf and sometimes more familiar end-of-pipe solutions. The later may seem attractive because they can be added without confronting more difficult changes in the systems that produce pollution and waste. Moreover, the end-of-pipe approach has numerous advocates in consulting engineers and a large industry selling the hardware of pollution control (e.g., scrubbers, incinerators, waste treatment plants). However, many attempts to use pollution control technologies in developing countries have encountered enormous difficulties and often pollution control equipment is a wasted investment. To offset this tendency, governments need a statutory commitment to pollution prevention as well as one to end-of-pipe technology. The government needs to provide a useful definition of what activities constitute pollution prevention and to make specific commitments in its own activities.

The U.S. Pollution Prevention Act of 1990 can serve as a model for other countries. After years of growing interest in a pollution prevention strategy, it was concluded that it was necessary to make a clear distinction between the many environmental regulatory programmes which had been created and a new emphasis on pollution prevention. The basic concept of the Pollution Prevention Act is to stress a non-regulatory approach. That is, the policy approach is to avoid command and control government requirements for the industry which would mandate exactly what the industry would do and how it would do it. Instead, the concept is to send a clear message to the industry that pollution prevention was the preferred approach to solving environmental problems. The U.S. government has developed many programmes to motivate the industry to voluntarily practise pollution prevention. These government programmes provide public information to the industry on how to implement pollution prevention, provide public recognition for companies which have successful pollution prevention programmes, and economic incentives and assistance for pollution prevention.

The Government of India has taken a step in this direction with its 1992 "Policy Statement for Pollution Abatement." Among other things it calls for assistance to SSIs in adopting cleaner technologies and recognizes pollution prevention as the first priority for environmental management in the industrial sector. What is lacking, however, are the specifics, such as a definition of pollution prevention, actions that government itself will take to encourage pollution prevention and actions that government will take to assist SSIs.

Assign priority to market based incentives rather than command and control

Since the SSIs operate in a competitive environment, it is more cost effective to use market based instruments for pollution and waste prevention as opposed to traditional command and control measures. The economic incentives approach brings environmental resources into the market and prices them at a level that reflects their true scarcity and the opportunity costs for their use. Users would have to pay to use environmental resources and such payments would force them to economize on their use. The entire spectrum of industrial decisions would be affected — the design of industrial processes and technologies, the types and quantities of raw materials used, the nature of products as well as innovation and adoption of cleaner production and abatement technologies. The approach also results in achieving the desired level of environmental quality at the minimum cost of pollution control by leaving to the polluter the level of individual pollution control and the choice of technology. For example, if an emission charge is to be levied, industries with high control costs would control less and pay more in charges and industries with low control costs will control more and pay less in charges. Overall the desired reduction in pollution will be attained at the minimum cost, and the industry will be under constant pressure to develop more cost efficient ways of reducing or abating pollution in order to reduce its control costs or payment of charges.

Despite the many advantages of using market based instruments, their use even in developed countries has been limited. It is only in the last decade that developed countries have begun to consider the application of economic incentives as a complement to traditional command and control measures. These results have been sufficiently encouraging to generate a more widespread use. A variety of instruments are at the disposal of policy makers. Which instrument is most suitable varies from case to case. For instance, in Malaysia, an effluent charge was introduced in support of regulatory standards for palm oil mills. China has introduced industrial discharge permits and emission charges which double when the allowable emission is exceeded. Turkey has made effective use of subsidized tax credit and tax deductions to induce industries to relocate to industrial zones. As opposed to these successful applications there are also cases such as those of Poland, Algeria and Egypt where the experience has not been so positive. To take the example of Poland, the incentive schemes failed because they were used in the wrong economic setting i.e. in an economy dominated by large subsidized state enterprises facing a soft budget constraint.

On an average however, if set at the right levels, economic incentives are most suitable for SSIs which operate in a competitive economy. A notable example is the case of Thailand where the Thailand Development Research Institute (TDRI) has proposed a deposit-refund scheme to provide a strong disincentive to dumping of hazardous waste and an incentive for proper treatment. Each waste generator will deliver a specified amount of waste each year to the Ministry of Industry for treatment and disposal. Illegal dumpers would pay a charge equal to the clean up cost which is estimated at twice the cost of collection, treatment and disposal by the waste treatment plant operator. Half of that amount would be put into an environment fund and the rest into an interest bearing escrow account, which serves as a waste delivery bond. Upon delivery of the contracted amount of waste, the deposit held in escrow would be refunded with interest to the waste generator. It is also proposed that this scheme be supplemented by an environment auditing system to verify the firm's claim that it generates less waste and is entitled to a rebate on its treatment fee.

If set at the right levels, economic incentives are most suitable for SSIs

Recognize the special problems of SSIs

While there usually is the capacity in large and medium size firms to respond to environmental regulations, that is not the situation for SSIs. Often they do not even know about regulatory requirements and, even if they know about them, they cannot afford environmental specialists to help them interpret and to comply with them. (We all have seen numerous examples of non-functioning air and waste water equipment installed at SSIs). Then, there are the problems of raising the necessary capital to implement pollution prevention and abatement measures and meeting compliance schedules in a timely fashion. To ensure that this happens, governments need to make special provisions for SSIs in environmental legislation. This will become increasingly important as SSIs will be required to control their wastes and emissions to meet environmental standards.

One such example and the first in the history of U.S. environmental regulation is the Clean Air Act Amendments of 1990. Until then, assistance to SSIs was only a Federal government responsibility. With Section 507 of the Clean Air Act Amendments, all state governments are required to establish Small Business Technical and Environmental Compliance Assistance Programmes to help small businesses contend with several new air pollution control responsibilities. Each state programme is expected to include three components: appointment of state small business ombudsman; establishment of a comprehensive small business assistance programme; and appointment of a seven-member state compliance advisory panel.

Take advantage of industrial siting policies

A proper relocation and siting policy can go a long way in sorting out some of the problems associated with the collection and disposal of wastes generated by small and medium scale industries. Locational policies seek to optimize environmental aspects with imperatives for regional balance, availability of energy and raw materials, proximity to markets and supplies of intermediate products, and local and regional aspirations. The policy should ensure that zonation pertaining to different types of industries are established. If SSIs with similar waste streams are located in the same geographical area, it would considerably reduce the logistic problems and associated costs of collecting wastes from scattered sites for common treatment. In Indonesia the government is making a concerted effort to channel all new investments into estates that are equipped with common treatment facilities.

A proper relocation and siting policy can go a long way in sorting out problems associated with the collection and disposal of wastes.

Of special interest are policies relating to Industrial Free Zones and Export Processing Zones. Due to the tremendous pressure to set up export oriented industries it is necessary to ensure that these industries abide by the international environmental regulations while at the same time being competitive on the world market. Some of the measures that could be advocated include tax advantages for the adoption of cleaner technologies in the EPZs and for the production of environmentally friendly products.

Create an ideal policy mix

The example of Indonesia provides a good illustration of the ideal mix of policy options that can be applied to control and prevent pollution emanating from small and medium sized industries. The industrial estate of Surabaya has set up a centralized wastewater treatment facility. The estate has specified minimum waste water treatment standards for each firm. Those exceeding the standards are obliged to invest in pre treatment facilities. In addition to this there is a graduated charge for waste water treatment based on the quantity and quality of the firms' waste stream. The revenues collected are used to cover the operating costs of the treatment plant and the sampling laboratory.

Institutional Level Actions

Set up Environmental Extension Services for SSIs

One of the most important tasks in managing the pollution problems of the SSIs is to stimulate, supervise and advise the entrepreneurs in the ways and means of reducing their industrial wastes and emission levels. This is best addressed at the level of the local or the district governments, since the local authorities have greater knowledge of their whereabouts, the pollution they generate, and the concerns of the local residents. In addition, it is easier for SSIs to organize themselves for collective action at the local level. In Japan for example, the municipal governments have established networks to the nine largest cities of counsellors who offer advice on the technical, economic, financial and legal matters related to regulatory compliance to the small and medium scale enterprises. The local government has also provided support in mobilizing members of the Yeizu Merine Products Cooperative Union to construct a fish waste processing plant as well as the introduction of other environmental protection measures.

One of the most important tasks in managing the pollution problems of the SSIs is to stimulate, supervise and advise the entrepreneurs in the ways and means of reducing their industrial wastes and emission levels.

In a setting such as India's it would be extremely useful and effective if the local and district authorities get involved with extension work to motivate and introduce the techniques of pollution prevention to the small companies within their jurisdiction. Recommendations along these lines have also been made by the PRISMA project undertaken by the Dutch Government. The PRISMA report recommends that the government should appoint "prevention teams" to motivate and advise the enterprises on various aspects of pollution prevention. In particular the government should be responsible for:

- Coordinating and ensuing that the activities of the different prevention teams are in line with one another
- Determining the framework within which educational material on the prevention of waste and emissions is developed
- Establishing an easily accessible data bank containing national and international information on the prevention of waste and emissions
- Adjusting and coordinating activities at the regional level between various organizations involved with the transfer of knowledge
- Giving priority to prevention-oriented demonstration projects within companies (PRISMA report).

Create an Information Dissemination Cell for SSIs

In order to reach the largest possible numbers of SSIs enterprises with pollution control information, it is advisable to work through the industry associations to which they belong. In Thailand for example the Federation of Thai Industries is empowered to ensure that its members comply with the environment regulations. In doing so it has established an environment and industry information system for the Management of Natural

Resources and the Environment for Sustainable Development. The diffusion of information requires the construction and reinforcement of information and cooperation networks from the global to the local levels. There s however some reservation regarding the effectiveness of such systems. As pointed out in the PRISMA report, SSIs especially may not consult these systems on a regular basis. In order to avoid this, it is recommended that the intermediary organization such as the industry association be responsible for providing selective information to the enterprises based on an analysis of their wastes and emissions.

The diffusion of information requires the construction and reinforcement of information and cooperation networks from the global to the local levels.

In the case of India, a focal point in the National Productivity Council should be made responsible for information about techniques and technologies for waste minimization. The focal point should be accessible to industries, industry associations and consulting engineers compliance schedules and should issue technical bulletins that describe pollution prevention options for complying with environmental regulations.

To activate this potential, the National Productivity Council could become a partner in the UNIDO Energy and Environment System (EEIS). This system is assisting institutions in the establishment of sustainable, cost-effective mechanisms for management of industrial environmental information targets to SSIs. The National Productivity Council could become the primary contact point with the responsibility to build and EEIs network within India by identifying and entering into working arrangements with from ten to fifteen other organizations which have direct associations with SSIs.

Facilitate Common Waste Treatment Facilities

Either the government or the industry associations should assist in the establishment of common waste treatment facilities to serve many small and medium scale enterprises with similar waste streams. In Thailand a centralized hazardous waste treatment facility has been set up in the Bangkok Metropolitan Area to treat the heavy metal-contaminated liquid and solid wastes of 200 electroplating and electronics factories. The management, including collection, transport, treatment and disposal of waste is in the hands of a private contractor who levies a fee to recover the operating costs. The fixed costs in terms of plant, equipment and land are incurred by the government.

Charging for waste treatment however can result in illegal dumping of the waste to avoid the fee. This has been the case in both Thailand and Hong Kong. There is normally disagreement over the level at which the charge should be levied. Normally revenue concerns would require that the fee should be levied such that it covers the investment and operating costs; trade concerns however would dictate that the fee should not exceed a level that would endanger the firms' competitive position; environmental concerns would also be reflected in a somewhat lower fee so as not to encourage illegal dumping of wastes. One way out of this problem could be the deposit refund type of scheme proposed by TDRI in Thailand.

Charging for waste treatment can result in illegal dumping of the waste to avoid the fee.

Promote outreach from large firms to SSIs

The government should adopt a specific policy directive to encourage the growth of SSIs as subcontractors to large industrial enterprises in the same industrial group so that those firms can avail of technical assistance from larger group members — notably their customers — to address certain of their pollution problems. This has been done in Japan where large enterprises belonging to the same industrial group or *keiretsu* have subcontracted SSIs to meet their demands and in turn provide technical assistance to them.

Enterprise Level Actions

Assisted demonstrations at enterprises

SSIs are skeptical about the financial and environmental benefits that can result from pollution prevention measures unless they can see for themselves the actual application of the measures. They are not willing to read or trust written material. This situation can be overcome by sponsoring demonstrations in individual factories of pollution prevention and then disseminating the findings of the demonstrations through association meetings and site visits.

One example of such a demonstration is a completed UNIDO project with the Egyptian Cement Manufactures Association and the Egyptian Environmental Affairs Agency. In this case, UNIDO worked with two cement plants of the Suez Cement Company over a year period in identifying and implementing pollution prevention measures. At the end of the year, the Association and Agency sponsored a seminar for all plants in the association to describe the findings and to discuss next steps. An unusual feature of this seminar was that it was combined with a workshop on the operation and maintenance of electrostatic precipitators, indicating that both pollution prevention and abatement were essential for complying with environmental norms.

An Indian example of such demonstrations is the UNIDO/National Productivity Council demonstrations in three sectors — agro-based pulp and paper, pesticide formulation and textile dyeing and finishing. To-date, the project has completed waste reduction audits in the approximately 15 plants and many of them have implemented some waste minimization measures, some with very in pressive financial returns. The fouir agro-based pulp and paper mills participating in the project have identified approximately 40 waste minimization options, mainly in the areas of energy and water conservation and about one half can be implemented at low cost (under 1.5 lacs).

Self-initiated demonstrations at enterprises

An alternative to national and international funding of waste minimization assessments is the provision of grants to enterprises, trade associations, equipment vendors and consultants that want to test innovative waste reduction technologies. These groups would be encouraged to put forward innovative source reduction and recycling options to state institutions. The state institution would screen the proposals and select the most promising for cost sharing. The groups receiving financial assistance would have to collect reliable performance and cost information and allow that information to be disseminated to others.

The US Environmental Protection Agency has funded such enterprise level support for several years under its Waste Reduction Innovative Technology Evaluations (WRITE). Grants are given by the US Environmental Protection Agencies to state agencies, who in turn solicit applications and select the most promising ones for funding. For example, it has supported the Hazardous Waste Research and Information Centre in the State of Illinois. The Centre is funding 6 out of 40 proposals, including the substituting water-based inks for solvent-based inks in flexographic printing, the use of soybean oil inks in offset printing and the use of zinc hydroxide in place of zinc cyanide for zinc electroplating.

An alternative to national and international funding of waste minimization assessments is the provision of grants to enterprises, trade associations, equipment vendors and consultants that want to test innovative waste reduction technologies.

The Government of India has the potential to initiate a similar programme under the funds for Industrial Pollution Control that it has received from the World Bank. Part of these funds are set aside for innovative waste minimization projects and have not yet been used because no arrangements has been established to disburse the funds. Also, it is possible that funds for innovative approaches would be available from Environmental Pollution Prevention Project of the US Agency for International Development.

Conclusion

Based on a review of the experience in other developing and developed countries, it can be concluded that an effective programme for assisting SSOs minimize waste as a cost-effective approach to compliance with environmental norms must combine actions at the policy, institutional and enterprise levels. Many potential actions that must be combined for an effective programme have been discussed. The actual combination, however, both within each level and among the levels, depends on the existing policy and institutional structure in each country.

Acknowledgement

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International Progress in Solid Waste Management

John H. Skinner

Solid waste management policy makers require information and guidance on all aspects of the problem which has assumed global significance. The International Solid Wastes and Public Cleansing Association (ISWA) is putting forth a number of programs to address this need. This paper outlines the elements of the strategy adopted by ISWA in this regard.

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Solid waste management has moved to the forefront of the environmental agenda. Activity and concern by citizens and governments worldwide have reached unprecedented levels. Nations are considering restrictions on packaging and controls on products in order to reduce solid waste generation rates. Local and regional governments are requiring wastes to be separated for recycling, and some have even established mandatory recycling targets. Concerns about emissions from incinerators and waste-to-energy plants have resulted in imposition of state-of-the-art air pollution controls. Landfills are being equipped with liners, impervious caps and leachate collection systems, and gas and groundwater is being routinely monitored. There is wide scale public opposition to siting of new solid waste treatment and disposal facilities. As a result, the costs of solid waste management are increasing rapidly.

Previously considered a local issue, solid waste management has international and global implications. Concerns about transboundary shipment of hazardous waste has led to the adoption of the Basel Convention by the United Nations. Recognizing the interrelationship between solid waste standards and economic development, the European Community is moving forward to harmonize waste disposal requirements in member countries. Around the globe, countries are discovering thousands of sites where hazardous wastes have been spilled, dumped or otherwise discarded resulting in contamination of soil, surface water and ground water. The costs of cleaning up these sites will stress national economies and at the same time offer enormous international business opportunities.

Solid waste management in countries with developing economies poses a special set of problems. In these countries quite often financing is not available for the construction of waste treatmen facilities, and there is a lack of trained personnel to operate waste management

systems. Also, there are generally no regulations or control systems, no administrative body responsible for solid waste control and no obligation for industry to dispose of wastes properly. The United Nations Environment Programme has focused on solid waste management in developing economies as a priority concern.

More than ever before, solid waste management policy makers worldwide need sound and reliable information on the technical performance, environmental impact and costs of solid waste collection, recycling, treatment and disposal systems. ISWA, the International Solid Wastes and Public Cleansing Association is putting forward a number of programs that are trying to address that need.

Solid waste management policy makers worldwide need sound and reliable information on the technical performance, environmental impact and costs of solid waste collection, recycling, treatment and disposal systems.

Mission of ISWA

The objective of ISWA is to promote the adoption of effective and economically sound solid waste management practices that protect the environment and conserve materials and energy resources. ISWA is a professional association open to members from all countries in the world. Its activity is solely in the public interest through professional development of its members; it does not pursue any commercial or political aims. ISWA is truly an international organization in that its governing body, the General Assembly, is made up of National Members from 21 countries around the world. Most countries with National Membership in ISWA. National Members must be national organizations representing all professional activities related to solid waste management in the member country. National Members are encouraged to form national committees of solid waste professional associations within their countries to assure a broad representation in ISWA. This international network of National Member organizations provides ISWA the ability to reach thousands of solid waste professionals throughout the world. ISWA also has over 700 individual and organizational members in over 60 countries. Recognizing the special solid waste management problems in developing countries, ISWA also provides a Development Membership category pending the establishment of a fully functioning National Member organization.

ISWA Programs

ISWA carries out its mission through a series of efforts to collect and disseminate information to its members The ISWA Journal, Waste Management and Research is published six times a year by Academic Press and has a nine year history of successful issues containing high quality peer reviewed articles. ISWA newsletter, the ISWA Times is published quarterly and provides practical and useful information to its readers. The ISWA Yearbook, the International Directory of Solid Waste Management and Public Cleansing, provides extensive listings of companies and organizations in the solid waste field, as well as a wide range of articles summarizing activity throughout the industry.

ISWA sponsors and cosponsors a number of conferences, workshops and symposia. Important ISWA conferences and congresses for the next several years include:

- 1994 ISWA Annual Conference, in conjunction with the UK Institute of Wastes Management, Torbay, UK, June 14-17, 1994.
- ISWA 25th Anniversary Congress, Vienna, Austria, October 16-20, 1995.
- ISWA Quadrennial Congress, Yokohama, Japan, October 27-November 1, 1996.

In order to provide the opportunity for the development of specialized ISWA activities, working groups on the following seven subjects have been established:

- Hazardous Waste
- Sanitary Landfill
- Incineration
- Recycling and Waste Minimization
- Collection and Transport
- Sewage and Water Works Sludge
- Biological Waste Treatment.

ISWA members can belong to these working groups and engage in practical information exchanges with members from other countries. Through these working groups ISWA holds many specialized symposia and workshops and has developed an international solid waste professional book and report series.

Integrated Solid Waste Management

ISWA members and most other solid waste management professionals recognize that there is no single,

simple solution to solid waste problems. Instead an integrated approach is necessary combining the elements of several techniques. In the United States, the Environmental Protection Agency published The Solid Waste Dilemma: An Agenda for Action, which outlines an integrated set of strategies for dealing with solid waste management. These strategies are very similar to those recommended by the European Commission, the United Nations Environment Programme and countries around the world. Integrated solid waste management is a comprehensive strategy involving four key elements applied in a hierarchical manner:

- Reducing the volume and toxicity of the solid waste that is generated
- Recycling or reusing as much as possible of what is generated
- Recovering energy from the remaining waste through combustion systems equipped with the best available pollution control technology
- Utilizing landfills with adequate environmental controls.

Solid waste management professionals recognize that there is no single, simple solution to solid waste problems. Instead an integrated approach is necessary combining the elements of several techniques.

Waste Reduction

Waste reduction activities are important to halt or slow down the increasing rate of waste generation per-capita. For example, the most recent data from the U.S. indicates the total amount of municipal solid waste increased from 180 million tons in 1988 to 196 million tons in 1990, which represents an increase in the per capita generation rate from 1.82 kg to 1.95 kg, per person per day.

Waste reduction has several aspects, all of which should be addressed. One is toxicity reduction, in which the nature of waste is changed by reducing manufacturer's use of toxic materials in consumer products. Another is volume reduction — cutting the amount of waste generated by using less material in the first place. A prime example of this is a reduction in packaging. Waste reduction also includes encouraging the production of products that can be recycled more easily, such as shifting from multimaterial to one-material packaging. Other options to reduce wastes include the redesign of products, material use changes, and restrictions on specific product types.

The approach to reducing waste must be broadly based incorporating actions that can be taken by industries, individuals, commercial enterprises and governmental agencies. Industry can reduce waste through raw material substitution and redesign of products and processes. Individuals, commercial enterprises and agencies can use their purchasing power to create a demand for low waste products or items produced from recycled materials. Governments should investigate the use of economic and other incentives to encourage waste reduction. Waste reduction efforts also need to focus on consumer behavior. Education and information dissemination programs can be effective means of causing desired behavioral and attitudinal changes.

There are many cases of successful reduction of wastes produced by industrial processes. Experience has shown that modifications to industrial processes that reduce waste also result in lower raw material, energy and waste disposal costs. Productivity is often enhanced and liabilities related to release of hazardous substances are reduced. The fact that waste reduction quite often pays has been demonstrated repeatedly.

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Recycling

There are two basic approaches to recycling solid wastes. The first involves separating recyclable materials by the waste generator and separately collecting and transporting these materials to recycling markets. The second involves collecting mixed wastes or mingled recyclable materials and separating them at a central processing facility. In the U.S., through a combination of these practices the percentage of the municipal solid waste stream recovered for recycling or composting increased from 13 per cent in 1988 to 17 per cent in 1990.

Prior separation of recyclable materials has the advantage that the materials are not contaminated by other wastes. However, this requires the waste generator (e.g. householder) to separate the wastes correctly and store them in separated form. Also, the generator needs to

transport the separated material to recycling centers or separate or compartmentalized collection vehicles need to be used. Key factors in success of preseparation efforts are the cooperation and willingness of the gener ator to participate in the program over the long term and the additional collection and transport costs that may be required.

Mixed solid waste can be separated for recycling at local processing centers or materials recovery facilities (MRFs). In the U.S. for example, there are over 200 MRFs in operation, construction, or advance planning stages. Some plants process segregated recyclable; others separate mixtures of glass bottles, aluminum cans and steel cans; still others process mixed residential or commercial wastes, separating the recyclable materials. The success of these plants depends on the processing costs and the quality of the recyclable material produced.

A major factor affecting recycling economics is the difference in cost between disposal and recycling. In many locales this cost difference is narrowing. For example, in the U.S. the disposal fee for landfills and waste-to-energy plants has increased dramatically over the past 10 years. Today, on the average, a solid waste management system in the U.S. can avoid $25 to $40 per ton in disposal costs for every ton it recycles, whether or not it gets paid for the recycled material. In some locations the savings are even higher.

A major recycling impediment is the question of continued viability and availability of secondary materials markets. Can manufacturers expand markets so they can accept all of the material that is being collected by the new residential programs? Topping the list of problematic waste material markets is the market for old newspaper. In the late 1980s, there was dislocation in markets due to an oversupply created by the large number of municipal collection programs that were all bringing new supplies to markets simultaneously. Many U.S. municipalities were forced to pay to recycle collected newspapers. Current market figures show that the value of old newspaper varies from $40/ton to a — (negative) $40/ton. Problems are also being experienced in other recycled material markets, including those for glass, plastic and for compost produced from yard waste and mixed municipal solid waste. There are some encouraging trends that suggest the problem of oversupply of old newspaper could be reduced. Some newsprint producers in the U.S. and Canada have announced plans for new facilities to make use of recycled fiber. Others have undertaken feasibility studies for new facilities.

A major recycling impediment is the question of continued viability and availability of secondary materials markets.

It is important to understand that separation of materials from the solid waste stream in itself does not constitute recycling. Recycling only occurs when these materials are incorporated into products that enter commerce. Therefore requirements to separate certain fractions of materials from waste may produce a supply of materials, but these requirements in themselves will not ensure recycling. In fact, if markets for these materials are not found, and the materials are subsequently disposed of, all of the costs of recycling are experienced with none of the benefits. Similarly, requirements to incorporate separated waste materials in products will not result in recycling unless these products are of a quality and price that they successfully compete in the market place.

To analyze the economic feasibility of recycling one must consider the price received for the recycled material, the solid waste collection and disposal costs avoided and the costs of separation, collection and processing the separated materials. In making these cost comparisons it is important that all environmental costs and benefits are internalized. Also, the benefits to future generations in terms of natural resources conserved or landfill space conserved must be considered. Any virgin raw material subsidy that artificially drives down the price must be accounted for so that virgin materials and recycled materials compete in an equitable manner. Similarly, procurement specifications that arbitrarily discriminate against recycled materials should be eliminated.

in order to effectively carry out successful recycling programs, solid waste managers must operate in a business-like manner as raw material suppliers. They must treat the users of their materials as customers. This means they must produce recyclable materials meeting the customer's material quality requirements, and offer recyclable materials at a price competitive with other material supplies. They must operate their separation, collection and processing systems to produce competitively priced, quality materials at the lowest possible costs. The elements of success of a recycling operation are the same as for any successful business; staying

close to the customer, understanding and meeting their quality needs and operating in a cost effective manner to produce a competitively priced product.

The elements of success of a recycling operation are staying close to the customer, understanding and meeting their quality needs and operating in a cost effective manner to produce a competitively priced product.

Combustion with Energy Recovery

Waste-to-energy facilities can achieve an 85 per cent volume reduction in the waste burned. In the U.S. these plants have increased their handling of solid wastes from a negligible percentage of the municipal solid waste stream in the early 1980s to almost 16 per cent of municipal solid waste today. Waste-to-energy plants face two main problems in their fight to win public acceptance: air pollution concerns and the heavy metal content of the ash generated in the combustion process.

On January 14, 1991, the U.S. EPA issued new municipal regulations (New Source Performance Standards, or NSPS) and guidelines for existing plants. These standards incorporate good combustion practices, emissions monitoring and highly efficient air pollution control systems to control organic emissions (dioxins and furans), metals, acid gases and other pollutants. The standards are similar to those used in other countries to regulate incinerators. EPA estimated that in 1994 the national costs of these rules will be $170 million a year for new facilities and $302 million a year for existing facilities. Therefore in the U.S. there will be a substantial financial investment to upgrade the environmental performance of municipal incinerators.

Another environmental concern that has developed over the post several years involves the disposal of ash residues from municipal waste incinerators. Usually significant amounts of lead, cadmium, zinc, mercury, arsenic, and other metals are found in incinerator ash, especially fly ash. The environmental concern is the potential for these metals to leach out of the residue when disposed of with other wastes in a sanitary landfill. This has led to the utilization of monofills or landfills used solely for ash disposal. In September 1992, the U.S. EPA issued an opinion that the ash generated by solid waste-to-energy incinerators is not considered a hazardous waste under Federal law and that the new requirements for solid waste landfills will ensure that the ash is disposed of in a manner that protects human health and the environment.

Also, technologies have been developed to chemically extract metals from incinerator ash or to solidify and stabilize the ash by adding cement or kiln dust to create a concrete like substance. While these technologies are effective in removing or stabilizing metals, they do result in added disposal costs. Some of these costs can be offset if the ash is treated to the extent that it can be used safely and sold as an aggregate or building material. In the U.S. over 8 million tons of incinerator ash are produced annually.

Landfills

Landfill technology has advanced very rapidly over the past decade. Today's state-of-the-art landfills are equipped with leachate collection systems, liner systems, systems for control of landfill gas, groundwater monitoring, closure and post-closure care and much more. The objective is to ensure that landfilling is performed in a manner that greatly reduces the change of environmental degradation and also, that any degradation that occurs is quickly detected and remedied.

In the U.S. as the number of landfills continues to decrease, two main consequences are seen: first, communities face longer transport distances to deliver their solid waste to disposal sites; secondly, several large facilities, designed to serve a limited number of communities for a given number of years, are seeing their lifespans drastically foreshortened by the influx of waste from outside their service areas.

Due to more stringent landfill regulations, many small facilities will shut down because they will be unable to meet the new requirements. A hoped-for-result is a decrease in opposition to landfills, stemming from greater public faith in the environmental soundness of facilities that are allowed to operate. Some observers believe the combination of continued strong public opposition and tougher landfill rules will result in a system of large, remotely located regional landfills. Signs of this can be seen already.

Strategy for Continuous Improvement

Over the past 20 years, there has been substantial progress in addressing solid waste problems. However, many complex problems still exist. To deal with them, the strategies that have been used in the past will not be

enough. As we move towards the 21st Century, a number of forces must come together to lead to continuous improvement in solid waste management. These include:

Continued, Rigorous Enforcement of Environmental Laws and Regulations. Environmental standards must be rigorously enforced in order to assure the public that our solid waste systems are operated in ways that protect human health and the environment. Enforcement must create an incentive for compliance with environmental standards. It must level the playing field so that violators are not at a competitive economic advantage to the good citizens that comply.

Waste Reduction as the Strategy of Choice. The traditional approach to solid waste management has been a pollution control strategy where wastes are collected and treated or disposed of after they are generated, or waste is cleaned up after it has occurred. A waste reduction strategy is different, it means not creating the waste in the first place. This can be accomplished through changing product designs, increasing process efficiencies, and extending product lifetimes. Waste reduction results in reduction in waste treatment and disposal costs, reduced liability for environmental damages, lower raw material costs and process efficiencies.

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Risk-Based Decision Making. Solid waste management decision-making must be based on a comparative analysis of the relative environmental risks of the various options available. Quite often there is public opposition to a particular facility because of concern about environmental risk. While the public expresses a preference for recycling over waste-to-energy or landfill, it is often forgotten that the recycling process itself produces waste or residuals that must be managed or disposed of (e.g. waterborne wastes produced from the delinking of recycled newsprint or increased air pollution from additional collection vehicles). In order to make an informed decision, the risk of one option must be compared to the alternatives. Priorities must be based on relative environmental risk. In order to do this we need to develop better and more reliable risk assessment methodologies and put them to use. Significant advances need to be made in our capabilities to assess the risks to ecological systems. An investment in risk assessment research will certainly pay off.

Public Information to Encourage Voluntary Action. Providing data and information to those who make or influence decisions can lead to voluntary actions with significant environmental benefits. A good example is the Toxic Release Inventory (TRI) in the US. Each year industries are required to publish the total release of certain toxic wastes to the environment and make this information publicly available. When the public for the first time realized the total environmental releases from all of these plants and facilities, they demanded that some thing be done about it. This led to the establishment of the 33/50 Program. Under this program companies voluntarily agree to reduce their waste discharges by 33 percent by the end of 1992 and 50 per cent by the end of 1995. Over 700 companies have made written commitments which will reduce the discharge to the environment of 150,000 tons of toxic chemicals by 1995. Information is a powerful tool which can stimulate real results.

Environmental Education. As the above example shows an informed public can be an effective force in environmental protection. However, professionals in the field must do a much better job in explaining to the public the true nature of environmental risks and what can be done about them. The National Environmental Education Act which was passed in the US in 1991 provides some excellent vehicles for doing this including support for environmental curriculum development, assistance for teacher training and scholarships and fellowships for environmental science and engineering. It is very important to increase environmental literacy to build public support for environmental programs and train future generations of environmental professionals.

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Economic Incentives. Market based economic incentives can be used as an alternate to regulation or as a means of making regulations more effective. For example, the liability standards under the US Superfund

legislation make a waste generator liable for environmental damaged caused by that waste. This produces a very strong economic incentive for waste reduction and on-site waste treatment. Other economic incentives such as pollution charges and deposit systems should also be evaluated for future solid waste management policies.

Research and Development. A sustained, long term research and development effort is necessary to improve our understanding of the environmental impacts of solid waste management systems and develop solutions. What are the health effects of environmental releases from solid waste management systems? How do pollutants move through the environment and change in their physical and chemical form? What are the routes of exposure for human populations and ecological systems? How can we monitor and detect pollutant levels in real time? What are the most cost effective approaches to waste reduction, recycling, combustion and disposal? These are just a few of the questions that research must address. However, research should not be limited to technological and physical science issues. Research into the social and economic aspects of solid waste management is necessary to understand and better design economic incentives and information and education programs.

Technology transfer to countries with developing economies is especially important, for these countries to be able to participate effectively in improving the global environment.

Technology Transfer — Domestic and International. Research and development alone is not enough, the results must be transferred into the field as new and improved solid waste management systems are developed. Therefore, efforts to apply the results of research are essential. This is especially true on an international basis where there are potentially large market opportunities for cost effective environmental technologies. Technology transfer to countries with developing economies is especially important, for these countries to be able to participate effectively in improving the global environment.

Integration of Solid Waste Management Policy with other Policies. Other national and international policies can have as strong or stronger influence on solid waste management as can environmental policies. Consider the effect of: energy policy on the incentives for waste-to-energy facilities, transportation policy on freight charges for recycled materials, agricultural policy on the uses of sludges as fertilizers or soil conditioners. Other examples include the effect of financial policy on investment into environmental technologies and military policy's effect on clean-up of defence installations. Solid waste management professionals must ensure that implications of these policies are assessed in national and international forums.

It will be necessary to combine technical and engineering skills with risk assessment, market forces, public information and education, enforcement strategies, pollution prevention, research and development and technology transfer. Solid waste management professionals must show leadership in developing broad based strategic initiatives to bring about continuous improvement in integrated solid waste management.

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Industrial Pollution Prevention in Developing Countries

James D. Gallup & James D. Westfield

This paper describes a major effort to address the lack of understanding about and emphasis on pollution prevention in the developing world. The U.S. Agency for International Development (USAID) funded Environmental Pollution Prevention Project (EP3) is an effort to introduce, promote and support pollution prevention in the USAID serviced developing world. A general description of the project and its activities is provided. Additionally, emphasis is placed on two ongoing EP3 country programmes, Tunisia and Chile, because they represent two different approaches to developing sustainable industrial and urban pollution prevention in India and other parts of the developing world.

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Pollution prevention, waste minimization, clean technology, however it is named, the concept become an important approach to industrial and urban pollution management in the developed/industrialized world. However, this has not always been the case in the U.S. and many other developed countries. Attention to pollution prevention has come only after regulatory command and control approaches emphasizing discharge and end-of-pipe solutions have proven too expensive, too slow and too limited in their adoption and effectiveness. It is now widely recognized that pollution prevention, waste minimization and clean technology should be the first line of defence against environemental pollution. Treatment, whether it is pretreatment, on site treatment or combined off-site treatment, should be applied after in-plant pollution prevention actions have been identified and implemented. While not all pollution can be prevented, enough is possible, practical and economically viable to make this phased approach described above as the one of choice.

Pollution prevention, waste minimization and clean technology should be the first line of defence against environemental pollution.

In much of the developing world, significant attention to environmental impacts and industrial and municipal pollution is only beginning. Unfortunately, the trend in these countries is to try to adopt and adapt the developed world's discharge and end-of-pipe command and control legislation. The bulk of the developed world's legislative, regulatory, enforcement and pollution management is and has been treatment and discharge dominated. Because of this history there is a great reservoir of ex-

perience and expertise which can be tapped for application in other parts of the world. The error of attempting to recreate this history is that this past emphasis on end-of-pipe approaches in the developing world is necessary because it is the most universally accepted, most reliable, most quickly implemented, most cost effective and most widely available approach. In spite of this history, pollution prevention has recently been shown to be the most appropriate first step to achieving industrial environmental consciousness.

The United States is a world leader in pollution prevention products, equipment, services and applications. The successful transfer of U.S. pollution prevention capabilities can help developing countries and former centrally-planned economies avoid some of the past environmental mistakes of the U.S. while continuing rapid development.

Pollution Prevention

Pollution prevention programmes center around several areas of activity: product formulation; process modification; equipment redesign; and recovery of waste materials for reuse. Pollution prevention programmes achieve: an improved environment; reduced material and energy costs; increased sales of products with reduced pollution potential; and new technologies with the potential for commercial development of new products. Pollution prevention techniques can be applied to any manufacturing process from something as simple as making a paper clip or matches to something as complex as assembling the space shuttle. Available techniques range from easy operational changes to state-of-the-art recovery equipment. The common factor in these techniques is that they reduce bottom-line operational costs.

Waste reduction is not a new concept — it has been around as long as humans have been producing products. While it has been known over the years by a number of names, it is merely optimization of the production process. For example, a late-eighteenth-century electroplating manual states that nothing should be allowed to go to waste in well-conducted works. The manual includes many waste reduction methods that are applicable and are discussed in the literature even today. This brings up the fact that many pollution prevention techniques are relatively "low-tech" In fact, many industries find that simple operational changes, increased training, and improved inventory management can significantly reduce waste generation rates.

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Pollution prevention techniques can be broken down into fine major categories:

- Inventory Management
  - Inventory Control
  - Material Control
- Production Process Optimization
  - Training
  - Operation and Maintenance Procedures
  - Material Change
- Process Modifications
- Volume Reduction
  - Source Segregation
  - Concentration
- Recovery, Recycle and Reuse
  - On-site Recovery
  - Off-site Recovery

These classifications are broad and there is some overlap. In actual application, pollution prevention or waste reduction techniques generally are used in combination so as to achieve maximum effect at the lowest cost.

Inventory Management: Inventory management is recognized by industry as an important pollution prevention technique. Inventory management includes proper control over water and raw materials, intermediate products, solvents, final products and associated wastestreams. In many cases waste is just out-of-dated, off-specification, contaminated or unnecessary raw materials, spill residues or damaged final product. Inventory management includes techniques to reduce inventory size and hazardous chemical use while increasing inventory turnover and methods to reduce raw material and finished product losses and damage during handling, production and storage. Proper material control procedures ensure that raw materials reach the production process without loss through spills, leaks or contamination. It also ensures that the material is efficiently handled and used in the production process and does not become waste.

Production Process Optimization: Improving the efficiency of a production process can significantly reduce waste generation. Some techniques are simple and relatively inexpensive ranging from eliminating leaks from process equipment to installing new process equipment. Production process modifications includes operation and maintenance procedures, material change and process equipment modification. A wide range of methods are available to operate a production process at peak efficiency. These methods are neither new nor unknown and are usually inexpensive to institute, as little or no capital cost is necessary. Most production processes, no matter how long they have been in operation or how well they are run, can be operated more efficiently. Some process steps may be unnecessary and eliminating them will reduce waste generation. One manufacturer discovered that standard operating procedure was to degrease all parts coming into the plant and then re-oil those that did not require further costing. By cleaning only those parts which needed further processing significantly reduced waste solvent generation.

Once proper operating procedures are established, they must be made part of the employee training programme. A comprehensive training programme is a key element of any effective waste reduction programme. Usually, all levels of personnel should be included, from line operators to the chairman or executive officer. The goal of any programme is to make the employee aware of waste generation, its impact on the company and the environment, and ways it can be reduced. Employee awards are often an effective way to motivate workers and strengthen waste reduction programmes. Significant amounts of waste can also be reduced through improvements in the way a production process is operated and maintained. Often overlooked, many wasteful operational practices have gone on so long they have become standard operating procedures. In some cases, maintenance personnel are so busy correcting current problems that preventive maintenance is overlooked until it is too late. A strict maintenance programme which stresses corrective and preventive maintenance can reduce waste generation caused by equipment failure.

A comprehensive training programme is a key element of any effective waste reduction programme.

Process Modifications: Process modification includes both material change and equipment modification. Some raw materials and solvents can be replaced with significant reduction in waste generation. Hazardous chemicals used in the production process can also be replaced with less hazardous or nonhazardous materials. Changes can range from using purer raw materials to replacing solvents with water-based products, which is a widely used waste reduction technique that is applicable to many industries. For example, a diesel engine plant switched from cleaning solvents and oil-based metalworking fluids to water-based products. This change not only reduced coolant and cleaning costs by about 40 percent, but also led to the elimination of a cleaning step which reduced material and labour costs.

Volume Reduction: Volume reduction includes techniques to separate problem wastes and recoverable wastes from the total wastestream. These techniques are usually used to increase recoverability or reduce the volume of waste generated. The available techniques used range from simple segregation of wastes at the source to complex concentration technology. Segregation of wastes is in many cases a simple and economical technique for waste reduction. For example, by segregating wastes at the source of generation and handling the hazardous and nonhazardous wastes separately, waste volume and management costs can be reduced. Additionally, the uncontaminated or undiluted wastes may be reused in the production process or may be sent off site for recovery. Segregation techniques are applicable to a wide variety of wastestreams and industries and usually involve simple changes in operational procedures. A common technique is to collect and store washwater or solvents used to clean process equipment (such as tanks, pipes, pumps or printing presses) for reuse in the production process.

Recovery, Recycle and Reuse: Recovering waste can provide a very cost-effective waste management alternative. Waste recovery should only be considered after all other waste reduction options have been instituted. In most cases the best place to recover process wastes is with in the production facility. Wastes which are simply contaminated versions of the process raw materials are good candidates for inplant recycling. Some wastestreams can be reused directly in the original production process as raw materials, such as cleaning waste from printers and coaters, electroplating drag-out solutions and dust collector residue from pesticide formulators. Some lightly contaminated wastes can be reused in operations not requiring high-purity materials,

including reusing spent solvents generated during the production of microelectronics in less critical metal degreasing operations.

The Project

EP3 is a seven-year, worldwide project of USAID which includes a USAID project management team, a contractor team led by Hagler, Bailly, Inc.; interagency and cooperative agreements with the U.S. Environmental Protection Agency (EPA) and the Water Environment Federation (WEF) and cooperation with other USAID and international donor funded environmental projects. This project offers USAID countries and missions technical field support in developing and implementing industrial and urban pollution prevention, waste minimization, and a wide array of urban and industrial environmental quality programs. EP3 has a core programme funded incremental and targeted for approximately $14,000,000 over the first five years of the effort. EP3 also has a facility (buy-in) for USAID Missions and other Bureaus to add funding for unique or more thorough country or region specific activities. It is expected that the buy-in arrangement will bring in a much larger amount of funding than the core. Both core and buy-in programmes have access to a large and broad EP3 pro bono programme. The pro bono programme includes technical assistance (TA) personnel, and pro bono services and assistance to support and extend country programmes. Both core and buy-in programmes have funding to tap and manage the pro bono services and to pay for travel, per diem and other related support costs.

EP3 offers technical, analytical, and informational support to facilitate the adoption of pollution prevention approaches and technologies through the following activity areas:

- **Environmental Policy and Institutional Support** — EP3 helps to reform or establish effective urban and industrial environmental legislation, regulations, and implementation guidelines to encourage pollution prevention.
- **National Cleaner Production and Pollution Prevention Programmes** — EP3 helps USAID missions and host-country governments to identify, design and promote national programmes that foster measurable improvements in environmental quality.
- **Pollution Prevention Assessments and Demonstrations** — EP3 conducts plant-level assessments and demonstrations in industrial facilities to identify options for improving productivity and reducing end-of-pipe control requirements through waste minimization, source reduction, and pollution prevention.
- **Technology Cooperation and Investment Promotion** — EP3 supports technology development and transfer, demonstrates innovative approaches, identifies business opportunities, and assists in mobilizing investment capital. It also cooperates closely with related programmes funded by others.
- **Pollution Prevention Training** — EP3 conducts in-country training at a variety of levels in industry, government, and nongovernmental organizations. EP3 tailors its training to different audiences such as plant operators, plant managers, financial analysts, and government environmental officials.
- **Pollution Prevention Information** — Through the Training and Information Clearinghouse network, EP3 responds to both general and specific questions related to urban and industrial environmental management.
- **Environmental Support Services** — EP3 responds to requests in a range of support services such as prefeasibility studies, environmental quality monitoring, life-cycle/fate-and-transport analyses, and risk assessments.

The goal of EP3 is reduction in environmental pollution associated with urbanization and industrialization in developing countries throughout the world. The purpose of EP3 is to create the necessary conditions for sustainable urban and industrial pollution prevention management in AID-assisted countries. The necessary conditions are:

- Knowledge of the means for and advantages of pollution prevention
- Familiarity with the advantages of cleaner production methods
- Assistance for introducing industrial and urban process and equipment innovations that minimize waste generation
- Sustainable locally controlled and operated pollution prevention programmes.

The targets of EP3 activities are host-country industry; national, regional, and local government; and nongovernmental both private and public, organizations (NGOs). Through a carefully integrated set of information, training, hands-on assessments, demonstrations, and policy support activities, EP3 intends to help build the

local capability, awareness and funding mechanisms necessary to institutionalize pollution prevention in targeted USAID-assisted countries.

Through a carefully integrated set of information, training, hands-on assessments, demonstrations, and policy support activities, EP3 intends to help build the local capability, awareness and funding mechanisms necessary to institutionalize pollution prevention.

The overall strategy for EP3 is based on nine elements: identify targeted opportunities; demonstrate early success stories; sustain information exchange; build local capabilities; drawn upon U.S. expertise; establish industry-to-industry linkages; implement a supportive policy framework; determine financial and economic benefits; and institutionalize pollution prevention.

The strategy for the first year will focus on putting the Washington based (USAID and Contractor/Cooperator) EP3 team and operations in place, preparing a pollution prevention information dissemination strategy, creating and increasing awareness of EP3 services among USAID Regional Bureaus and USAID Missions, compiling and beginning to disseminate information on U.S. pollution prevention products and services, facilitating cooperative arrangements with Environmental Protection Agency (EPA) and other sources of pro-bono technical assistance, and designing and initiating several country support programmes. EP3 will be completely operational by the end of year one (July 1994), with enough field experience to fine tune activities for the second and following years. During the first few years a high priority will be placed on activities which produce visible and quantifiable pollution prevention related accomplishments.

The principal outputs of EP3 fall within three general areas. First, phase I country support programmes consist of a pollution prevention country assessment, a series of pollution prevention industry assessments and cleaner production demonstrations, and a national EP3 strategy. The first four Phase I country support programmes constitute early learning countries to help refine the approach for programmes in other countries. Second, phase II country support programmes consist of an EP3 country programme workplan, 10-15 training courses, 8-10 cleaner production programmes instituted in industrial plants, establishment of a national programme for pollution prevention, and policy reform recommendations. Both phase I and II country programmes will rely heavily on buying funding. Third, EP3 will also establish a central training and information clearinghouse in Washington, D.C. with regional clearinghouses in each of the EP3 countries.

Very early core outputs will include definition of, objective and, wherever possible, quantitative measures of desirable project outcomes and sustainability, criteria for selecting industries in each EP3 country and to help establish the type and nature of industrial PP practices to be encouraged, and the type of early country activities necessary to involve the largest and most pertinent group of private, NGO/PVO and public entities in the EP3 Country Programmes to assure the sustainability of pollution prevention after EP3. A variety of information and training products will also be produced. These will include Audio/slide shows, training courses, information packages and policy and regulatory assistance information.

This very early core funded work, will for example:

- Suggest and support/defend a set of criteria to be used within the project to measure project accomplishment.
- Further expand the recommended criteria descriptions by major project initiative (country programme, audits, training, clearinghouse, etc.) to include objective measures and suggested approach to measurement.
- Provide examples of how pollution prevention programme effectiveness measurement has been or is being accomplished in the U.S. or other countries.
- Define and describe up to ten key industrial categories (to include tanning and textiles), with up to three subcategories per industry, which are the priority industries for EP3. Industries are to be selected/justified based on criteria tailored to EP3, expected accomplishments and proposers knowledge of pollution prevention and the developing world.
- For the leather tanning and textile manufacturing industrial categories, from the above, a matrix (with substantial backup and documentation) will be prepared containing industry; industry subcategory; priority pollution prevention actions and plant level innovations for that industry/subcategory; best industrial pollution prevention practice (BIP) target or actual values for each pollution prevention priority action; what product, equip-

ment or action is required to achieve BIP; and other parameters.

- Suggest how industrial visits and audits can facilitate collection of the data necessary to measure or confirm pollution prevention initiatives and practices and to define BIP for that country and industry. This element will focus on tanning and textiles.
- Tunisia and Chile country programme activities will be examined to identify how sustainable pollution programmes are being built. The following descriptions also illustrate two of the general approaches chosen by EP3 to facilitate creation of sustainable programmes:

USAID Mission buy-ins can be structured to respond to and be consistent with core activities but because they are designed to address country specific needs and opportunities it is difficult to predict their nature, timing or required effort. It is expected that each buy-in will be dealt with as a separate country programme. As much as is possible, coordination and integration into core activities and cooperation and information transfer among buy-ins will be emphasized. At present, there are two ongoing buy-ins; one spanning two years in Tunisia and a second covering three years in Chile. Each of the ongoing buy-ins will involve a mix of the Eight EP3 activities listed earlier. As specific work plans are developed and lessons learned there will be amendments to the overall project work plan. In this way the project work plan will be a living and changing document and the country programmes will benefit from the wealth of experience in and outside of EP3. Tunisia and Chile have progressive and reasonably stable democracies. Their economies are healthy and both have advanced to a state of development where very soon they may not qualify for USAID assistance. There are a wide variety of industries, mostly privately owned. Many of the major industries are government owned and controlled. This is more the case in Tunisia. They both actively export to other countries in their region and Europe (Tunisia) and the US (Chile) and industry is becoming more export oriented. There is a well developed pollution control system in both countries including a set of laws and regulations and a history of enforcement. Pollution control is mostly end-of-pipe treatment directed and the governments are rapidly implementing discharge control based regulation and enforcement. However, because they are only beginning to focus on control and treatment there is still an opportunity to introduce pollution prevention and to greatly influence both the public and private sectors to focus on this before they require/attempt universal treatment.

Tunisia

The objective for the Tunisia EP3 programme is to establish self sustaining industrial pollution prevention activities in the private and public sectors and to demonstrate pollution prevention actions in industry. Although two years is an extremely short time to create sustainable activities in any area there, several conditions and attitudes make the acceptance of this objective reasonable. Environmental protection has become a visible and well understood goal of the government and population in Tunisia. An excellent foundation has been established for an industrial pollution prevention initiative by previous activities of USAID and the Tunisian National Government. Tunisian industry, individually and through their federations, has agreed to actively cooperate in EP3 and other pollution prevention programmes.

The strategy to create self sustaining pollution prevention activities in Tunisia will involve:

- Creation of a local EP3 office and staff
- Development of locally available pollution prevention data, procedures and tools
- An intensive and extensive pollution prevention introduction, information and education programme
- Industry activities directed at identifying and assisting in the solution of pollution problem
- Emphasis on services to private sector industries and firms and developing the ability to charge clients for services (taking a commercial attitude)
- Cooperation with and coordinating the pollution prevention activities of others working in Tunisia creating mechanisms which will support and fund expanded and continuing pollution prevention activities
- Focusing on industrial initiatives which offer the possibility for short term success and broad application

The following task structure and content help set the stage for the creation of a self sustaining pollution prevention programme in Tunisia. Work during the first year of Tunisia EP3 programme will focus on six tasks:

- Local office opening and staffing
- Acquisition of standardized procedures and approaches
- Kickoff, information and education activities
- In-industry assessments activities
- Support to government programmes

- Identification of mechanisms necessary to sustain pollution prevention in Tunisia

During the first six months of the programme many activities will take place and general information dissemination will be emphasized. Industry activities will include several demonstration and training audits. Industries chosen for this include battery manufacturing, tanning, textiles and chemicals. The industries participating will sign a general agreement with EP3 to cover liability, responsibility and commitment to pollution prevention. Initially, all services will be provided for free, but the goal is to begin to charge for information and services. This approach, the movement to developing a self supporting office, and demonstrating that those receiving services will value them enough to pay is one of the objectives of the Tunisia country programme. The Tunisia pollution prevention sustainability programme is focused on the creation and extensive support of local (Tunisian) personnel, demonstrations, cooperative arrangements, institutional associations, funding mechanisms, etc. which once established will continue to function after EP3 funding and assistance decrease or disappear. Industry and facility assessments are only one part of the equation. This model assumes that although sustainable industrial pollution prevention is the objective, industry must not be the only recipient of attention and assistance.

This approach, the movement to developing a self supporting office, and demonstrating that those receiving services will value them enough to pay is one of the objectives of the Tunisia country programme.

The first key element of Tunisia model is the creation of a widely recognized private sector pollution prevention entity; the EP3 staff and office. This entity is expected to continue to exist and expand its activities after EP3 funding is terminated. Where ever possible, everything done in Tunisia by EP3 both supports pollution prevention in industry and strengthens the EP3 staff and office capability and reputation. The second key element is to help the staff and office develop sources of funding for the time after EP3 support is completed. The third key element is that the EP3 director in Tunisia is responsible for day to day activities and the overall programme. He works closely with the EP3 team; he alone is responsible for representing/providing the Tunisia perspective.

Chile

The goal of the Chile country programme is the same as that for Tunisia. However, the approach and funding are significantly different.

The Chile country programme is focused on private sector industry. The first year activities include mostly diagnostic studies (pollution prevention audits) in industries. First, these studies will be performed in industries in the Capital (Santiago) and later, in other parts of the country. Several diagnostic studies will be performed in several priority industries (as determined by the steering committee). The first set of industries to be covered include tanning, textiles and meat processing. The initial studies will be mostly staffed by US specialists and the objective will be to demonstrate the value of pollution prevention and to train locals (both in industry and in the consulting community). The industries served must sign an agreement covering the same areas as in the Tunisia agreement but there is no plan for the EP3 programme to ultimately charge for services. The training of local consultants and companies anticipates that they will follow on to provide pollution prevention TA for fees.

Initially there will be very little attention paid to general information dissemination, general training, policy assistance or other institutional support. Even in later stages of the country programme these areas will receive little attention. Industrial pollution prevention will be the objective and industry will be the major group receiving project attention. In addition to diagnostic studies early project activities will include:

- Training visits of Chilean industrialists and consultants to US industries and courses.
- Seminars and workshops for industrialists and consultants on pollution prevention diagnostic studies, technologies and results from other EP3 country programmes
- Assistance to Chilean training and education institutions to develop programmes focused on industrial pollution prevention
- Development and implementation of strategies for financing industrial pollution prevention actions

Observations & Conclusions

The developing world represents a major challenge to any environmental programme because of the prevalent attitude that industrialization and economic development take short term precedence over environ-

mental protection. There are numerous other negative factors including central control/management of economies; public sector dominance of the major industries; significant funding needs in health, poverty, population and infrastructure and a tendency to believe end-of-pipe treatment is the best approach. There are also a number of positive aspects/conditions in the developing world including a growing understanding of and emphasis on environmental protection; the trend to privatization; the movement away from centrally controlled economies; the early state of overall environmental degradation (in some places); the lack of well established end-of-pipe treatment regulation and enforcement programmes and the demonstration of superior economic benefits to industry, the public and the environment of pollution prevention.

The developing world represents a major challenge to any environmental programme because of the prevalent attitude that industrialization and economic development take short term precedence over environmental protection.

EP3 is an attempt to institutionalize industrial and urban pollution prevention in the developing world. It mostly focuses on the industrial sector during the early project activities. The anticipated level of core and buy-in funded activity will allow a number of significant country programmes to be developed and supported. The ongoing core and buy-in funded programmes are receiving significant attention and support in the countries and by others involved in international environmental protection. The main differences in approach to developing a sustainable industrial pollution prevention programme in the two country programme described include: the emphasis on in-industry activities, the approach to demonstrating willingness to pay, in-country cooperative/counterpart arrangements, project office staffing, the inclusion of non-industry groups and the length of EP3 support. There are many more similarities in both the country programmes than there are differences and some of the differences are only temporal.

At the start of 1994, both the programmes have experienced a number of important successes and they are growing in impact and extent. Selected industries are beginning to implement pollution prevention programmes and others are beginning to request audits and diagnostic studies. One of the first diagnostic studies in Chile demonstrated that the textile plant studied can comply with all environmental discharge regulations by implementing no and low to medium cost pollution prevention initiatives. No treatment is required and the medium cost actions will pay-back within 18 months. In Tunisia, the EP3 kickoff meeting was attended by over 100 specially invited industrialists, government officials, private sector consultants and trainers/educators.

One of the first diagnostic studies in Chile demonstrated that the textile plant studied can comply with all environmental discharge regulations by implementing no and low to medium cost pollution prevention initiatives.

Training, publicity and information dissemination is also underway and measurable results are expected. It is too early to determine which of the individual components or combinations of components of the programmes are critical to success. It is also very possible that there are several approaches which can be successful. People, their commitment, local conditions and luck are also a few of the factors important to success and sustainability. The people working on the project, both core and buy-in as well as many other helping in the US and the countries, are both top notch and very committed. Progress will be monitored and evaluated and programme elements will be altered to respond to lessons learned. This assistance and support process and the adoption of pollution prevention approaches is critical if the industry in the developing world is to meet its environmental responsibilities. □

Merging Productivity Improvements with Environmental Conservation

René (C.W.M.) van Berkel & Frans (F.A.B.) Verspeek

The improve the quality of life, industrial waste and emission generation have to be significantly reduced. Treatment technologies added at the end of the pipe result in less immediate damage to the environment. But the preventive approach of improving existing manufacturting technology makes more sense. The paper presents the methodology behind cleaner production with a case study.

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The basic idea of "cleaner production" is quite simple: minimise or eliminate waste and emissions at their source, rather than treat them after they have been generated. Cleaner production research in Western Countries (like the USA, Canada, the Netherlands and Scandinavia (Huisingh et. al, 1986; Hirschhom et. al, 1991 & Freeman et. al, 1992) and upcoming experiences in countries like India and China[1], revealed numerous options available for industry. Despite the fact that these genrally result in both economic profits and environmental benefits, there are numerous impediments that hamper the implementation of cleaner production. The main barriers to cleaner production are lack of information, management attitudes and inappropriate incentives.

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Concepts & Definitions

Although people wishing to investigate the world of preventing waste and emissions start out full of enthusiasm they quickly find that it is extremely difficult to establish exactly where to start. There is a Babel-like confusion that can be traced back to terms which have different meanings for different groups. The actual content of each term used is subject of discussions between moderates and the orthodox. The main issue of these debates is the choice between such terms as 'cleaner production', 'waste reduction', pollution prevention',

1. Demonstration in Small Industries for Reducing Waste in India UNIDO/National Productivity Council: Improving Clearner Production in China, World Bank/Technical Assistance Program.

'waste minimisation', 'source reduction' and the relation of theses terms to on site and off site recycling. Running right through this debate is also the signle or multi media approach (Washington, 1987 & Weenen, 1990).

The following definition of cleaner production has been extensively used in The Netherlands:

Cleaner production means avoiding or minimising the generation of waste and emissions — in terms of volume and or toxicity — through source reduction or on site recycling and thereby saving raw materials and energy.

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This definition reflects a broad interpretation of waste. All waste streams can be subject to prevention, no matter how they were previously disposed of. Cleaner production is thus a multi media concept, aiming at the reduction of the volume and/or the toxicity of hazardous and solid waste and emissions to water, air and soil. This broad inter-pretation of waste has been combined with a narrow interpretation of prevention, which excludes offsite recycling from cleaner production. Limiting clearner production to activities within a company strongly reflects the changes at the source necessary for cleaner production. Prevention thus encompasses source reduction and on site recycling. Source reduction can further be divided to product modification, input substitution, technology modification and good housekeeping (Table 1):

- Product modifications change the product characteristics, such as shape and material composition. The lifetime of the new product is extended or it is easier to repair it. The manufacturing process might also become less polluting. Changes in product packaging are also viewed as product modifications.
- Input substitution refers to the use of renewable raw materials or adjunct materials with a longer service lifetime.
- Technology modification includes improved process automation, process optimisation, equipment redesign and process substitution. The modified technology creates less hazardous wastes and emissions.

Table 1: Prevention options

Cleaner production technique	Examples	Environmental advantages	Economic benefits
Product modification	United Kingdom/New product: water-based adhesives, to replace solvent-based adhesives	Water-based adhesives are non-toxic, no pollution of water and air systems. Energy conservation for drying.	Savings on equipment, raw materials, safety precautions and overhead costs.
Input substitution	India/Reduction of sulphide in effluent from sulphur black dyeing by substitution black dyeing by substitution of sodium sulphide with hydrol (a by-product of the maize starch Industry).	Reduction of sulphide in effluent. Elimination of the foul smell of sulphide in the work place. Reduction of waste in the maize starch industry.	No capital expenditure involved, and saving in not having to install additional effluent treatment.
Technology modification	Sweden/Minimisation of organic solvents in degreasing and painting. For degreasing a totally enclosed 'tunnel; is used, with a recirculating circuit. Furthermore a change to biodegradable cutting oils allowed an alkaline degreasing procedure.	Reduction of the release of organic solvents, reduction of hazardous waste, and only little additional water pollution.	New degreasing process reduced annually costs (about 25,200 US Dollars) and did not require the installation of recovery equipment.
Good housekeeping	Poland/Waste reduction in steelwork painting	Reduction of hazardous waste (sludge and organic solvents).	Reduction of high disposal costs.
On site recycling	Greece/Chrome recovery and recycling in the leather industry, using an electrolytic technique involving a dived call.	Reduced chromium content of effleunt waters.	Investment with payback period of 11 months. More consistent product quality.

Source: Cleaner Production Programme (1993).

- Good housekeeping refers to changes in operational procedures and management in order to eliminate waste and emission generation. Examples are spill prevention, improved workers' instruction and training.
- On site recycling refers to the useful application of waste materials or pollutants at the company where they have been generated. This could take place through re-use as raw material, recovery of materials or useful application.

The diversity of benefits of cleaner production for the enterprise can be summarised in the Dutch acronym KICK (Cost, Innovation, Continuation and Quality) (Berkel, 1992). Cost savings can occur due to savings on raw material purchases and reduction of disposal and treatment costs. Cleaner production is often effected by the use of innovative technologies. These strengthen the competitiveness of the enterprise. Cleaner production efforts can also contribute to the continuation of the business by improvement of the public image of the enterprise or by offtering opportunities for market expansion. Finally, cleaner production can have a positive spin off on product quality. Improved process control reduces risks of off specification products becoming waste and simultaneously the overall product quality improves. Cleaner production has also a series of environmental advantages. Previous research reveals that cleaner production efforts contribute to the reduction of wastage (of natural resources), minimisation of waste generation and minimisation of environmental pollution by hazardous substances (Berkel, 1991).

Cleaner Production Assessments

Defining cleaner production is very important if one wishes to stimulate the implementation of cleaner production concepts of industry. The second step is to provide companies with a systematic working method. Such a tool kit has been developed and published as the "Manual for the Prevention of Waste and Emissions".[2] This manual describes both the method and the procedure for cleaner production in companies. The central element in the **method** is the analysis of the material flows entering and leaving the company in order to identify opportunities for cleaner production. This method is embedded in a **procedure** that fosters the actual implementation of these options and initiates ongoing cleaner production activities within the company.

Methodology

Initially, the manufacturing process is examined and reevaluated. First, an inventory is made of the material flows, entering and leaving the company. This results in a process flow diagram, leading to an a ssessment of all sources of waste and emission generation. Secondly, investigations must be done in order to assess which factors affect the volume and composition of the wastes and emissions generated. This element is the process evaluation, which results in an assessment of the causes of the waste and emission geneation. Finally, an inventory of prevention options can be made by proper application of the cleaner production techniques to the source and cause of the waste stream. This option generation is a creative step, generally taking place in a brainstorming session within the company.

Source Identification

Source identification starts with the drafting of a list of unit operations, with their associated material in-and output and transformations. Manufacturing generally comprises a number of such unit operations. These can be defined as an area of the process or a piece of equipment where materials are input, a function occurs and materials are output, possibly in a different form, state or composition. It is importannt to choose the right level of detail during the division of the manufacturing process into unit operations. It might be wise to start with a general list with the main unit operations and go into details in a later stage only for those unit operations that cause serious waste generation. By connecting the individual unit operations in the form of a block diagram, one can prepare the process flow diagram. To reduce complexity, one should try to start with the raw material at the top of the diagram and end with the final product at the bottom. For each unit operation, material inputs should be placed at the right side of the diagram and material outputs at the left side. An essential step is checking the process flow diagram. What goes in, must come out somewhere. So, all inputs should have related outputs, as product or waste, and all outputs have to be traced back to inputs. Unit operations, can be the source of various waste streams. Therefore, the completed

2. Hoo, S. de, H. Brezet, M. Creul & H. Dieleman (1990), *Manual for the Prevention of Waste and Emissions.*, SDU, The Hague. An English edition of this manual is incorporated in the *PREPARE: Manual and Experiences Document*, (1991) Some other cleaner production assessment manuals are: *Minnesota Guide to Pollution Prevention Planning* (1991), Minnesota Technical Assistance Program, Minneapolis, USA; *Audit and Reduction Manual for Industrial Emissions and Wastes* (1991), United Nations Environment Programme (UNEP), Pairs, France: *Facility Pollution Prevention Guide* (1992), United States Environmental Protection Agency, Cincinnati, USA.

process flow diagram should be used to check all unit operations for wastes generation, and thereby, compile the list of all waste sources.

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Cause analysis

The next step is to evaluate all material flows. One should try to quantify the volume and composition of all material flows, which could result in a mass balance for all individual unit operations or for the entire company. As there is generally a lack of detailed data, it is hard to compile such mass balances. For the purpose of cleaner production, evaluating the unit operation is of equal importance as compiling reliable mass balances. This evaluation should result in an understanding of the cause of waste generation at the unit operation. In a simplified model, one can distinguish five factors that affect volume and composition of the waste streams. These are product, input materials, waste and emissions, technology and process execution (housekeeping) (see also figure 1). Following these five factors, the process evaluation should give an answer to five basic questions:

- How do product specifications affect the volume and composition of the process wastes and emissions?
- How do input materials affect the volume and or composition of the process wastes and emissions?
- Which technological factors (like process design, equipment, piping etc.) affect the volume and composition of the process wastes and emissions?
- Which housekeeping factors (like planning, workers' training & motivation, etc.) affect the volume and composition of the process wastes and emissions?
- How do waste handling procedures affect the volume and composition of the process wastes and emissions?

Discussions between operators, supervisors and plant management on these questions, generally result in a thorough understanding of the causes of waste generation.

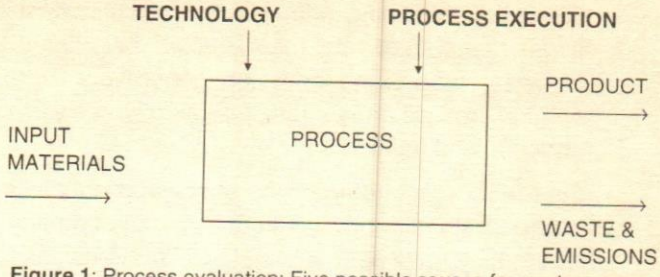

Figure 1: Process evaluation: Five possible causes for waste generation (Crul, 1991).

Option generation

The next logical step is to create a vision on how to eliminate or control the causes of waste generation. Once more, the simplified model of the unit operation can help us. All five possible causes of waste generation can be dealt with by a particular cleaner production technique (figure 2). By doing so, information from the cause analysis is used for the identification of the most appropriate prevention technique and information from the source identification for targeting to the source unit operation. Generating suitable prevention options is still a creative step, the information obtained so far is used as a guiding tool in this creative process.

The basic quetions for the option generation are;

- How should the product be modified to minimise or eliminate process waste generation?
- Which input substitution is necessary to minimise or eliminate process waste generation?
- How should the technology be modified to minimise or eliminate process waste generation?
- How should the housekeeping be improved to minise or eliminate process waste generation?
- How could waste materials be recycled on site?

Brainstorming about these questions in an assessment team proves successful for generating options. Outside experts can contribute by leading and provoking the brainstorming session and putting forward options that have been proven fessible in similar unit operations.

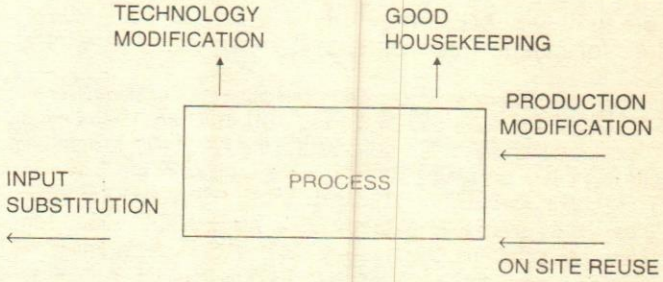

Figure 2: Option generation: Application of the cleaner production techniques (Crul, 1991)

In order to fully exploit the benefits of cleaner production it is essential to frequently perform such assessments of unit operations at various levels and departments within the company, thereby cleaner production could become an ongoing activity.

Procedure

This method of option generation based upon examination and re-evaluation of the material flows and unit operations is embedded in a procedure with four stages. In the Dutch Manual for the Prevention of Waste and Emissions (Hoo et al, 1990), these are planning and organisation, assessment, feasibility analysis and implementation (figure 3).

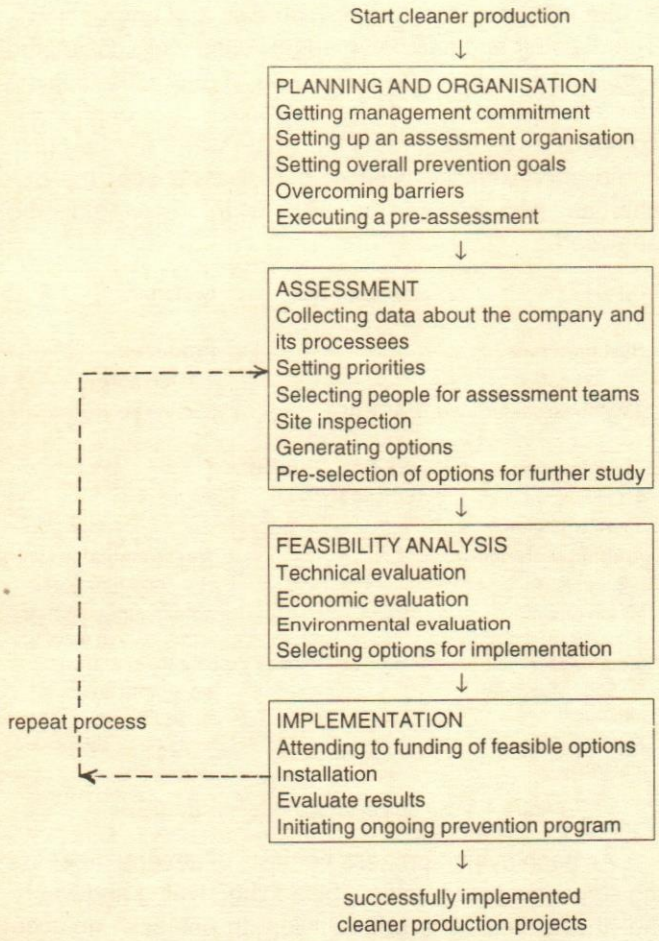

Figure 3: Overview of the procedure for cleaner production.

The planning and organisation phase aims at convincing all persons in the company of the necessity to prevent waste and emissios and the benefits that can be achieved. A project organisation must be set up to initiate and co-ordinate the prevention activities. The phase consists of five activities: getting management commitment and involvement, setting up a project team, establishing goals, overcoming barriers, and the execution of a pre-assessment.

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The assessment is the next logical step; the phase in which prevention options are actually generated. The detailed study of the areas of priority aims at the establishment of as many prevention options as possible. Generating, examining and selecting the prevention options are thus central in this phase. The assessment phase has six elements: the collection of data on the company and its processes, setting priorities with regard to waste streams, materials, processes and/or company activities, the setting up of assessment teams, site inspection, option generation and pre-selection of prevention options for further study.

The outcome of the assessment is a list of prevention options for the studied areas of priority. The next step — the feasibility analysis is to evaluate whether those options are technically and economically feasible; i,e, whether the prevention options can be put into practice. Three activities make up the feasibility study: the technical and financial evaluation and the selection of options still has to be introduced (Berkel et al, 1990).

Those prevention options which have been established as feasible must be introduced and evaluated in the implementation phase. Measurements and records are checked against the prevention goals and the expectations. Four activities are important for the implementation: attending to funding of feasible options, taking care of the planning and execution of the options, assessing the results of implementation and giving shape to an ongoing prevention program.

The experiences show that plants which have already made significant reductions in some of their waste streams, continue to find options to more efficiently convert raw materials into valuable products (Berkel & Brown, 1993). By doing so, they increase production efficiency. None of the companies has indicated that its program has reached its full reduction potential, or even

believes that there is such a defined level. Invariably, companies seek continuous improvement through onging source reduction. These ongoing activities are especially stimulated by a company's source reduction program, with at least some of the following management components: high-level leadership (from operations and environmental management), cost accounting and employee involvement. Companies in the INFORM's study (Dorfman et al, 1992) that adopted any of these key program features reported significantly more source reduction activities than companies lacking them.

Our research in co-operation with small and medium sized enterprises, proved that the Manual is a good tool for generating prevention options (Berkel & Kortman, 1993). The working method had been tailored to the company's characteristics by the university researchers. Flexibility in the procedure can be achieved through the proper use of the results of the pre-assessment. During the last couple of years, several other cleaner production assessment manuals have been published.[3]

Case Study

AGAVE is a small textile processing house in the Eastern part of The Netherlands. The company, with 35 employees, dyes cotton, polyester and cotton/acrylic yarns and knitwear. The textile industry in The Netherlands works under continued stress, from an economic angle because of the increasing foreign competition (i.e. with the Eastern European countries), and from an environmental angle, because of the upcoming governmental requirements with regard to reduction of waste water loadings. The companies have to reduce dyestuff discharges by 95 per cent and salt discharges by 50 per cent by 1995. Furthermore, they have to pay a ground water utilisation fee of approximately 0.2 – 0.5 US Dollars/m^3.

In order to identify successful options the company decided to participate in the PROGRES project (a government funded demonstration project on cleaner production). The project started in September 1990. A project team was formed, consisting of 2 university researchers and 2 company representatives (the technical directior and the chief of adminsitrator). This team met approximately once in every 6 weeks during the 15 month project (12 meetings). The joint task force systematically assessed cleaner production options within the company.

3. Some other waste prevention assessment manuals are:
Minnesota Guide to Pollution Prevention Planning, Minnesota Technical Assistance Programme, Minneapolis, USA, 1991.
Audit and Reduction Manual for Industrial Emissions and Wastes, United Nations Environment Programme (UNEP), Paris, 1991.
Facility Pollution Prevention Guide, United States Environmental Protection Agency, Cincinnati, USA, 1992.

There were quite a few barriers to overcome in this project: As a job worker, AGAVE has little influence on the product specifications and the planning of its production activities. The company is extremely dependent on a few clients and a handful of suppliers. AGAVE, as a small dyeing house, has no influence on the manufacturers of dyestuffs and process equipment. Despite these impediments, economically feasile options were generated and implemented, and thereby some of the most compelling environmental issues have been addressed.

The research started with the execution of a pre-assessment. All unit operations in the plant were identified, as well as the materials flows entering and leaving each of these operations resulting in an input/output inventory. Figure 4 indicates the major materials and energy flows. The dyestuff and adjunct materials used were calculated from the recipes. The water and energy consumption was not known on unit operation basis, but only at the company level. Regarding the waste water discharge, in compliance with the licence, only twice a year the discharges (volume and quality) were monitored and analysed.

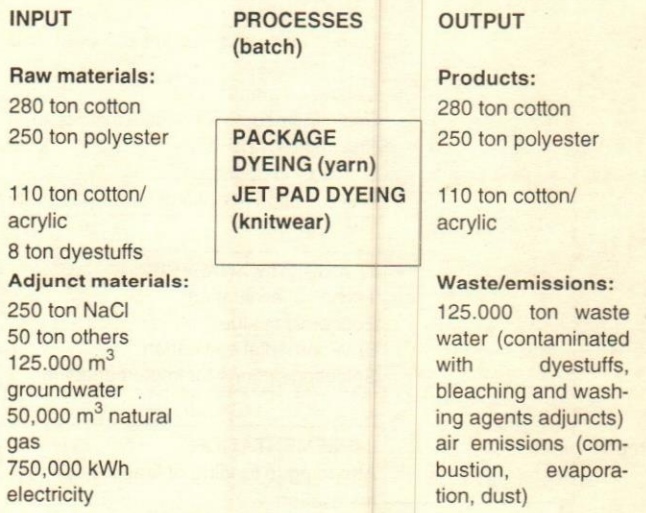

Figure 4: Input-output inventory for the dyehouse

As each dyeing process consists of several processing steps (such as washing, bleaching, dyeing and washing) these data were not sufficient to establish detailed flowcharts for the different processes. Based on this inventory, and common knowledge about fixation-ratios for the different dyestuffs, 3 assessment targets (energy, dyeing process and good housekeeing) were selected for additional investigation.

In a brainstrom session in which all the members of the project team participated, the options were

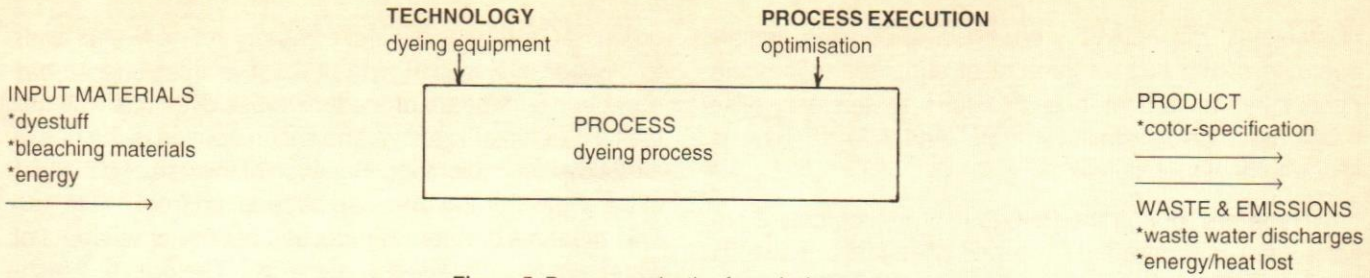

Figure 5: Process evaluation for a dyeing process

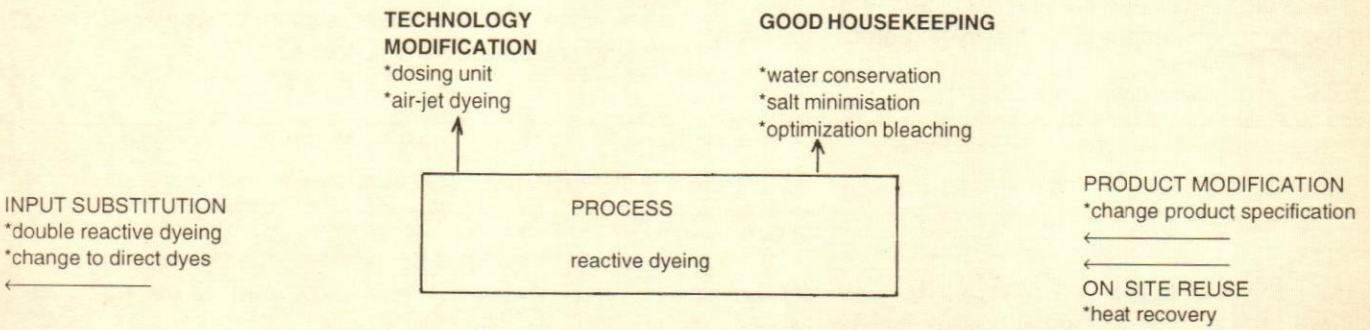

Figure 6: Option generation for a reactive dyeing process

generated, following the general approach of process evaluation and option generation. Figure 5 illustrates this process evaluation and figure 6 the option generation.

The questions to be answered were:

- How do product specifications influence the quantity and quality of dyestuff discharges? What functional and aesthetic properties should the final product have and how do these influence the dyeing process?
- What is the composition of the dyestuffs (reactive, direct, sulphur, disperse, basic)? What adjunct materials are necessary, i.e. bleaching materails, accellerators, etc.? Are these necessary to arrive at the desired final product quality?
- What kind of dyeing process is used (package dyers, jet dyers)? What is the liquid in the equipment?
- Are workers properly instructed with regard to minimising waste, optimal salt use, optimal loading capacity, planning of colour shifts and optimising equipment maintenance?
- How much is the dyestuff discahrge? Can the energy loss (heat) be recovered?

To reduce the energy consumption 3 options were analysed. Two of them were rejected during the project — Combined cycle heat and power generation were not feasible and controlling the peak load demand (by spreading out the drying activities) was not practical in these process. The third option was the use of a high rendement furnace (with a energy efficiency of 88 per cent). During the project one boiler was replaced which resulted in a 10 per cent reduction of natural gas consumption.

In the assessment the dyestuffs were analysed by looking at the fixation efficiency of the different dyestuffs in combination with the type of fabric (table 2). The reactive dyes account for over 50 percent of the dyestuff discharges. Professional literature revealed a diversity

Table 2: Dyestuff assessment

Fibre	Production (ton/year)	Dyestuffs	Dose range (kg/ton fabric)	Fixation (eff. (%)	Discharge (kg/ton fabric)	Discharge (kg/year)
Cotton	210	Reactive	10-15	65%	3,5 - 5,3	725-1100
	30	Direct	10	85%	1,5	45
	60	Sulphur	85	80%	17	1020
Polyester	250	Disperse	5-7,5	85%	0,8-1,1	190-280
Cotton/acrylic	110	Basic	5	95%	0,25	
		Reactive	10-15	65%	3,5-5,3	205-300

of solutions, but AGAVE's choices were limited, mainly because of the lack of interest of suppliers to procure necessary equipment and dyestuffs to operationalise these alternatives (Smith, 1991). And AGAVE has no scope to do it themselves.

Therefore, during the PROGRES-project, only 2 options were pursued. First the use of reactive dyestuffs with a higher fixation efficiency was adopted. The option is possible for a limited number of colours and in AGAVE, it has been implemented for the dyeing process of army green. AGAVE was the first company in The Netherlands to pioneer this special type of reactive dyestuffs. It has now been a standard procedure to use dyestuffs with this higher fixation efficiency. The second option is the use of air-jet dyeing equipment. Because of the use of a mixture of air and water the ratio can be reduced from 1:9 to 1:3. This means a theoretical reduction of 66% of the input of water, adjunct materials and energy. The option is technically and economically feasible. The company decided that when old equipment should be replaced, air-jet dyeing equipment will be chosen.

Table 3: Waste Minimization of AGAVE

Option	Implementation	Environment	Technology	Economics
Use of a high rendement furnace.	Implemented.	Calculation after 2 months estimates a reduction of 17.00 m^3 gas/year.	New furnace has a rendement of 88% instead of 80%, so theoretically a reduction of 10% possible.	Investment of 40,000 US dollars.
Use of double reactive dyes	Implemented for one specific color (army green). Tested for more colors, but limited applicability.	57% reduction of the dyestuff-discharge (when processing 'army green').	Fixation from 65% to 80% because of the availability of more reactive groups in the dyestuff	Cost neutral No Investment, reduction of the discharge costs, but the raw material (double reactive dyestuff) is more expensive.
Introduction of dosing units	Implemented.	10% reduction of dyestuff Input.	Dosing unit is only applicable on jet dyers	Initial investment of US dollars 12.500 paid back after one order
Optimisation of salt use/(reactive dyers) recipes-adjustments.	Implemented,. All possible recipes have been charged.	Minimal 10% reduction of salt input and salt discharge.	No technological adjustment necessary.	Limited cost saving.
Optimisation of loading capacity	Implemented, loading from 500 kg yams to 550 kg. Higher testing failed.	10% reduction of water consumption, energy demand and adjunct materials (f.e. dyestuff) per kg of yam.	No technological adjustment necessary.	Limited cost saving and higher productivity.
Substitution of washing for bleaching	Implemented 80% of the processes. Only bleaching optical white cotton and bad quality yarns.	Reduction of input and emission of hypo chlorite.	No technological adjustment necessary	Small cost saving and possible higher productivity.
Substitution of peroxide for hypo chloride	Implemented for the remaining 20% of the processes (optical white cotton and bad quality yarns).	No more use and emission of hypo chlorite.	No technological adjustments necessary	Unknown in detail
Minimisation of water consumtion	Implmented, two water meters installed in a large machine, thereby controlled water input. Positive effect on using water in other production units.	10% reduction of water demand (130.000 m^3 to 117.000 m^3).	Installation of water meters	Limited cost savings
Substitution of direct dyes for reactive dyes	Not yet implemented, in testing stage.	Large reductions possible on consumption of water, energy and electrolyte.	Use of new fixation method. Applicable in common dyeing units.	Unknown in detail
Introduction of air jet dyeing	Not yet implemented. Only feasible for replacement investments.	When cloth/water ratio diminishes from 1:9 to 1:3, theoretically 66% reduction possible on water, adjunct materials and energy input.	Replacement of equipment.	Unknown in detail

Good housekeeing

Most of the feasible options generated were good housekeeping options, divided into three segments minimising water consumption, optimal use of salts for dyestuff fixation and softening of the ground water and minimal use of bleaching materials. The installation of water meters, and the internal monitoring, resulted in an overall reduction of the water consumption, not oly for the machine where the meters were installed. Tests with increasing the loading capacity resulted in an increase from 500 kg to 550 kg and thereby a decrease of water, energy and salt input Critical analyses of the recipes revealed that in the past the salt dose was too high, and a reduction of at least 10 per cent is possible. New recipes have been formulated choosing the optimal salt dose. For the bleaching process, it was possible to simple wash the yarns and knitwear with water and detergents for 80 per cent of the orders, thereby reducing the use of chemicals. The remaining 20 per cent still must be bleached. After the project the bleaching agent has been changed hypo chlorite has been discontinued only hydrogen peroxide is used (when necessary). All these options are rather simple to implement, mostly without any investment or additional costs and result in a reduction of the input of raw materials (ground water, salt, bleaching materials and/or energy) and improved productivity.

Concluding Remarks

As illustrated cleaner production has proven to be a very valuable concept for abating industrial wastes and emissions. It makes far more sense to try to eliminate or reduce waste and emissions at their source rather than to treat or control the noxious effects of already generated waste streams. And, generally economic benefits can be achieved from doing so as raw materials are saved. Table 3 summarises the most promising options at AGAVE. So despite all initial barriers to the prevention process, several possibilities turned out to be environmentally and economically sound solutions thereby creating a higher productivity with lower management costs.

It makes far more sense to try to eliminate or reduce waste and emissions at their source rather than to treat or control the noxious effects of already generated waste streams.

Acknowledgement

This paper is based on the results and experiments of several Dutch cleaner production projects. These projects have been conducted by several groups of researchers and a number of small and medium sized enterprises. The methodological research of René van Berkel has been supported by the Fundation for Socio-Environmental Scientific Research, Which is funded by the Netherlands Organisation for Scientific Research.

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Cleaner Technologies for Select Industries

Nikhil Ghare, Vijay Kulkarni & Purushottam Khanna

With the realization that adoption and promotion of cleaner technologies is considerably impeded by lack of centralized data base on availability of and accessibility to cleaner technologies, National Environmental Engineering Research Institute, Nagpur has prepared an information package on cleaner technologies which contains over 500 case studies for 14 industry sectors. The paper illustrates cleaner technologies available in the database for pulp and paper, leather tanning and metal finishing industry.

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Cleaner production has been defined by UNEP as the conceptual and procedural approach to production that demands that all phases of the life cycle of a product should be addressed with the objective of prevention or minimization of short and log term risks to humans and to the environment. The goal of cleaner production is essentially that of sustainable development; production processes, product cycles, and consumption patterns which allow for human development, and the provision of basic needs without degrading or disrupting the ecosystems in which human development must operate.

The problem of cleaner production is like the problem of sustainable development, everyone knows we want it; no body knows exactly what it is. In the literature the term 'clean' has been often employed to refer to a variety of processes including cleaner technologies of production as also clean-up processes which lead to green products. The central tenets of the cleaner production approach are that the measures should be preventive and integrative.

Cleaner Technology Database at NEERI

Cleaner Technologies (CT) are the practical application of knowledge, methods and means so as, within the needs of man, to provide the most rational use of natural resources and energy and to protect the environment.

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Table 1. Cleaner Technologies — Case Studies (India)

Industry	Waste minimization at source				Resource recovery based on EOP treatment		Waste Utilization	Total
	Product	Input material changes	Technology changes	Good house-keeping	Raw material recovery	Byproduct recover		
Pulp & Paper	0	0	4	0	1	2	2	09
Textile	0	5	14	1	10	1	1	32
Leather Tanning	0	7	6	0	1	1	0	15
Metal Finishing	0	0	1	0	0	0		
Food Processing	0	0	0	0	0	2	0	02
Oil Refineries	0	0	0	0	0	1	0	01
Steel	0	0	1	0	1	0	1	03
Fertilizer	0	0	12	2	5	10	5	34
Sugar	0	0	0	1	1	0	0	02
Distillery	0	0	1	0	1	2	0	04
Cement	0	0	0	2	0	0	1	03
Dying & Printing	0	0	0	0	0	0	0	00
Chemical	0	5	25	4	13	23	17	87
Miscellaneous	0	0	0	0	0	0	1	1
Total	0	17	64	10	33	42	28	194

Table 2. Cleaner Technologies — Case Studies (Abroad)

Industry	Waste minimization at source				Resource recovery based on ECP treatment		Waste Utilization	Total
	Product	Input material changes	Technology changes	Good house-keeping	Raw material recovery	Byproduct recover		
Pulp & Paper	1	8	24	0	12	4	0	49
Textile	0	2	6	8	14	7	3	40
Leather Tanning	0	9	2	1	6	2	0	20
Metal Finishing	0	10	11	3	23	12	2	61
Food Processing	0	2	1	2	2	9	0	16
Oil Refineries	0	0	2	0	2	0	0	04
Steel	0	0	0	0	0	0	0	00
Fertilizer	0	1	3	0	1	1	0	06
Sugar	0	0	0	0	1	1	0	02
Distillery	0	0	1	0	0	2	0	03
Cement	0	0	2	0	0	0	1	03
Dying & Printing	0	1	2	0	2	2	0	07
Chemical	0	8	49	7	12	10	4	90
Miscellaneous	0	2	5	0	5	2	1	15
Total	1	43	108	21	80	52	11	316

There are three broad elements of cleaner technologies, viz.

- Resource conservation technologies aiming at waste minimization at source
- End-of-Pipe treatment technologies designed to recover raw materials, energy, water and by-products
- Waste utilization technologies for reclamation and utilization of wastes as secondary raw materials

Adoption and promotion of cleaner technologies in India, so far, is considerably impeded by lack of information exchange between various interest groups on opportunities for pollution prevention. Even a centralized data base on availability of and accessibility to cleaner tech-

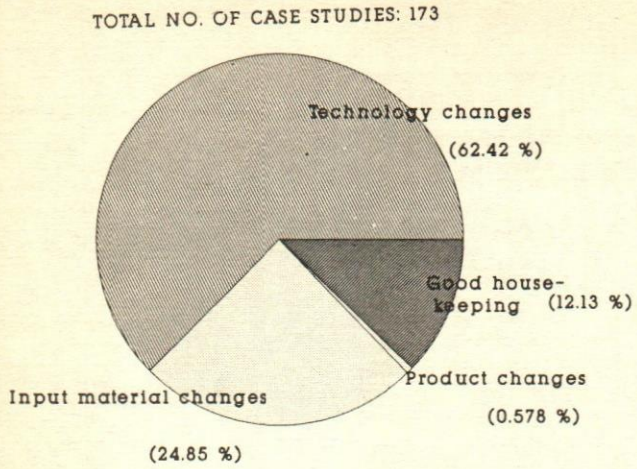


Fig. 1(a). Cleaner Technologies Case Studies (Abroad) — Waste Minimization at Source

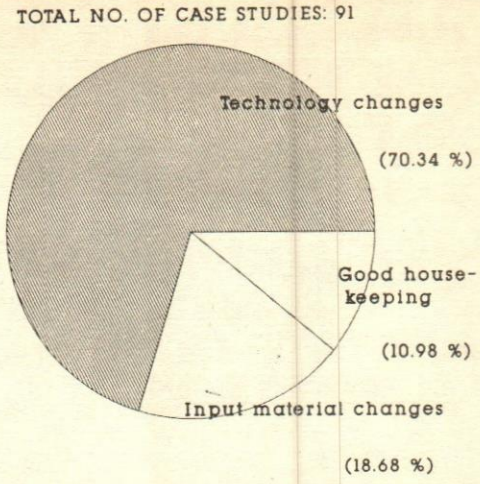


Fig. 1(b). Cleaner Technologies Case Studies (India) — Waste Minimization at Source

nologies alongwith their economic evaluation, does not exist in India. National Environmental Engineering Research institute, Nagpur has undertaken the task of preparing an information package on cleaner technologies since April 1991.

The information available nationally and internationally has been scanned through analysis of published literature, accessing established databases and interacting with the R & D centres within industries, industry associations and eminent experts in the field as also technical wings of financial institutions. As part of the project, over 1000 research papers/documents have been scanned for cleaner technologies. The data collection/collation activities were subsequently oriented to the format for case studies as standardized by UNEP for ensuring harmonization of information. Case studies in this format have been prepared reviewing the literature collected. Information on 510 case studies has been collected for 14 industry sectors. The summary of case studies is presented in tables 1 and 2. Analysis of the case studies in terms of waste minimization and end-of-pipe treatment technologies is presented in Figures 1 and 2. For on-line information storage, editing and retrieval of case studies software package named CTBASE has been developed in FOXBASE.

Cleaner Technologies for Select Industry Sectors

With a few exceptions, it is difficult to identify the manufacturing process by trade name. The process of conversion of raw materials into finished products involves a series of unit processes and operations. Case studies reported in literature, many a time, relate only to

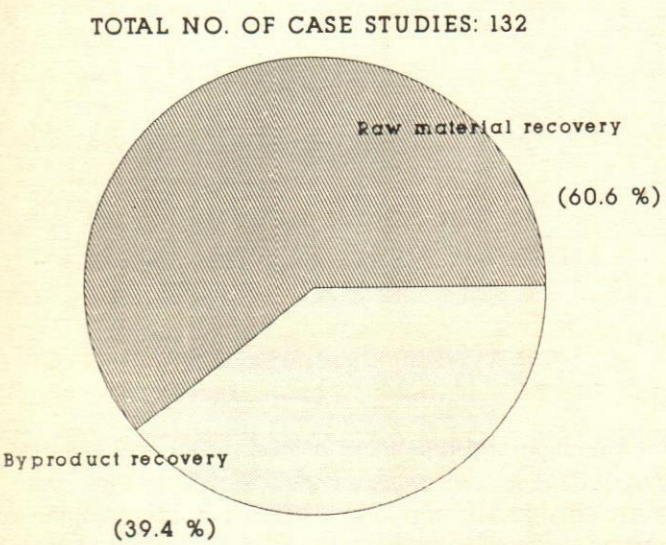


Fig. 2(a). Cleaner Technologies Case Studies (Abroad) — End of Pipe

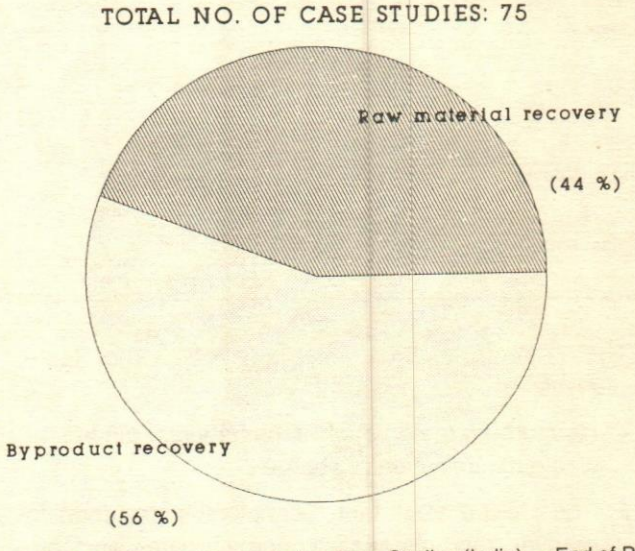


Fig. 2(b). Cleaner Technologies Case Studies (India) — End of Pipe

modifications in individual process component. Hence, the information base developed at the Institute has been analyzed to delineate cleaner technology options for unit processes and operations.

Analysis for pulp and paper, leather tanning and metal finishing industry is presented in the form of overall process flowsheet, unit processes/operations where cleaner technology options are available, benefits of cleaner technology and stage of development & location in Figures 3 to 5 and Tables 3 to 5.

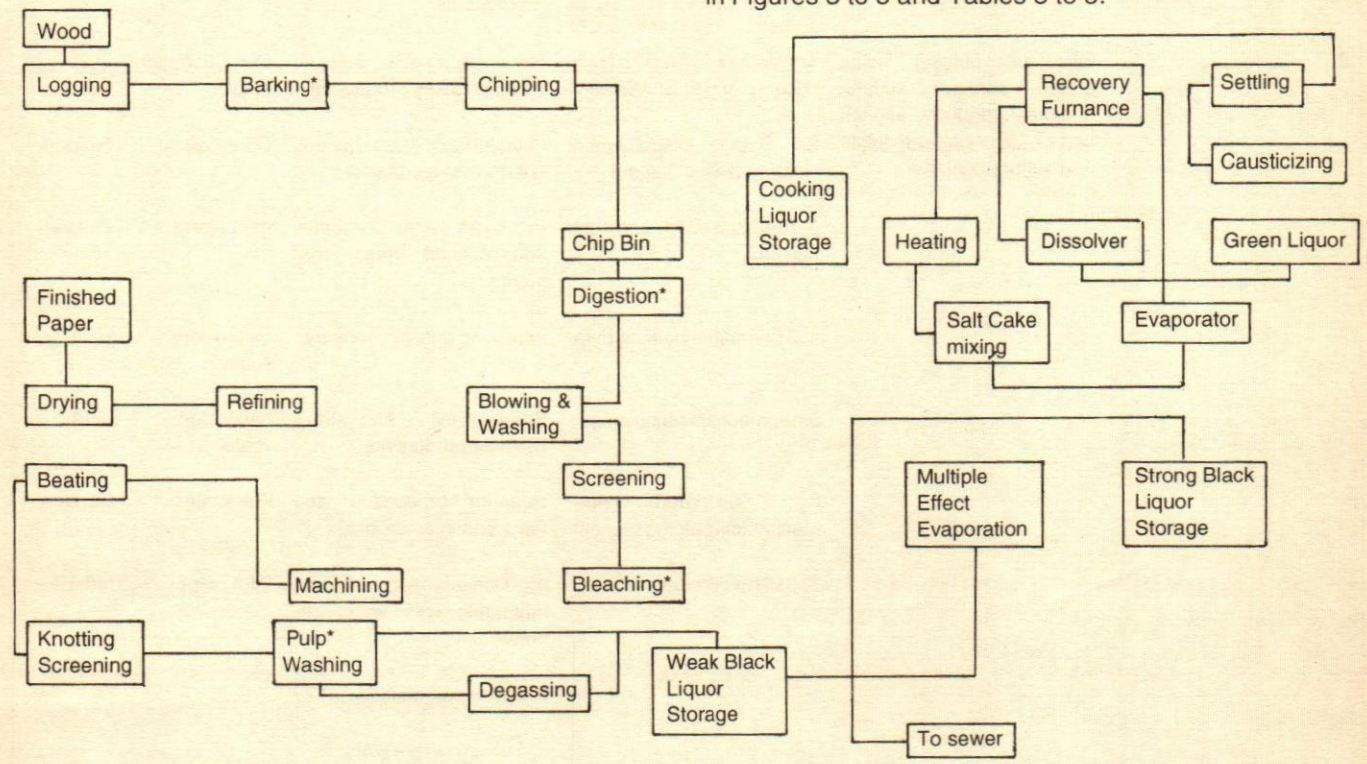


Fig. 3. Process Flowsheet for Pulp & Paper Industry

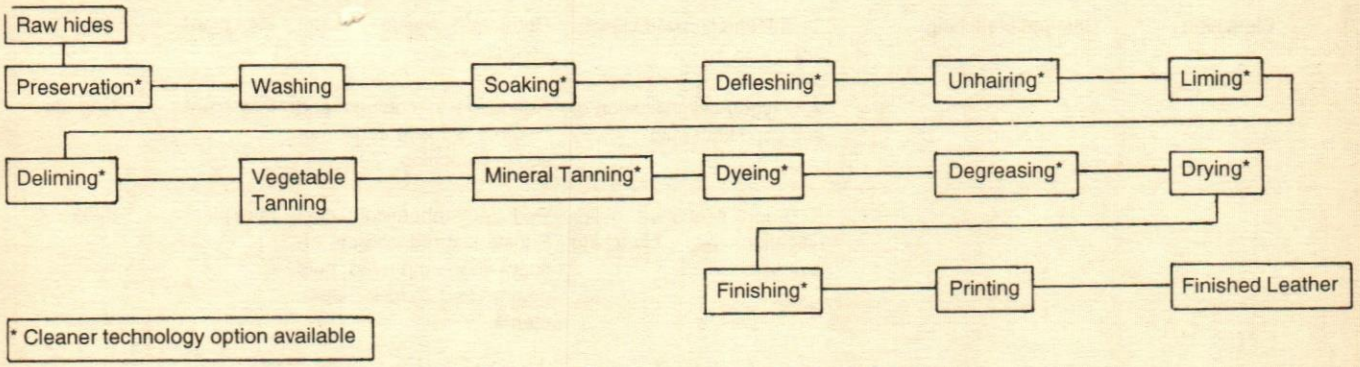
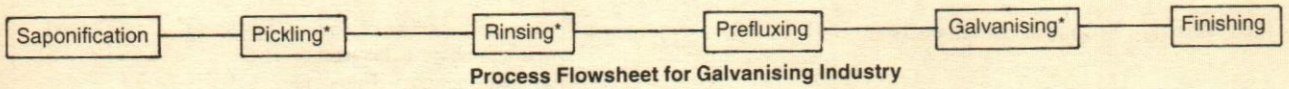
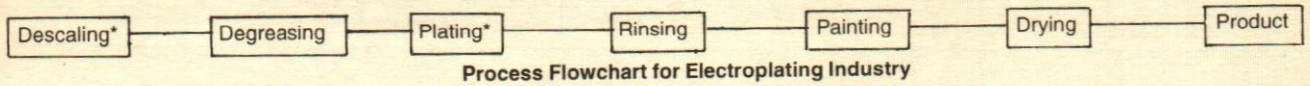


Fig. 4 Process Flowsheet for Leather Tanning Industry



Process Flowsheet for Galvanising Industry



Process Flowchart for Electroplating Industry

Fig. 5 Process Flowsheet for Metal Finishing Industry

Table 3. Cleaner Technologies for Pulp and Paper Industry

S.No	Unit Process	Conventional Technology	Cleaner Technology	Advantages	Stage of Development	Location (country)
1.	Wood barking	Wet barking	Dry barking	Elimination of Generation of wastewater	Pilot Plant	USSR
2.	Pulping	Chemical pulping using either sodium sulfate, sodium hydroxide, sodium carbonate or calcium sulfite and sulfurous acid	1. Alcohol based pulping such as ALCELL, ASAM	No water soluble waste or noxious gases production	Demonstration plant	
			2. Rapid Displacement Heating (RDH) pulping	Less amount of energy and chemical requirement	Commercial	Finland
			3. Pressurised groundwood pulping	Improved paper properties and reduced energy consumption	Pilot plant	Finland
			4. Thermomechanical pulping	Improved energy recovery	Laboratory scale	USA
			5. Biomechanical pulping	Energy saving and stronger pulp production	Laboratory scale	USA
			6. Sulfonated chemimechanical pulping process	Superior production and reduction in emissions	Full scale	Canada
			7. PUNEC Process	a. Conservation of raw materials, less water requirement b. Lower capital cost c. Solvent is renewable d. Less Polluting process	Pilot plant	India
3.	Bleaching	Chlorine bleaching	1. Chlorine di-oxide bleaching	Reduced waste water production	Pilot plant	India
			2. Oxygen delignification of softwood kraft pulp	Reduction in chlorine and chlorine di-oxide consumption in bleaching	Pilot plant	Canada
			3. Short sequence delignification and bleaching process	Reduced chemical cost Substantial reduction in effluent load Improved pulp quality and small investments	Pilot plant	India
			4. No chlorine compounds bleaching process	Total elimination of toxic chlorinated organics	Pilot plant	Finland
4.	Pulp Washing	Counter-current washing	High density displacement washing	Reduced number of equipment enables installation in smaller space. Pumping energy and washing water quantity are reduced	Full scale	Finland

Table 4. Cleaner Technologies for Pulp and Paper Industry

S. No	Unit Process	Conventional Technology	Cleaner Technology	Advantages	Stage of Development	Location (country)
1.	Preservation	Chemical preservation (common salt)	Chilling using cold air	Oxides are free of salt & other chemicals Better working conditions	Pilot plant	France
			Metal oxinates & 5% common salt mixture for skin preservation	Reduction in the amount of common salt in the effluent	Pilot plant	CLRI, Madras
2.	Soaking	Co-current soaking	Counter-current soaking	Less water requirement	Full scale	CLRI, Madras
			Proteolytic enzymes & organic sulfur compounds soaking at acidic pH	Faster & more uniform unhairing during the liming	Pilot plant	CLRI, Madras
3.	Defleshing	Defleshing before pre soaking	Defleshing after presoaking	Reduced load to ETP	Pilot plant	CLRI, Madras
4.	Unhairing	Chemical unhairing (sulfide unhairing)	CLARIZYME unhairing (enzymatic unhairing)	Total elimination of sulfide	Pilot plant	CLRI, Madras
				Collection of hair of good strength & marketable value		
5.	Liming	Calcium hydroxide liming	Sodium hydroxide replacing large amount of Ca hydroxide	Reduction in the load to the ETP	Pilot plant	CLRI, India
6.	Deliming	Ammonium chloride deliming	Sodium bicarbonate & hydrochloric acid deliming	Rapid & safe deliming process	Pilot plant	Germany
			Carbon-di-oxide deliming	Reduced ammonia odour Easier handling Improved quality & degreasing action Reduced risk of acid shock, cleaner grain	Pilot plant	Sweden
		Ammonium compounds deliming	Organic esters not causing swelling of collagen material	Reduced load to EP	Pilot plant	CLRI, India
7.	Mineral tanning	Chromium sulfate or chromium salt tanning	Aluminium & titanium complex mineral tanning (Synektan TAL)	Large reduction of chrome in the effluent	Full scale	ICI, UK
			Titanium tanning	Excellent resistance to abrasion of the sole leathers	Pilot plant	Spain
			Aluminium sulfate & vegetable tanning in same bath	Better cleaness Chromefree solid waste Energy serving	Pilot plant	Greece
			Tuftan tanning	Reduction in the chrome requirement for tanning	Bench scale	CLRI, India
8.	Dyeing	Dyeing in open dyeing machines with manual control	Dyeing in Multima machines with computer control	Reduction in energy & raw material requirements	Bench scale	CLRI, India

		Coal tar dyes & soil emulsions	Wood dyes	Reduction in load to ETP	Bench scale	CLRI, India
			Glue-stock dyeing	Reduction in load to ETP	Bench scale	CLRI, India
9.	Decreasing	Solvent decreasing (Kerosene, mineral turpentine)	Aquous decreasing	Reduction in load to ETP	Pilot plant	CLRI, India
			Microbial lipase decreasing	Reduction in load to ETP Good efficiency	Pilot plant	CLRI, India
10.	Drying	Fuel oil fired heating	Heat pump drying	Energy saving Soft leather production with good properties	Pilot plant	Spain
11.	Finishing	Organic solvent method	Instant colour concept method	Reduced liabilities	Pilot plant	CTC, France
			XEROFINIS or finifast process of finishing (Dry finishing)	No Air pollution Saving in space, investment, chemicals, energy requirement Application of almost all types of finishes on leather	Pilot plant	CLRI, India

Table 5. Cleaner Technologies for Metal Finishing Industry

S.No.	Unit Process	Conventional Technology	Cleaner Technology	Advantages	Stage of Development	Location (country)
1.	Descaling	Descaling of wire rod coils by: 1. Dipping in a hot acid bath 2. Rinsing 3. Lime treatment	Mechanical descaling of wire, rod, coils	Greater safety and reliability	Pilot plant	Canada
2.	Decreasing	Trichloroethane decreasing	1. ISC-108, an alkali cleaning compound, decreasing	Reduction in pollution	Pilot plant	UK
			2. Biodegradable 'Bioact' decreasing	Environment friendly	Laboratory scale	Sweden
			3. Steam decreasing 4. Detergent degreasing	Reduction in waste decreasing solvent and toxic organic chemical loading to ETP	Pilot scale	USA USA
3.	Plating	Hexavalent chromium plating	Trivalent chromium plating	Reduced waste treatment cost	Pilot plant	USA
		Manual electroplating	Automated electroplating	Reduction in chemical use and waste water treatment cost	Pilot plant	USA
		Cadmium electroplating	Aluminium electroplating	Reduction in operating and disposal cost	Pilot plant	Denmark
		Chromium electroplating with large anode to cathode distance	Chromium electroplating with smaller anode to cathode distance	Reduction in chromic acid requirement	Pilot plant	USA

		Electroplating in an open electroplating bath	Polypropyleneballs floated on top of electroplating bath	Less amount of energy & chemicals requirement	Pilot plant	USA
		Cyanide dip and chromic acid bright dip passivation	Sulfuric and stabilized hydrogen peroxide dip passivation	Reduction in waste disposal volume	Pilot plant	USA
Galvanishing Plant						
1.	Pickling	Disposal of pickling acid solution	Continuous filtration of pickling acid solution	Reduction in wastewater treatment cost	Pilot plant	USA
2.	Pickling Rinse Tank	No agitation	Continuous air agitation of pickling rinse tank	Reduction in pollution	Pilot plant	USA
3.	Prefluxing	No air agitation & filtration of prefluxing solution	Continuous air agitation & filtration of preflux solution	Reduction in pollution	Pilot plant	USA
4.	Galvanising	Galvanising in a galvanising bath containing molten zinc	Galvanising in a horizontal tube containing molten zinc	Reduction in energy and raw material requirement	Laboratory scale	France

Acknowledgement

The work presented in this paper forms part of work being carried out at the Institute with Central Pollution Control Board sponsorship. □

The Interdependent Reality

Interdependence is and ought to be as much the ideal of man as self-sufficiency. Man is a social being.

— Gandhi

Waste Minimization in Textile Industry

Chittaranjan Desai

The textile industry generates a lot of waste and has come in for stringent effluent standards by the Government. This paper covers the major waste minimization efforts carried out by a textile processing house in Gujarat and emphasizes that waste minimization is the best way to reduce the environmental pollution due to wet processing, besides being a productive and cost reduction tool for the management.

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Recently environmental issues have assumed great significance in the textile industry. Surat being the largest manufacturer of synthetic fabrics, with more than 220 process houses, faces considerable pollution problems as wet processing consumes sizeable amount of water and raw materials. The Gujarat Pollution Control Board has standards which are even more stringent than many of the highly developed European countries and USA — the standards are the same for effluent disposal to inland surface waters as well as public sewers, which is not the case in any other country as seen in table 1. (Reetz, 1991). Hence finding a viable means to tackle the problem has become a pressing need.

Table 1. Comparison of effluent standards for developed countries & Surat, Sachin.

	Standards For	Surface Waters	Standards For	Public Sewers
Country	BOD	COD	BOD	COD
Surat	30	100	30	100
Sachin (G.I.D.C.)	15	50	—	—
Belgium	30	400	300	750
Denmark	10-20	70-100	—	—
France	40/100	—	500	—
Germany	25	160	*	*
Italy	40	160	250	500
Spain	40	160	300	500
U.K.	30-70	—	*	*
N. Carolina, US	NA	NA	250*	600*

*Charges are levied on polluters according to the concentration of pollutants.

An important alternative to treatment is waste minimization. This concept analyses processes to determine what changes can be made to reduce pollution at source [Smith, 1989]. Waste minimization becomes critical to centers like Surat, where most of the process houses and for that matter even municipal sewer treatment plants have only primary effluent treatment plants. Waste minimization requires little or no capital investment and

results in substantial cost savings in the process hence improving the profitability.

Waste minimization requires little or no capital investment and results in substantial cost savings in the process hence improving the profitability.

Waste Audit

At paradise prints, a textile process house, a complete waste audit of all the processes and machines in terms of water consumption, COD, BOD, Suspended solids & pH was carried out to get a complete picture of major trouble spots.

All the above parameters except BOD, were tested in the process house laboratory. BOD values were obtained from an environmental laboratory. The process wise effluent analysis is shown in the table 2. Besides COD, BOD values of all the auxiliaries and dyes used were also obtained and then using their monthly consumption figures, an ABC analysis of major pollutants was prepared. This database was further enhanced by adding data like Biodegradability, Fish toxicity, Metal content, from Safety Data Sheets supplied by environmentally conscious suppliers like Sandoz. The auxiliaries consumption/month, their respective COD, BOD loads and other environmental data are as shown in Table 3. As seen, many gaps exist for information like bioelimination, fish and oral toxicity as they are not readily available with the manufacturers.

Table 2. Fabric Quality & Processwise Effluent Analysis

Quality & Process	Machine	Meters	Weight in Kgs	Water in Liters	COD in ppm	SS in ppm	pH
Scouring	Devrekha Jet	2,400	127.2	450	1,818	574	>10.5
Scouring Oxalic Wash	Devrekha Jet	2,400	127.2	450	843	165	4
Hot Rinse	Devrekha Jet	2,400	127.2	450	300	53	6
Dyeing (White)	Devrekha Jet	2,400	127.2	450	1,2176	15	5-6
Dyeing (P. Green)	Devrekha Jet	2,400	127.2	450	3,410	245	5-6
Printing	Flat Bed Prtg. M/c.	7,000	371	24,000	72	33	7.5
Prtg. Washing (Composite)	Washing Tanks	42,000	2058	45,500	824	259	7.3

Chemical Substitutions

Several chemical alternatives exist for various wet processing processes. The following factors were considered to select environmentally friendly chemicals:

- Biodegradability/Bioeliminability
- Aquatic Toxicity
- COD, BOD values
- Metal concentration.

Some substitutions carried out in various processing stages, are as follows:

Scouring: More than 600 tonnes/Year of non-ionic detergent based on Nonyl phenol ethoxylate is currently being used in Surat. This product on biodegradation gives toxic metabolites, which are highly poisonous to the fishes. Hence German manufacturers had voluntarily renunciated its manufacture from 1988. Now it can be substituted even in India, by Alfa Olefin Sulfonate, marketed by Gujarat Godrej as Ginasul 6836. It is easily biodegradable, non toxic and cheaper as well. Besides fatty alcohol ethoxylates, which are also biodegradable, are also available. Many stain removers contain solvents like Carbon tetrachloride. The harmful effect of CFC's like Freon on Ozone layer is causing a lot of concern, what is less known is, that Carbon tetrachloride has ten per cent more Ozone depletion than CFC! Thus CCl_4 based products should also be eliminated immediately. Oxalic acid used for removing rust stains is also quite toxic to aquatic organisms and besides has a considerable COD, BOD. It can be partially replaced by Hydrochloric acid. Hydro (Sodium Hydrosulphite) causes huge depletion of dissolved oxygen in the water. Considerable reduction in COD can be achieved by replacing Hydro which has a COD of 333 mg/g by 1/5th qty. of Thiourea Dioxide (Diosyn-HF) having COD of 208 mg/g, thus effectively reducing COD by 87.5 per cent and Hydro costs by 43 per cent.

Dyeing: Acetic acid alone can contribute to more than 20 per cent of a process houses's total COD, BOD loads. It can be substituted by Formic acid resulting in 83 per cent and 91 per cent COD and BOD reductions respectively. COD, BOD can be further reduced by 93

Table 3. Chemicals & Auxiliaries Eco-Tox Data

Auxiliary	Fish Toxicity	Qty/Mon in Kgs	COD	BOD	COD Kgs/Mon	BOD Kgs/Mon	% COD	% BOD
Indrez AG		4800	0.97	0.22	4636.8	1041.6	66.9%	51.9%
Acetic Acid	LD0 = 100, LD100 = 200	380	1.04	0.85	395.2	321.1	5.7%	16.0%
Ethyl Acetate	NA	200	1.54	0.29	308	58	4.4%	2.9%
Non Ionic Detergent	12	125	1.76	0.47	220	58.4	3.2%	2.9%
Oxalic Acid	Ld0 = 20	1100	0.18	0.14	195.8	154	2.8%	7.7%
Hicoklarin KD	NA	165	0.95	0.2	156.1	32.2	2.3%	1.6%
Sandopur PCI	500	80	1.28	0.18	102.4	14.2	1.5%	0.7%
Formic Acid	LD0 = 100, LD100 = 200	270	0.35	0.15	94.5	40.5	1.36%	2.02%
Silicone Defoamer	NA	250	0.37	0.03	91.5	7.3	1.3%	0.4%
Lyogen DFT	500	45	1.95	0.54	87.6	24.2	1.3%	1.2%
Sodium Hydrosulfite	NA	250	0.33	0.22	83.3	55	1.2%	2.7%
Urea	LD0 = 16000, LD100 = 300	850	0.09	0.09	76.5	76.5	1.1%	3.8%
Ginasul 6836		150	0.5	0.15	75.6	22.7	1.1%	1.1%
Shidofix N	13	80	0.91	0.25	72.5	19.8	1.0%	1.0%
Sandacid PBI	>100	40	1.57	0.22	62.7	8.7	0.9%	0.4%
Sudirol K		60	0.9	0.2	53.8	12	0.8%	0.6%
Diosyn HF		200	0.21	0.15	41.6	30	0.6%	1.5%
Sequacel HD		90	0.4	0.1	35.6	9	0.5%	0.4%
Catalyst DD		200	0.15	0	29	0.8	0.4%	0.0%
U.D.A. Powder	>100-500	35	0.77	0.23	27	8.1	0.4%	0.4%
Hicoleveler BJD		45	0.59	0.09	26.5	3.9	0.4%	0.2%
Mercerine PES	NA	80	0.32	0.06	25.8	4.7	0.4%	0.2%
Lyogen PA 66		35	0.51	0.02	17.9	0.8	0.3%	0.0%
Citric W		800	0.02	0.01	16	4	02%	0.2%
Diaton PR		35	0.07	0.02	2.6	0.7	0.04%	0.03%
Ammonium Sulfate	TLm = 1290 (96 hrs)	1100	0	0	0	0	0.0%	0.0%
Caustic Soda		1100	0	0	0	0	0.0%	0.0%

per cent and 99 per cent respectively if Catalyst DD (Dharamsee Morarjee) is used instead. Carriers based on chlorobenzenes are highly toxic — even carcinogenic and hence should be eliminated from, the dyeing process. A few manufacturers like Sandoz (India) have voluntarily renunciated their chlorobenzene based carriers. Many-PJD type leveling agents contain chlorobenzene as well as perchloroethylene or trichloroethylene, which are again potential carcinogens. The levelling agents also contribute heavily to the process house's effluent load. The conventional leveling agent for polyester based on castor oil ethoxylate has COD, BOD values of 1947 mg/g and 537 mg/g, it can be replaced by Hicoleveller BJD (Hico) having COD, BOD values of 588 and 150 mg/g only. Again this turns out to be the more economical alternative. High quantities of Sequestering agents are required in Surat due to the very hard water. Poly phosphates like TSPP and Sodium Hexa meta phosphate, which have been banned in Europe since long, are still being used as water softeners. They are not easily biodegradable and hence large amounts end up in the river and ocean. Here they are hydrolyzed to orthophosphates, and can cause Eutrophication. Thus these products should be voluntarily banned by the processors. Other popular sequesterants like EDTA and NTA based products are also non biodegradable have a strong affinity for heavy metals and thus could release them later on in the river. Recently phosphonates (Sequacel HD-Excel) have been introduced in the market. They have a higher chelating value than EDTA and hence very little

quantities are required to soften the water, besides they do not promote algae growth. Hydro in reduction clearing, can be replaced by Disyn HF as stated earlier.

Printing

A major environmental problem caused by printing emanates from Pentachlorophenol, used as a preservative in the printing gum. It has a TLV value of 0.5 mg/meter of skin and causes dermatitis, its chronic exposure can lead to liver and kidney damage & it's also carcinogenic. PCP has been banned from January 1993 in India but the gum manufacturers, barring IGI, are still blatantly using it. Considerable Phenol is used for nylon printing, which can be substituted by Diethylene glycol. Citric acid contributes quite a bit to the plant COD, BOD levels (686 & 400 mg/g respectively). Substantial reduction in these levels can be obtained (more than 97 per cent) by using Citric-W (Gunjan Organics). Ginasul 6836 can also be used for washing of prints instead of non-ionic detergent, as discussed earlier. Zinc sulfoxylate formaldehyde (Safolin) and tin chloride used for discharge printing, increase the heavy metal content of the effluent. They can be substituted with Sodium sulfoxylate formaldehyde (Rongalite-C) under alkaline conditions to eliminate these metals as well as reduce costs. Lots of kerosene is used for preparing emulsion thickening in printing of pigments. Apart from being a major air polluter, it can also be a serious fire hazard in a process house. It can be completely eliminated by using new acrylic thickeners like Alcoprint P (SM Dyechem).

Dyes

The dyes used in Surat are known to be carcinogenic and hence were discontinued [Desai, 1992].

Water conservation

The average water consumed per day in a medium sized process house has gone down in the industry, as most of the process houses have replaced the conventional Jet Dyeing machines with the new more economical low liquor ratio machines (M:L = 1:3). They require less than 1/3rd of the water and energy requirement of the conventional machines. The condensate, which was drained earlier, is now being collected and reused as boiler feed water. The Cooling water of jet dyeing machines and vacuum hydroextractors on stenters is also collected in tanks and reused now.

Printing machine modification

As very light weight thin saree fabric qualities are printed in Surat, lots of printing paste tends to penetrate the fabric and ends up on the continuous rubber blanket of the machine, while printing. Lots of water is required to wash this paste off the blanket. The printing machines consume the biggest chunk of 67 per cent of the total water used by the process house. Two major modifications were done on the machine to solve this acute problem, as shown in Fig. 1.

First a rubber doctor blade was attached before the washing unit to scrape off the excess paste from the blanket. This is collected in a trough and a bucket underneath and then reused for combination shades. A staggering eleven tonnes of printing paste is currently being collected and reused and has given savings of tune of more than Rs. 125,000 per month. The COD reduction is more than 1400 Kgs/month and the colour in the effluent has gone down from 100 Colour Hazen Units to 10 (i.e. almost colourless).

The next step was reduction of water consumption on the machine. Now fresh water is first filled in the underneath tray, after blocking the drain and then water is continuously recycled using a one HP pump and small plastic pipes, as shown in the Fig. The water is drained periodically when it gets highly contaminated and fresh water refilled. Water meters were attached on printing machines to accurately assess water conserved which was found to be more than seventy thousand litres per machine per day. i.e. a staggering one hundred and fifty million litres of water (more than 90 per cent reduction) can be saved on our seven machines per year by implementing this relatively simple system! The payback period of the modification is less than one month.

Dyebath Reuse: Generally almost 95 per cent of dye exhaustion takes place in polyester dyeing. Hence an alternative to the discharge of this is to collect it in an overhead tank, analyze it for remaining dyes/chemicals quantities and then reconstitute the bath for further use. In this manner, a single dye bath is currently being reused for more than fifteen times for white shades and four times for light shades in our unit. This reuse technique has reduced our dyeing effluent COD load by 85 per cent yielded 40 per cent savings in energy and 80 per cent in chemicals, water and effluent treatment costs.

Waste Minimization Group

A Waste Minimization Group has been formed voluntarily by the local process houses, dyestuff manufacturers and academicians, to propagate such cleaner technologies and waste minimization in our industry. The main objectives of WMG are:

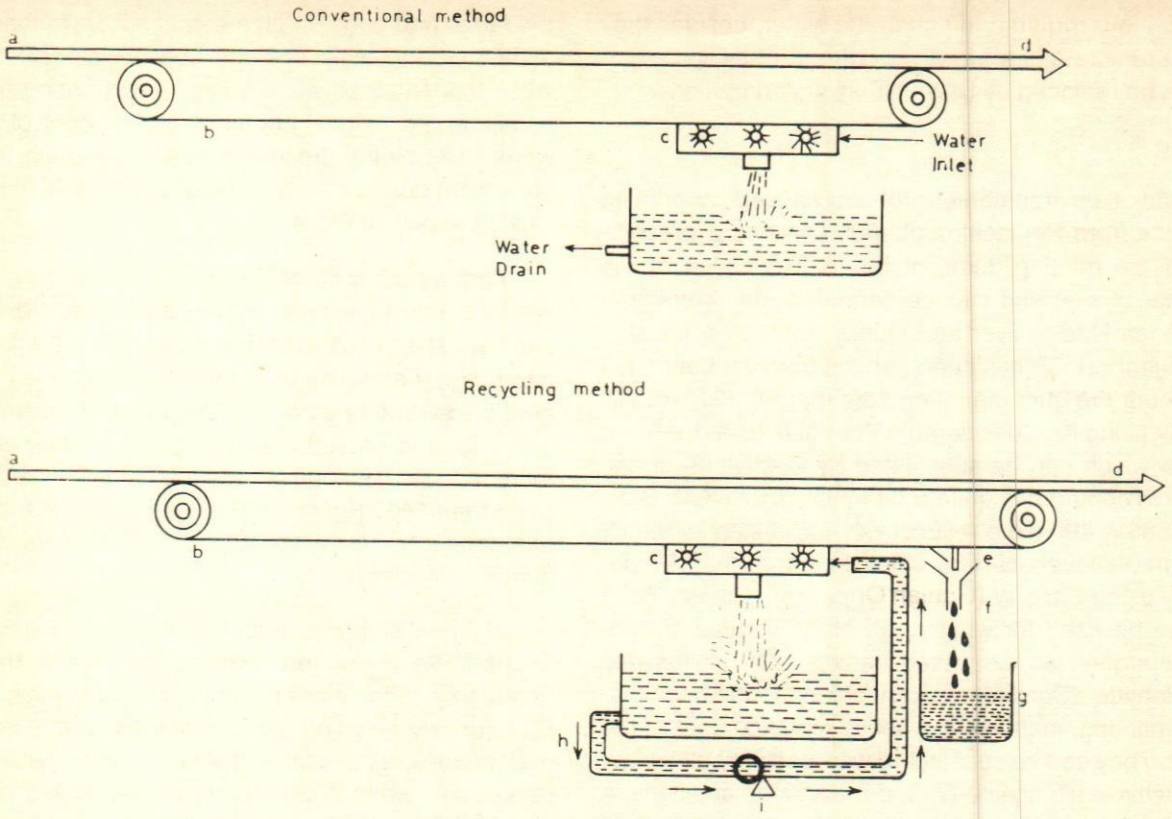

Fig. 1. Printing Machine Modifications
(a) Fabric (b) Rubber blanket (c) Washing unit (d) Driers (e) Doctor blade (f) Trough (g) Collection vessel (h) Plastic pipe (g) Pump.

- To create awareness about environmental issues of our industry and how cleaner technologies can actually reduce costs and pollution as well,
- To share experiences regarding waste minimization amongst members.
- Activities started on priority are:
- Informing the Industry about the cost benefits achieved from Environmental Audits and Waste Minimization in the form of a Newsletter.
- Analyzing 200 chemicals and dyes commonly used in Surat, for environmental and toxicological properties like biodegradability, heavy metal content, BOD, COD, carcinogenicity, fish toxicity by the Environmental Engineering Department & Bio-Sciences Department. (Safety Data Sheets).
- Preparing lists of environmentally friendly and harmful items from the above study.
- Organizing seminars and workshops on environmental issues of our industry.
- Preparing Manuals on waste minimization, energy conservation and water conservation.

Conclusion

The final block in keeping our environment clean would be the "Who cares a damn?", an attitude which has existed all these years. A combined effort from the textile processors, their suppliers, policy makers and PCB's can go a long way in reducing pollution.

Environmental aspects of wet processing will gain more importance in the coming years. The standards to which the industry will have to work, will become more stringent and effluent treatment costs will increase substantially. Under these circumstances, waste minimization can reduce the environmental impact of wet processing as well as be a productive and cost reduction tool for the management.

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Fly Ash Utilization in India: Problems & Prospects

NPC Research Division

As coal consumption will continue to increase with more thermal projects coming in to operation, the fly ash generation will also be rising in the country. Fly ash is a hazardous industrial waste, but this waste can be converted into wealth. This study examines the problems of ash utilization in India. The study also suggests measures necessary to achieve bulk utilization of fly ash in such areas as brick making, PPC, AC-products, light weight aggregates etc.

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Fly ash is a hazardous industrial waste. It poses a formidable challenge to human ingenuity in regard to its satisfactory utilization and/or disposal. Its generation is the highest at the thermal power plants. Currently India's thermal power generation capacity stands at 48,722 (30.3.93) MW per year which is slated to double during the next one decade or so. Besides thermal power plants coal ash is also produced by other coal consuming industries such as Cement, Fertilisers, Sugar, Rubber, Iron & Steel and all others requiring heat or steam for their operations (table 1). Until recently, dumping of ash in rivers, lakes, ponds or other similar sites was the principal means of disposal of coal ash generated by the industry. Where such sites were not conveniently located, coal ash was merely allowed to accumulate on the nearby available land, productive or otherwise. These disposal practices caused widespread pollution of land, air and water. But only recently measures have been adopted to check on these practices, making it all the more exigent for coal users to look for more suitable means of coal ash utilization.

Table 1. Coal Use by Different Industries in India 1992-93

(Million Tonnes)

Industry Sector	Assessed Demand	Actual Despatches	% of Total
Steel & Coke Ovens	22.73	18.59	11.4
Power Utilities	107.62 (2.17)	104.74 (1.73)	64.2 (100)
Cement	10.57	8.05	4.9
Fertilizer	3.00	3.31	2.0
Others (Brick Kilns, Captive power, etc)	36.15 (1.57)	28.41	17.4 (Nil)
Total	180.07 (3.74)	163.11 (1.73)	

Figures in bracket indicate Washery Middlings

Source: Annual Reports, Ministry of Coal (1992)

Thermal Power Plants

In India, the thermal power generation capacity is largely coal based with a very small percentage of

generation contributed by gas based plants. There are over 80 TPPs in operation at present and another 84 thermal power projects are under execution with a total capacity of 47,133 MW. Out of these, 18 projects are gas based and 61 will operate with coal. The remaining five will be using other fuels. India's thermal power generation capacity has been growing at a fairly fast pace (table 2). Thermal power generation is likely to dominate the power scenario of the country for quite sometime to come, this will be more so because of the cost advantage.

Table 2. Growth of Installed Power Generating Capacity

End of Plan Period	Installed Capacity (MW)					
	Hydro	% Change	Nuclear	Thermal	% Change	Total
1st Plan	950	..	..	1755	..	2705
2nd Plan	1917	102	..	2736	56	4653
3rd Plan	4124	115	..	4903	79	9027
4th Plan	6964	69	640	9054	85	16658
5th Plan	10833	55	840	15207	68	26880
6th Plan	14460	33	1095	27030	78	42585
7th Plan	18566	28	1565	44598	65	64729
1990-92	19251	4	1785	48096	8	69132
8th Plan*	25499	32	2950	71788	49	100247
9th Plan*	41744	64	6400	91025	27	139169

Source: Reuben (1992)
*Estimated/Planned

Currently total ash generation by thermal power utilities is estimated at about 40 million tonnes which may mount to 90 million tonnes by the year 2000 (table 3). As coal consumption will continue to increase with new thermal power projects coming into operation, the ash generation will also be rising in similar proportion. Several experts and organizations have estimated future ash arisings. NTPC's Department of R & D has placed ash generation at 110 million tonnes by 2000 AD. National Buildings Organization puts it at about 120 million tonnes per year with an estimated annual growth of about 15% in thermal power generation. CBRI, in 1988, has envisaged ash arisings to be 37 million tonnes in 1989-90 with further additions at a rate of 0.2 to 0.3 kg of fly ash per each

Table 3. Estimated Ash Generation & Coal Consumption

Item	Year				
	1989-90	1995	2000	2010	2020
Installed Thermal Power Capacity (MW)	45,000	54,000	70,000	98,000	137,000
Coal Consumption (Million tonnes)	110	200	250	300	380
Ash Generation (Million tonnes)	38	75	90	110	140

Source: Palit (1992), CMIE (1993).

Table 4. Composition of Lignite/Bituminous Coal Ashes

Constituent/Property	Unit	Lignite	Bituminous Ash	IS 3812-1981
SiO_2	%	45-59	49-67	35.0 min.
Al_2O_3	%	23-33	20-30	70.0* min.
Fe_2O_3	%	0.6-4.0	05-22	—
CaO	%	5.0-16.0	0.1-2.0	—
MGC	%	1.5-5.0	0.1-1.0	5.0 max.
SO_3 max.	%	0.1-0.3	0.2-1.0	2.75
NA_2O	%	0.1-1	0.1-0.2	1.5 max.
K_2O	%	0.1-1.5	0.1-1.0	—
Ti O_2	%	0.5-1.5	0.1-2.0	—
LO1	%	1-2	0.1-16.0	12.0 max.
Fineness (Specific Surface)	cm^2/g (Blaines)	2800-3250	3500-6500+	3200–2500
Compressive Strength at 28 days using Mix. B[1]	kg/cm^2	—	80.4-94.5	Not less than 80% of the strength of corresponding c.c.
Lime Reactivity	kg/cm^2	56.25-70.31	45-85+	40-30
Specific Gravity	—	2.146-2.429	1.91x	—
Drying Shrinkage	%	—	0.054[2]	0.15-0.10 max.
Auto clave Expansion	%	—	0.08[2]	0.8 max.

* including SiO_2 & Fe_2O_3; 1 Mix of B-4 part of OPC and 1 part fly ash by weight
+ NTPC Plants; × DVR Durgapur; 2 Bhatinda TPS
Source: Gourishankaran (1988), Garg (1988), BMTPC (1993)

All these estimates confirm that there is bound to be a substantial rise in the volume of ash arisings in the coming years.

KWH of energy produced. Although, found to be varying between the sources, all these estimates confirm that there is bound to be a substantial rise in the volume of ash arisings in the coming years.

Fly Ash & Its Composition

Coal ash forms about 3-30 percent of the burnt coal and gets separated into two parts; bottom ash and fly ash. The chemical composition of coal ash depends on several factors — geological and geographic, as well as those relating to the combustion conditions and the efficiency of the air pollution control equipment. The oxides of Si, Al, Fe and Ca constitute 95% to 99% of the ash, and the rest is made up of small amounts of Mg, Ti, S, Na & K (0.5-3.5%) and traces of about 20-50 other elements. By and large, the distribution of major elements is found to be just about the same in fly ash and bottom-ash but in the case of trace elements, concentrations can vary in the two types. The chemical and physical properties of Indian ash show marked variations, depending largely on the coal quality which usually varies from mine to mine. Some thermal plants burn lignite also. Indian coal ash can therefore be classified into two distinct groups — bituminous and lignite. Lignite ash contains more CaO + MgO than Fe_2O_3, whereas the bituminous coal ash has a greater percentage of Fe_2O_3 than CaO (table 4). Despite such variations, most fly ashes meet the requirements of IS: 3812-1981. Mineralogical composition of fly ash shows the presence of trace elements with a fairly high concentration in some cases (table 5).

Table 5. Concentration of Trace Elements in Fly Ash (ppm)

Element	Symbol	Concentration
Sodium	Na	1299
Potassium	K	18275
Lanthanum	La	238
Cerium	Ce	145
Mercury	Hg	48
Terbium	Tb	8.87
Thorium	Th	25
Chromium	Cr	404
Hafnium	Hf	32.6
Scandium	Sc	106
Zinc	Zn	2027
Iron	Fe	106667
Tantalum	Ta	5.05
Cobalt	Co	128
Europium	Eu	5.6
Smarium	Sm	1.99
Gold	Au	0.69

Source: Jain (1993)

Coal Ash & Pollution

The presence of trace metals like arsenic, codmium, vanadium etc, even though in very small amounts, can be very harmful to human population as well as to plants and animals. Inhalation of metals present in the flyash released into the air is said to be more harmful than ingestion by way of food and water. Being highly toxic, these metals can cause severe poisoning and several other health hazards to human habitations located around the thermal plants burning coal. Dumping of fly ash in and around water sources can cause severe water pollution either through leach action or as soluble contents from fly ash. This is particularly so during rainy season when organic matter solubalize Cal. Cu. Pb. and Zn. from fly ash at lower pH values. At higher pH values, Fe & Si also become soluble. The presence of these elements in the water can prove to be extremely harmful to aquatic life too. Similarly land pollution can become a serious problem as a study done by EDF in some areas has shown (EDF, 1991). Uncontrolled accumulation of coal ash thus carries with it the danger of a severe ecological disturbance in its immediate neighbourhood.

Ash Storage

The requirements of land for merely dumping/storage of coal ash generated by TPPs runs into several thousands of acres. According to one estimate (Financial Express, 1993) 28,300 hectares of land would be required for the storage of coal ash expected to be produced by several thermal power plants by the year 2000. This is based on the assumption that the current rate of utilization of coal ash at about 3% of the arisings will continue unchanged. NTPC's R & D Division, on the other hand, places the land requirements for ash disposal at about 56,000 acres (22,267 hectares) based on the simple ratio of 0.8 acre of land for the storage of ash equivalent of 1 MW power generated by a TPP. The average height of the ash dykes in this case has been taken as 8-10 meters.

The ash ponds alone occupy vast tracts of land in every TPP where the wet system of ash collection is installed. In the Singrauli area which is considered as India's power capital, having installed coal fired thermal

power capacity of 6360 MWs (1990), the area occupied by ash ponds was about 555.0 hectares (EDF, 1991) and the projected requirements were placed at 4,500 hectares for the estimated plant life of 30 years. Similar situation obtains in almost all other TPPs where the wet system of ash collection is in operation.

Central Poliution Control Board estimates land requirements for TPPs at 1-10 acres for every 1 MW generating capacity for ash disposal for 30 year plant life. Based on this formula, the total minimum land requirements for all the TPPs with an installed capacity of 70,000 MW in 2000 AD (table 3) will be around 70,000 acres or 28,237 hectares. A country like India with agriculture as its mainstay cannot obviously afford to let such a vast area of land being set apart for ash storage only. It is, therefore, necessary to look for and establish regular utilization avenues of coal ash.

The cost of ash collection in a thermal plant through wet system is estimated to be around Rs. 20 crores for a plant capacity of 420 MWs (2 units of 210 MW each) (TIFAC, 1990). If by adopting suitable means, the utilization of ash can be improved, the ash storage problem can be brought under control. Apart from this, significant savings may accrue from ash utilization. The land that can be saved for better alternative uses would also be welcome.

World Overview

A conservative estimate of the world production of ashes places it above 500 million tonnes of which erstwhile USSR accounted for nearly 31 per cent followed by USA with 24.2%. According to the UN data published in 1974 ash utilization in different countries varied between 20% and 80% with higher utilization of coal ash than lignite ashes — the latter being largely used for reclamation of mined land. The share of coal in the world's total energy needs by 2000 is expected to reach 4.4 billion tonnes with USSR and USA heading the list of major coal producers at 1500 and 1000 million tonnes per year. A similar rise in the coal ash production is also expected, though the trend of increasing use of beneficiated coal may help reduce ash arisings in some of the large user countries of coal for power generation. Ash utilization in the U.S.A reached about 20% in 1971 but is said to have gone above 25% now. However, it is still far short of the utilization rate reached by some of the European countries (Finland 84%, France 72.5%, U.K. 55%, Poland 50%, Holland 70%, West Germany 80%). A major portion of the fly ash goes into cement and concrete industry, either as a raw material or as an additive or as a replacement in the final pozzolana mix and in the manufacture of light weight aggregate. Besides these it is also used for such applications as structural fill or a stabilizer for road bases. In addition, bottom ash along with boiler slag are being used as a fill material, sand blasting grit or fine filter aggregates. Some countries have also found it useful as road aggregate both in base mixes and wearing courses. Soil amendment, mine fire control or abatement are two other uses where fly ash has found acceptance in some countries.

Attempts are being made to make economic utilization of fly ash as a raw material source for some scarce and widely used metals like magnesium, chromium, titanium and vanadium as well as alumina and magnesite. Extraction of cenospheres is another area where it has been successfully exploited by a few countries. The possibility of using it as a source of hydrides for the

Table 6. Fly Ash Applications in Different Countries

Country	Approx Qty of ash generated per year (M.T.)	Major Fly ash Technologies in use	Approx % of Ash consumption
USA	100	Concrete roads, dams, bricks-insulating and decorating, LWA, Metals/Minerals extraction, cement manufacture	25%
Poland	20	Cellular concrete, Sintered flyash aggregate, clay bricks, light weight masonary mortar, cement replacement, Road construction	50%
U.K.	11	SLWA, Aerated concrete blocks Fill material, cement concrete grouting foundations	55%
Belgium	0.9	PPC, Cement & concrete manufacture, bricks, road construction, building industry, Fill material, soil amendments	65%
Denmark	12	Cement industry, concrete, fill material, Road construction	65%
Netherland	N.A	Decorative bricks, concrete, cellular concrete, roads construction, prefabricated blocks for walling	70%
Germany	N.A	Bricks, cellular concrete blocks/slabs	80%

Source: TIFAC, (1992); Torrey (1981)

storage of hydrogen energy is also being seriously worked upon.

Bricks of different kinds, hollow or solid, made from lime fly ash, clay-fly ash or from cement sand with or without chemical additives are other major sources of fly ash utilization in many countries. Cellular concrete in different shapes and forms as pre-fabricated slabs or blocks etc. is also now popular as a means of fly ash consumption. Other areas of application are also being researched upon in different countries. Several technologies are already well established and in use and newer ones are on the threshold of being put in the market. Table 6 shows a few of the established technologies for the manufacture of fly ash based products in some of the developed countries.

R & D Efforts

In USA, Japan, UK and other European countries, the research into the utilization of fly ash was commenced during 1940-1960. In UK, the Institute of Fuel set up a research programme for the use of fly ash in buildings and civil construction works. Mixtures of OPC and fly ash were successfully tested and utilized in cementing oil wells in America and Europe. Sintered fly ash also came to be developed and marketed commercially in several countries notably U.K., Poland and Holland. In India such research started much later. By now considerable published material on the utilization of fly ash for different applications had become available in some of the specialized international journals. Bokaro thermal plant set up around 1950 was the first to test and use its fly ash to a limited extent but largely depended on the internationally published know-how and technologies. However, later around 1963 when fly ash production began to grow and its environmental impact started causing concern, a large number of research organizations embarked on this research in a systematic manner, CBRI, CFRI, CRRI, NCBM, CSMRS, TNHRs and NLC are some of the major research institutions involved in this research effort in India. Around this time the Bureau of Indian Standards also brought out specifications and guidelines for sampling, disposal and standardization of fly ash and some of the fly ash based products. There are over 50 areas of fly ash applications or products made with it. Most of these are listed in Appendix 1 which also shows likely consumers/user organizations of such applications/products. The list cannot, by any means, be regarded as complete or final as further research all over the world continues to develop other profitable avenues of fly ash utilization.

There are over 50 areas of fly ash applications or products made with it.

Bulk Utilization Technologies

Of the several technologies developed so far only a few seem to have the potential for large scale consumption of fly ash at present. Some of the more important flyash products/processes now in use in several countries and which have also been researched upon in India are:

Bricks	Cellular concrete
Light weight Aggregate	Ready mixed fly ash concrete
Portland Pozzoland Cement	Fly ash masonary mortars/ plasters
Cement Abestos Products	
Soil Reclamation/Land fill/Minefill	Soil stabilization in road construction

Bricks

A number of brick making technologies have come to be developed. The major ones are:

(i) Clay-fly ash bricks

(ii) Lime-Sand-fly ash bricks

(iii) Cement sand-fly ash bricks

(iv) Lime fly ash gypsum bricks

(v) Calcium Silicate bricks

(vi) Insulation bricks

(vii) Acid resistant bricks

While the first four types of bricks are common use items, the remaining three are special purpose bricks and have limited consumption in the civil construction works. In the process of making clay bricks, lakhs of acres of land has been used up and its top soil destroyed. According to one estimate, about 50,000 acres of fertile top soil is being damaged in the country every year (FE, 1993). Yet there have been reports of persistent shortage of bricks along with other building materials (Rajinder Kumar, 1988). It can be easily imagined how serious the problem of top soil destruction would have been if such shortages of bricks would have had to be made up by producing more burnt clay bricks. The alternative raw material for brick making which is currently available in abundance is fly ash. It can replace natural

clay in varying percentages depending upon which of the technologies shown below is employed.

Type of bricks	% Consumption of fly ash by weight
Fly ash clay bricks (FaC)	30-80%
Lime fly ash bricks (FaL)	upto 80%
Cement sand-fly ash bricks (FaCeS)	80-90%
Lime fly ash gypsum bricks-(FalG)	30-75%

Except in FaC bricks where clay will continue to be the main raw material along with fly ash, all other types of bricks use flyash along with non-clayey raw materials. Some processes also use chemical accelerators but their proportion is extremely low. A lakh of bricks can consume around 30-125 tonnes of fly ash in the first case (FaC) depending upon the type of soil. In other cases, fly ash consumption is slightly higher and may vary from 100 tonnes to 225 tonnes for a lakh of bricks depending upon the ultimate proportion of the raw materials actually consumed.

The quality of bricks in all cases is claimed to be superior to that of the ordinary 'A' class clay bricks, in all respects — strength, shape, finish, water absorption etc. However, in all these brick technologies the characteristics of fly ash are required to conform to IS: 3812.

Fly ash bricks are either burnt like ordinary clay bricks or autoclaved in some cases. In one case the bricks are water cured thus saving the fuel cost involved in kiln burning or autoclaving but the water cured bricks do not possess the same degree of compressive strength as is specified for burnt clay bricks. The colour of fly ash bricks of all types is generally black or dark grey and contrasts sharply with the red colour commonly associated with burnt clay bricks.

Despite the development of several indigenous brick making technologies their commercialization so far has been rather tardy.

Despite the development of several indigenous brick making technologies their commercialization so far has been rather tardy. The main reasons for this seem to be:

(a) a higher initial cost of fly ash bricks

(b) poor acceptance of fly ash bricks because of their appearance and general public unawareness of their superior qualities of strength and finish etc.

However, if the current shortage of bricks, which is expected to increase further as and when more developmental works come to be undertaken can be made up only by fly ash bricks and assuming that 50% of the total shortfall of clay bricks can be made good by fly ash bricks, it would require an output of 9500 million bricks per year. This level of brick production can sustain at least 250-300 brick plants each making 30-40 million bricks per year. This would mean direct conservation of large quantities of top soil and the consumption of several million tonnes of fly ash bringing in large scale savings to ash producing utilities.

Light Weight Aggregate

There is a severe shortage in the country of naturally occurring coarse aggregates generally used for concrete construction. This is substantiated by the figures estimated by the Ministry of Housing (table 7) for housing construction during the 8th plan period. One of the most important substitutes of natural aggregates is the light weight aggregate made from fly ash as raw material. The manufacture of fly ash light weight aggregate indeed offers a promising mode of disposal of sizeable amounts of ash. Unfortunately, however, there has been little or no progress in this direction in our country until recently. LWFA has been in use in several countries for the past few decades, although in India there is no evidence of its use despite some of its favourable characteristics which make it eminently suitable for use in many construction areas. These characteristics are its (i) high porosity (ii) near spherical shape (iii) smooth surface (iv) uniform size distribution and (v) chemical stability and water absorption capacity. Considerable savings are possible with the use of LWFA due to its high strength low weight ratio in concrete construction. It is reported that the use of LWFA in the construction of General Petrolem building in Los Angeles enabled savings of at least $ 1,80,000. Haulage and handling costs are also reduced to a great extent because of the lower weight of the concrete made with

Table 7. Demand & Availability of Some Important Building Materials during 8th Plan (1992-97) for 217.7 lakh housing units

Item	Unit	Likely Demand	Likely Availability	Shortage	Possible growth rate
Bricks	Million nos.	286496	231598	54898	3%
Cement	Million tonnes	131.98	114.93	17.05	6%
Aggregate	Million cu.m.	555.94	270.35	285.59	6%

Source: Suresh (1993)

LWFA. LWFA thus holds the promise of lower concrete construction costs as well as the utilization of large quantities of fly ash arisings from power plants and other coal consuming utilities.

LWFA concrete is bound to become a preferred product for most concrete construction works in course of time as it possesses several advantages over conventional concrete, e.g.

(i) It reduces cost of construction involving large quantities of cement concrete.

(ii) It imparts increased resistance to fire and earthquake hazards.

(iii) It enhances thermal and accoustical qualities of concrete.

(iv) Construction is made simple and speedy with light weight precast units made from LWFA concrete.

(v) Saves on transportation costs.

(vi) Size for size LWFA concrete consumes less cement for every cu.m of concrete.

Although light weight aggregates go back to early twentieth century, commercial manufacture of this product started only during the late fifties. There are several LWFA products now available abroad under different brand names. According to a FIP report, the world production of this material in 1974 amounted to 16 million cu.m.

The three process technologies used for the manufacture of LWFAs are

(a) Sinter process

(b) Hydrothermal process

(c) Cold bonded process.

Manufacture of LWFA from sintered fly ash took place as far back as in 1950 but the first commercial plant using this process came up only in 1957 in the UK when a product known as LYTAG was put on the market. The Hydrothermal process involves the use of lime silica and water to react with fly ash to form crystalline calcium silicate hydrates. Such hydrates possess higher strength and lower shrinkage than calcium silicate hydrates formed at lower temperatures. Palletisation of the mix and its autoclaving at 100° to 250°C follow to form LWFA known as Aardelite. The cold bonded process makes use of the pozzolanic properties of flyash though additions of lime or OPC are often necessary to provide a source for Calcium Hydroxide. Since cement helps the development of better initial strength it is usually preferred. Several products made by the cold bonded process are being marketed abroad. In India, however, experiments conducted by a few research organizations have been confined to the production of sintered fly ash aggregates but the commercialization of this process has not become possible even after several years of its development.

The high volume consumption of fly ash in the manufacture of LWFA makes it a highly attractive item for commercial exploitation. In fact, LWFA offers the best prospect amongst various fly ash products/processes (table 8) for gainful utilization of fly ash. Every cubic meter of light weight concrete requires around 3 tonnes of aggregate which means the consumption of about 1.5 tonnes of fly ash for every cubic meter of concrete. The economics of using lightweight concrete may however vary from place to place depending upon the local availability of stone concrete. It is said that around 90-

Table 8. Estimated Fly Ash Consumption in Some Important Products/Processes

S.No.	Recommended Use	Likely rate of consumption	Remarks
1.	PPC Concrete	3.0% by volume of concrete	
2.	Lime-Pozzolana Mortar	16.3% by volume	
3.	Admixture in concrete	7.0% of concrete	can replace cement upto 20%
4.	Lime Fly ash cellular concrete	78% by weight of raw material	
5.	Bituminous concrete	150/240 kg./m^3 of concrete	
6.	Clay-Fly ash bricks	40% by weight	
7.	Calcium-Silicate bricks	4.5% by weight	
8.	Lime-Fly ash bricks	80-85% by weight	
9.	LWFA	90-94%	
10.	OPC Clinker	25% by weight of raw mix.	
11.	Fly-ash Mortar	Upto 40% of cement	
12.	PPC	15-30% by weight of PPC	
13.	Mass concrete	upto 15% of cement	
14.	Road stabilization	74 tonnes per km	Around 70% of end product.
15.	SFALA concrete	1.25 tonne/m^3 of concrete	
16.	A.C Sheets	Upto 40% by weight	Higher consumption is also possible
17.	Land Fill/Reclamation	Max. 70%	
18.	LWFA concrete	1.5 t/m^3	

Source: CBRI, BMTPC 1993, CRI 1971 and CBRI Nayak (1992)

When a TPP reaches the 1200 MW capacity level and produces about 160,00 cu.m. of fly ash, a sintering plant should be considered an economically viable adjunct.

94% of flyash can be consumed in the manufacture LWFA. A plant of 30 TPD can produce around 9,000 tonnes of LWFA annually consuming around 8000 to 8,500 tonnes of fly ash. It can therefore be a very good source of fly ash utilization for any utility consuming high volumes of coal. "When a TPP reaches the 1200 MW capacity level and produces about 160,00 cu.m. of fly ash, a sintering plant should be considered an economically viable adjunct", is the advice offered by one U.S. expert.

Cement & Cement Products

The main avenues for fly ash utilization in the cement industry are:

a. raw material for OPC clinker making

b. as a pozzolana in making PPC

c. as replacement of cement in concrete and mortars

On the basis of 100 kgs of fly ash for every tonne of OPC a cement plant with a capacity of 10 lakh tonnes per year can utilize around one lakh tonnes of fly ash annually. Since a split-location unit for clinker making is also economically feasible, the need for transportation of fly ash which is much more difficult and hazardous, can be avoided. Split location clinker units are quite common in some countries and some split location cement units are also operating in India. However, there exists only limited possibility of these becoming more popular in the near future in India.

There exists only limited possibility of these becoming more popular in the near future in India.

The pozzolanic properties of fly ash (IS: 3812-1981) make it highly suitable for the manufacture of PPC. Some cement companies are already using fly ash for this purpose, though not to the possible extent. Currently the manufacture of PPC itself is not very satisfactory being no more than 15% of the total cement production. Of this around 1/3 is being made from fly ash the rest being based on other pozzolana materials notably broken brick bats etc. There is considerable scope for improving the utilization of fly ash for PPC manufacture in our country but before this can be done the use of PPC will need to be popularized. Since the manufacture of PPC calls for strict raw material and process control the technology available in the country should be carefully chosen so as to ensure that the end product conforms to the prescribed quality and gives the expected performance results.

In many countries PPC production and utilization is 40-60% of the total cement production. There should be apparently no serious difficulty in reaching this level of PPC manufacture and application in India also. Since some kind of public prejudice exists in regard to the use of fly ash because it is believed to be a spent material and hence a waste product. There is, therefore, a bias against any material produced from or with fly ash. This public prejudice, though untenable scientifically, has to be neutralized through a persistent public education programme. Once consumer resistance to the use of PPC is overcome which has been proved to be a reliable substitute for OPC, this route of fly ash utilization can become quite attractive. Research shows that 15 to 20% (by weight) of fly ash can be consumed in the manufacture of PPC. If therefore, right conditions can be created for the use of PPC upto even 40% of our total cement production at 50 million tonnes per year a consumption of 3 million tonnes of fly ash can be ensured for the manufacture of PPC every year. There is however a snag. Fly ash to be used for making of PPC has to be dry and of a specific quality. It may be difficult for some of the coal ashes to be used for this purpose as in most of the thermal power plants, the wet system of ash collection is operating.

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Replacement of Cement

In many applications where cement is used as a construction material fly ash can partially replace it without affecting its performance in any significant way. The cement blends for masonary and plastering purposes are two such applications where fly ash can replace cement to a fairly high level. Since it is possible

that the use of fly ash, particularly in construction works, could be viewed with suspicion, the use of such blends even for plastering and masonary will have to be specifically promoted and encouraged. Technically these blends have been proved to be as good, as OPC based mortars/plasters. Ready mixed plaster/masonary mortars are being marketed in several countries. These can certainly be popularised in our country too and a good potential for the bulk utilization of fly ash can be created. The economic aspect of these blends can be suitably exploited by the industry but they must also ensure that unscruplous dealers do not take the consumers for a ride by palming off pure fly ash as OPC based products. The increased use of fly ash blended plaster/mortars will go a long way to help overcome the ever growing shortage of cement in the country. Cement industry can be substantial source of fly ash consumption and, if co-ordination between power utilities, the major producers of fly ash and the cement industry can be hammered out the problem of fly ash disposal can be met half way at least.

Cellular concrete

Cellular concrete is a light weight material produced by autoclaving a given mix of fine silicious powder such as ground sand or fly ash and a binder such as cement or lime. By the addition of a foaming agent the concrete formed achieves cellularity due to the formation of microscopic pores. The lime-flyash cellular concrete is said to possess similar properties as those attained by cellular concrete made from cement and sand. The blocks or slabs made thus are both light and possess good physical properties. These can be used for both load and non-load bearing walls in multistorey constructions. Because of its good strength and light weight, it can help reduce overall construction, handling and transportation costs. It has been found that good quality cellular concrete can be made economically with fly ash additions upto 80%. In developed countries cellular concrete in the form of blocks and slabs is quite popular and several factories are producing this material for use in multi-storey construction. Some attempts at bulk production of this material have been made in India also but for one reason or the other these have not been proved highly successful. According to one estimate around 120 tonnes of flyash per day can be consumed by a plant of about 50,000 cu.m. annual capacity.

A.C. Sheets/Products

The manufacture of A.C. sheets/products involves the use of cement and asbestos as two main raw materials. It has been found that replacement of OPC with good quality fly ash is possible upto about 40% without affecting its properties of strength, appearance or shape. The Government has already announced excise duty exemption for all building materials which use 25% or more of fly ash as raw material. This enables a considerable cost reduction in the manufacture of A.C. sheets and the use of fly ash for this purpose has therefore become quite attractive. However, the quality of ash which can be used to replace OPC in the manufacture of A.C. sheets/products is difficult to obtain for various reasons. Due to this, the consumption of fly ash by A.C. products industry has remained restricted.

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The current installed capacity for the manufacture of A.C. sheets is about 9.15 lakh tonnes/year and 2.12 lakh tonnes per year for A.C. pipes. Based on a consumption norm of 40% by weight 4.5 lakh tonnes of fly ash can be utilized by the industry at full capacity. A.C. sheets are an excellent substitute for use as roofing/ceiling material in low cost housing as well as in other industrial and storage buildings. Since there are good prospects for this industry to expand when the rural housing and industrial development gets going and leads to a greater demand for A.C. products, the scope for fly ash consumption may be high provided the quality of ash turned out by coal burning utilities can meet the needs of the industry.

Road Construction

The use of fly ash as sub-base or base course in road construction has been well established. Trials carried out by CRRI (Seehra, 1988) have shown satisfactory results. Similar trials by other research organizations such as NLC and Highway Research Station (Madras) also confirm the results obtained by CRRI. The road construction techniques developed by CRRI and others for soil stabilization have been approved and recommended by the Central Assessment Committee of the Ministry of Shipping and Transport. IRC has also issued some specifications for road construction using lime pozzolana mixtures etc. IRC 15-1978, IRC 68-1976, IRC 74-1976 and IRC 37-1979, 1992 are relevant in this connection. The road construction techniques which employ fly ash are:

(i) Lime-flyash soil stabilization

(ii) Lime-flyash concrete

(iii) Lime-flyash bound mecadam

(iv) Cement fly ash concrete

(v) Lean cement fly ash concrete

The use of some of these techniques in road construction can be beneficial as a saving of around 18-20% can be easily achieved particularly if fly ash of the right quality is available at a reasonable distance from the road construction site.

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Besides soil stabilization, other areas where fly ash can be used in road construction are (i) as a filler material/embankment and (ii) as a wearing course. For use as a filler, no pozzolanic reactivity may be necessary but compaction may be unavoidable. Soil addition may also be necessary to achieve adequate stability and to avoid side erosion. For wearing course fly ash can replace sand. When the lime content of flyash is high it can replace lime-sand filler. Road construction techniques employing flyash call for observance of certain precautions and a specified drill. If and when any of these techniques are proposed to be adopted it would be better to seek the advice of specialized organizations like CRRI etc. at least in the initial stages. Besides roads, flyash can also be employed for soil stabilization in the construction of runaways, aprons taxi tracks and parking areas of airports. The design and construction techniques used are similar to those laid down in IRC Spec. 68-1973.

There has been a steady growth in road network from 1950-51 onwards (table 9). The average annual growth rate in road length at present stands at 12-14 percent and is likely to increase further to cope with the growing needs of the transport sector and rural development on which a great deal of stress is being laid in the Eighth Plan. During the Plan period an extensive road construction programme has therefore been planned. The proposed expenditure on roads during the Plan (1992-97) is Rs. 13,210.04 crores.

According to one CRRI estimate approximately 74 tonnes of flyash is consumed in the construction of one km of a 3.5m wide road. Assuming that around 2-2.5 lakh kms of road length may be constructed in each year of the 8th plan the total flyash consumption per year may be in the region of 17.5 million tonnes per year, therefore if road construction agencies involved can be directed to make maximum use of available flyash from the nearest source, a considerable dent can be made in the growth stacks of fly ash all over the country.

The total flyash consumption per year may be in the region of 17.5 million tonnes per year.

Land Fill/Land Reclamation

The beneficial applications of fly ash developed so far, require substantial capital investment in processing equipment and time to develop appropriate markets for fly ash based products. In the case of ash utilization as a fill material the real advantage lies in the fact that with minimum processing costs, maximum utilization is possible. The properties of fly ash as a fill material are grain size, density, compaction characteristics, shear strength and permeability. Each plant has however, its own variables in terms of the type of boilers, firing system and the grade of coal used and of course the degree of coal pulverization. Together they contribute to the unique quality of fly ash generated by the plant. Indian ashes by and large are said to meet the required characteristics and can therefore be considered as a suitable fill material.

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Table 9: Growth of Roads from 1950 onwards (000 Km)

Item	1950-51	1960-61	1970-71	1980-81	1987-88	1989-90	
National Highways	19.81	23.8	29.13	31.67	32.33	33.69	
State Highways	42.56	61.69	88.22	94.36	112.50	NA	
Other Roads	337.57	438.99	799.53	1315.27	1698.59	2069.5*	Includes Distt. & Village roads

Source: Eighth Five Year Plan * Estimated

There are over 50,000 brick kilns in the country using clay for brick making. Most of them use leased land for removing top soil for brick making. The wasteland after digging operations is usually left to resurrect itself. Filling of these depressions with ash could provide a very large source of ash disposal. Besides the land laid waste by brick making there are around 1300 lakh hectares of wastelands (table 10) of which a good portion is said to be of acidic soil. Such areas can be reclaimed with fly ash using its alkaline properties, instead of costly materials like gypsum or pyrites etc which are used at present. On an average one hectare of acidic soil requires 20-40 tonnes of fly ash for correction (IFFCO, 1993). There is, therefore, considerable scope for fly ash to be utilized for land reclamation particularly of acidic soils.

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In mined areas, coal waste in the form of mine spoils, unless properly disposed of, can cause severe damage to the land. These spoils may generate acid mine drainage, erosion or sedimentation. To reclaim and restore such areas for productive use, fly ash can be utilized for stabilizing the coal waste areas, as is being done in several countries. Such reclamation with fly ash can result in several other beneficial effects also. The mining sector in India has a poor record in regard to environmental protection. The mining operations are known to cause severe land degradation all around the mined areas. According to a rough estimate such land rendered waste due to mining operations may run into lakhs of hectares. Unless as a policy abandoned mines and other dereclict lands around are reclaimed and restored to productive use, the situation may continue to worsen as more areas come under mining.

The mining sector in India has a poor record in regard to environmental protection.

During the past 2-3 decades experiments have been in progress to utilize fly ash for hydraulic mine filling but it seems these have not as yet fructified into a workable technology nor it seems any of the mine authorities has shown any willingness to adopt such methods for mine filling. Since there are several thermal power plants located close to coal mines, mine filling, if found acceptable to coal mines both operationally and cost wise, can bring about tonnage consumption of flyash.

Table 10. Estimated Waste Lands in India

(Lakh Ha)

State/Union Territory	Non-Forest Degraded Area	Forest Degraded Area	Total
A.P.	76.92	37.34	114.16
Assam	9.35	7.95	17.30
Bihar	38.96	15.62	59.58
Gujarat	71.53	6.83	78.38
Haryana	24.04	0.74	24.78
H.P.	14.24	5.34	19.58
J & K.	5.31	10.34	15.65
Karnataka	71.22	20.43	91.65
Kerala	10.53	2.26	12.79
M.P.	129.47	71.95	201.42
Maharashtra	115.60	28.41	144.01
Manipur	0.14	14.24	14.38
Meghalaya	8.15	11.03	19.18
Nagaland	5.08	8.78	13.86
Orissa	31.57	32.27	63.84
Punjab	11.51	0.79	12.30
Rajasthan	180.01	19.33	199.34
Sikkim	1.31	1.50	2.81
Tamil Nadu	33.92	10.09	44.01
Tripura	1.08	8.63	9.73
U.P.	66.35	14.26	80.61
W.B.	21.77	3.59	25.36
U.T	8.89	27.15	36.04
Total	936.91	358.89	1295.80

Source: Eighth Five Year Plan, SPWD (1984)

Constraints & Impediments

Despite all the research and development efforts at developing technologies for the manufacture of fly ash based products, it is of concern that the utilization of ash in the country has shown very little improvement so far. Commercialization of indigenous technologies has not made much headway. For example, fly ash brick making is confined only to a few entrepreneurs (table 11) and that too in those parts of the country where ordinary burnt clay bricks are comparatively expensive. There are a few more cases where technology has been imported and

Table 11. Commercialization of CBRI Technologies for Clay-fly Ash Bricks

Organization/Entrepreneur	No. of Bricks Produced/capacity	Year	Manufacturing Cost of 1000 bricks	Cost of fly ash per tonne Rs.	Remarks
Bharat Heavy Electricals Hardwar	25,000	1977-78	130.0	10-13	Closed
NTPC, Singrauli STPS	45,000	1977-78	84.0	20	One-time Production for own use
UPSEB, Obra TPS	22,00,000	1977-78	90.0	5	Not in regular operation
NTPC STPS, Ramagundam	12,00,000 60,00,000 1,50,00,000	1980-81 1981-82 1982-83	110.0 125.0 130.0		Not in regular operation
Ram Kishore Singhi Kiln Nasik	15,00,000 7,00,000 3,00,000 10,00,000	1981 1982 1983 1984	— — — —	NA NA NA NA	Reported to be in regular operation
Panchsheel Bricks Co. Faridabad	1,50,000	1974	—	NA	Present status not known
FCI, Ramagundam	Approx. 100 lakhs	1970	NA	NA	Not in operation
Bharat Aluminium Co. Korba	*	1970-71	—	—	-do-
NTPC, Korba TPS	*	1979-80	—	—	-do-
Kolaghat Thermal Power Station Kolaghat, W.B.	30 lakh/yr	Recent	NA	NA	Under Erection
CPWD Delhi	20 lakh/yr		NA	NA	Not in regular operation
DVC, Durgapur	2000/hour		NA	NA	Under Erection
Building Centre Chandrapur Maharashtra	30,000/day		NA	NA	Under Erection

Plant & its Location	Capacity	Present status	Remarks Rate of fly ash utilization %
Jagaddhatri Brick Works, Barrackpore	9000/day	In operation	83
Bright Bricks Pvt. Ltd., Raichur	1000/hour	-do-	80-82
Neyveli Lignite Corporation	1000/hour	-do-	82
S.S. Brickfield (P) Ltd., Bandel	30,000/day	Under commissioning	80-85
Pulver Ash Products Ltd, Titagarh	80,000/day	-do-	80-82
Thirumala Fly ash Tech (P) Ltd., Vijaywada	30,000/day	-do-	—
Gujarat Narmada Flyash Co., Gujarat	NA	Proposed	80
Neyveli, Lignite Corporation, Neyveli Tamil Nadu	1000/hour	In operation	82

Source: CFRI & BMTPC (1973), Hajela (1988)

flyash bricks are being made. The two such known enterprises are

Company	Source of Technology	Capacity	Fly ash Utilization
Sand Plast (India)	Dorstner Germany	4000 bricks per hour	30-35%
Beror, Rajasthan		hour	
Sterling Kalk sand bricks Ltd.	Bremen, Germay	4000/5000 bricks per hour	30%

Commercialization of indigenous technologies has not made much headway.

The position of ash utilization in other processes/products is equally dismal. There are only three plants manufacturing cellular concrete products two of which have imported technologies. In the case of LWFA

The overall scenario of fly ash utilization in the country is thus very dreary as the current level of ash consumption are far below the country's needs.

only one company has recently installed a plant again with imported technology. Some cement companies are utilizing fly ash for making small quantities of PPC. Similarly only a few A.C. products manufacturing companies are able to use fly ash to a limited extent. The overall scenario of fly ash utilization in the country is thus very dreary as the current level of ash consumption are far below the country's needs. This situation is the outcome of several contributory causes, but the difficulties generally cited for low level ash utilization are:

1. The wet system of fly ash collection/disposal is the single important cause utilization. In this system fly ash is mixed with bottom ash in slurry form before transporting it to ash ponds or lagoons. The process renders fly ash largely unsuitable for all purposes where pozzolanic properties of fly ash are essential for its use. Fineness and lime reactivity are seriously impaired and the ash from ponds is rendered unfit for use in most applications.

2. Variations in ash composition are unavoidable as it largely depends on the quality of coal consumed. The variation in properties of ash extends to all power utilities. A customer can never, therefore, be sure of the quality of ash available from a particular source.

3. There is no system of testing, labeling and packing of coal ash. Most of the ash producers are not equipped to certify the quality or specification of an ash lot. This undermines the confidence of the end users of fly ash from a particular source compelling them to set up such testing and other facilities at their own cost. This obviously makes them somewhat reluctant to use fly ash, particularly if a suitable alternative is readily available.

4. Most thermal stations are located in remote areas and unless the user industry is located in close proximity, lifting and transporting of fly ash can turn out to be costly. It has been found that if fly ash has to be transported beyond a distance of 20-25 kms., its use would become uneconomical.

5. The indigenous technologies available in the country for the manufacture of fly ash products are neither cost effective nor are backed by problem solving service from the concerned research organizations. This makes the local entrepreneurs somewhat scary of these organizations and they usually resort to technologies and equipment, wherever and whenever they can.

6. The production cost of fly ash products has been generally found to be comparatively high making it difficult for these products to compete with conventional products already well established in the market.

7. There are serious doubts in the minds of prospective customers about the quality and durability of fly ash products due to a general lack of public awareness. The situation is further worsened by the cost factor. This makes the market acceptance of fly ash products in preference to conventional materials somewhat difficult.

8. Govt. construction agencies do not use fly ash products in government works. These do not also find a place in the relevant schedule/specification. A clear cut govt. policy in this regard seems to be lacking. This fact fortifies the negative public response to fly ash products.

9. Locally available equipment required for the manufacture of fly ash products such as Brick Presses, Cutting equipment etc. have not been found to be of acceptable quality. Most prospective manufacturers of fly ash products, therefore, prefer to go in for second hand imported equipment event at a high cost.

10. Initial investment in setting up a unit for fly ash products is fairly high but the returns are uncertain. This makes a prospective entrepreneur somewhat scary of fly ash projects and he invariably looks for a better alternative investment.

11. There is little co-ordination between the producers of ash, the Building Research Organizations and the Industry in general. In the absence of such co-ordination, the developed technologies turn out to be unrealistic and far removed from the needs of the industry and the market realities.

12. The average power plant manager is engrossed in the disposal of ash from the plant and as long as land is available, he worries little about the quality of the ash and its possible end use. This lies at the bottom of the general indifference to the gainful

utilization of ash and also the lack of any promotional measures to attract the right type of customers for ash.

13. A venture capitalist in India is used to tax concessions and financial incentives. In the absence of such advantages he feels insecure and deliberately overlooks the possibilities of setting up a fly ash product unit.
14. Promotional efforts in the form of demonstration works, extension services, awareness campaigns are totally absent both at government and the plant level.
15. The enforcement of pollution control measures at the plant level is not very strict as the need for power is currently of a much higher order. Many breaches are overlooked. The plant authorities therefore rarely feel it obligatory to look for safer and better avenues of fly ash utilization.

Market Potentials

Except for a very small section of the professionals, public awareness and acceptability of fly ash products in India is extremely poor. Even amongst professionals the awareness is rather shallow and does not extend beyond a few products such as bricks and PPC. In the absence of any sustained campaign to spread public awareness of the positive advantages flyash products can offer, the general public continues to depend solely upon conventional building materials. The indifference of the ash producers and the lackadaisical attitude at government level have equally contributed to the present lack of awareness and the resultant situation where there are few takers of fly ash based building materials despite the continued shortage of standard building materials over the years. Recent studies revealed almost complete lack of interest in fly ash based products amongst the dealers/traders as well as contractors/builders. The only categories which seemed to show some awareness and an equal willingness to use flyash are the manufacture of such items as A.C. products, PPC, and bricks. Their keenness for making these fly ash products is undoubtedly actuated by government concessions on excise duty etc.

Public awareness and acceptability of fly ash products in India is extremely poor.

The present market demand for fly ash products is negligible, which is not at all surprising. Given the rather low levels of public awareness and the indifference of the ash producers, traders/dealers and builders/contractors

The present market demand for fly ash products is negligible.

have shown little inclination to promote sale of fly ash based products. The consumption of fly ash at present is mainly confined to some limited applications such as A.C. products and PPC with very small quantities of fly ash going into such areas as brick manufacture, land fill, lightweight concrete, dams construction etc. Market potential of some fly ash products such as bricks, LWFA, cement manufacture etc will therefore have to be exploited through aggressive promotion techniques if the consumption of fly ash is ever to improve. Such promotional efforts must be backed by a clear cut government policy in this regard. For a satisfactory implementation of this policy a national level Ash Board on the lines of the one existing in UK may also have to be considered on a priority basis. To replace or substitute an established product is obviously not an easy task and would call for comprehensive efforts at all levels using high pressure selling techniques with full government support. The manufacture and promotion of fly ash products will necessarily have to be a simultaneous and co-ordinated effort. Since building materials like bricks, cement and aggregate have remained in short supply for several years, the void created by their shortfall can be filled in initially at least with some ease provided the overall cost and quality of substitute fly ash based products are sufficiently competitive. Once the public acceptance of such products begins to improve, efforts can be directed to the setting up of additional manufacturing capacities. Backed by suitable measures, legislative or otherwise, future market demand for these products, can then be gradually raised to sustainable levels. The consumption possibilities of fly ash for each of the major fly ash products have been briefly explained in the earlier paras. To further substantiate these an effort is now made to explain at length such possibilities in respect of one such building material-fly ash bricks.

Burnt clay bricks constitute about 13% of the total cost of building materials consumed in a construction work. The current market potential of these bricks is placed at 88% which may increase further with economic turnaround expected in the next few years. Clay bricks will therefore continue to be the main competing product for fly ash bricks, because the former also has the advantage of the unmitigated trust of the general public gained through their usage over the years. The current shortage of bricks is quite substantial (table 7) and is unlikely to come down in the near future. The production of clay bricks has been affected by the changing needs of

the modern construction industry which now requires better quality bricks with smooth surface, uniform size and shape and above all greater strength. All these requirements have caused a serious setback to the production of ordinary clay bricks. The bricks-kiln industry no longer attracts new entrepreneurs and many already in this industry are migrating to other greener pastures. Out of 386 brick kilns existing in and around Delhi during 1989-90, many have closed down their business and the number of these brick-kilns is now no more than 250-260. Similar conditions are also said to be prevailing elsewhere in the country. The current bricks production seems to show a negative growth which may further worsen when the stiffer pollution control measures now under consideration are enforced and/or the existing ones are made more stringent.

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According to a National Sample Survey Organization Study, the number of buildings constructed during 1980-81 (NSS 35th round) and 1988-89 (NSS 44th round) were as under:

		Pucca	S.Pucca	Kutcha	Total
1980-81	Rural	1.73	0.70	—	2.43
1988-89	Rural	4.23	2.31	3.89	10.43
1980-81	Urban	0.67	0.12	—	0.79
1988-89	Urban	2.28	0.29	0.19	2.76
1980-81	Cities	0.05	0.01	—	0.06
1988-89	Cities	0.15	0.12	0.010	0.06
Total 1980-81		2.45	0.83	—	3.28
1988-89		6.66	2.612	4.09	13.362

Since the use of burnt bricks in kutcha construction is nominal we have excluded these from consideration. The total no. of building construction of all types have thus been taken to be as under:

1980-81 3.28 million

1988-89 9.272 million

Based on the norms adopted by NSS (44th round — 1988-89) the demand for burnt clay bricks for the estimated building construction during 1988-89 for semi and pucca building construction was as under:

Brick Requirements (1988-89) (in million nos.)

	Pucca	S. Pucca	Kutcha	Total
Cities	1395	206	1	1602
Urban	44688	1363	152	46203
Rural	139167	13629	7780	160576
Total	185250	15198	7933	208381

Ministry of Urban Development has estimated the growth rate of bricks @ 3% per annum, (table 7) . At this annual rate of growth the brick requirements for years 1990-91 to 1999-2000 work out to be as under: (in million nos.)

1990-91	221071	1995-96	256281
1991-92	227703	1996-97	263969
1992-93	234534	1997-98	271888
1993-94	241570	1998-99	280045
1994-95	248817	1999-00	288446

The present availability of burnt bricks is placed at 230,000 millions. As mentioned earlier the production of burnt clay bricks is declining and the negative growth is estimated at 0.5 per cent per annum. Assuming that there will be a further drop in the current negative growth the shortage of bricks may continue to rise as would be clear from the following estimated demand and availability figures of burnt clay bricks upto the year 1999-2000.

Year	Demand	Availability	Short Fall (million Nos)
1994-95	248817	230000	18817
1995-96	256281	228850	27431
1996-97	263969	227706	36263
1997-98	271888	226567	45321
1998-99	280045	225434	54611
1999-00	288446	224309	64137

The shortage of bricks which was placed at 15,000 million numbers during the eighties is thus likely to grow to a colossal figure of 64,137 million by the year 2000. This in itself should provide an opportunity for flyash bricks to enter the market in a big way provided the market price of these bricks can be made adequately competitive and the sales promotion of flyash bricks is fully buttressed by countrywide demonstrations etc. in regard to their strength, finish, shape and economy in use. A new product intended as a substitute for an existing one already well accepted obviously cannot and will not attain instant success. It is bound to be a slow

process, the pace being governed by such factors as their quality and cost and the tenor, vigour and intensity of the promotion campaign. Assuming that all such factors can be taken care of, the market penetration curve of fly ash bricks may take the shape shown in Fig. 1. The process is bound to be slow to start with, but as the promotional measures begin to have their impact, the market acceptance of these bricks is also bound to pick up particularly in areas where clay bricks are expensive and/or are more difficult to obtain. This trend is expected to last for another two years or so. Later with promotional efforts going into full swing public resistance to this new product may begin to wear off and its acceptance may take a steady upward turn reaching 50% of the shortfall by 2000 A.D. or so. Thereafter, the substitution curve may straighten out and depending on the prevailing market forces may take a form which is difficult to forecast at this point of time.

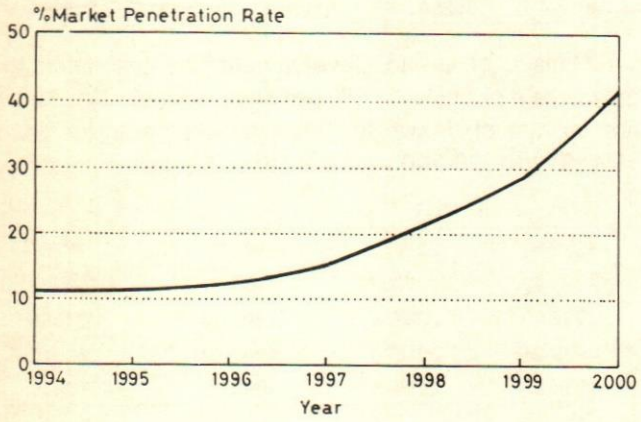

Fig. 1. Market Penetration Curve (Fly Ash Bricks)

Necessary Measures

For improving fly ash utilization it is necessary that:

a. The quality of ash is improved by refurbishing where necessary, the fly ash collection system. Mixing of fly ash and bottom ash in slurry form must stop at all coal burning utilities and especially thermal power plants.

b. The ash produced must be analysed and certified as to its composition and properties. It should then be packed labelled and stored suitably for convenient/economical transportation by the ultimate users.

c. All new thermal power projects and other coal burning units must provide for an integral system of economic utilization of fly ash at the planning stage itself after a thorough evaluation of the technologies available indigenously for the manufacture of fly ash products/processes.

d. The ash producing units must accept responsibility for the safe handling/disposal of ashes. Dumping of ashes must be prohibited under all circumstances.

e. Bottom ash which has limited utilization possibilities, should be seggregated and used for filling ditches, mines, depressions, stagnant water ponds in the area around the plant in direct consultation/co-operation with the village panchayat, distt/municipal boards as the case may be. Thermal power plants can set up demonstration works on the plant complex to educate and convince the prospective user public about the utility value of fly ash products, particularly bricks, PPC etc. produced from fly ash.

f. Once the availability of ashes of the right quality is ensured steps may be initiated to encourage entrepreneurs to set up manufacturing units close to the power plants. Infrastructural facilities like water, land, power, technical and marketing assistance may be offered to the extent feasible.

Product cost is an important factor for successful market penetration particularly when the competing products are already well established. Unfortunately, the product cost under indigenous technologies has been found to be non-competitive in almost all cases which may take the market promotion of fly ash products difficult. It is therefore essential that:

a. The economic aspects of indigenous technologies are carefully examined and technologies revamped where necessary so that along with other positive features of fly ash products the cost can also be suitably matched for successful product promotion.

b. Co-ordination between ash producers and building research organizations should be ensured in order to develop and garner maximum utilization of ashes at the project stage itself. Research at organizations may also be sponsored by ash producing units, where necessary.

c. The possibility of giving cost subsidies at least in the initial stages may be favourably considered so as to help fly ash products to gain market acceptance.

d. Uninterrupted supply of certified ash from the ash producing units to the fly ash product manufactur-

ing units located within an economic distance is ensured.

Coal burning utilities incur considerable amount of resources on ash disposal by providing ash ponds, ash dykes etc. and in the process, enhance the possibilities of land, and water pollution of the area. Utilizing ash in one or more ways can not only reduce the dangers of pollution but may also help offset part of the ash collection and disposal costs. Since the dangers arising from ecological disturbance have long term impacts on the local community and the country in general, it is necessary for the coal burning utilities to:

a. Educate their employees on the ever growing public concern about pollution and the ecological imbalances likely to be caused by their plant operations. The emphasis must be on solving the problem at the source itself.

b. Make them alive to the urgent need for planning and implementing pollution control measures as an obligation that cannot be by-passed.

c. Invite employees to offer suggestions as to how plant operations could be improved to reduce environmental pollution and the possibilities of health hazards so as to improve the ecology of the area. To encourage employees, rewards in cash or kind may also be offered for suggestions found workable.

It would be necessary to backup these by appropriate government measures both promotive and prohibitive.

a. The announcement of a clear and comprehensive government policy at the highest level in regard to the generation/disposal/utilization of coal ash within the Indian industry is of utmost relevance. The primary aim of such a policy pronouncement should be to discourage further accumulation of coal ashes at the source of generation. It should provide directions and guidelines to coal burning utilities in regard to the adoption of most effective means of ash disposal/utilization both from pollution angle and converting the waste materials into useful products.

The primary aim of such a policy pronouncement should be to discourage further accumulation of coal ashes at the source of generation.

b. Brick Kiln industry has been using clay from the fertile land ever since its inception. Thousands of acres of land are laid waste every year which a country like India can ill afford. A selective ban on the use of top soil from agricultural land (or restrictive use of clay) needs to be considered on priority to prevent further land degradation.

c. Coal ash utilization in brick making should be made compulsory for all the brick kilns. Adequate incentives, financial or otherwise, may be offered to induce them to use flyash. As a promotional step, free supply of fly ash to all brick kilns could be offered at the kiln site, to start with.

d. Manufacture of PPC is another area where the use of fly ash could be further encouraged either by offering suitable incentives or by creating a vicarious market demand with a suitable cost subsidy to the end users.

e. Fly ash products like bricks, PPC and other composite building materials, currently do not find a place in the specification/rate schedule of govt. construction agencies. As a public confidence building exercise it should be made compulsory for these agencies to include such materials in their schedule/specifications and make it obligatory for them to use these in all construction activities to the maximum extent possible.

f. As a corollary to the above, government construction agencies like PWD, MES, NBO, DDA, NBCC, HUDCO etc should construct demonstration works by using approved fly ash products/processes and jointly publicise these.

g. Our building material research organizations be made responsible not only for research but also for ensuring the acceptance, promotion and commercialization of developed such technologies/processes.

h. In these days of hard sell, no new product can hope to secure a reasonable market share unless it is backed by a suitable promotion campaign. Since compulsion is not looked upon favourably by the public, a well planned and professionally managed promotion campaign through the mass media would be essential. The matter of ash utilization no doubt has already reached a stage where further delay can prove highly detrimental.

Concluding Remarks

In conclusion, it may be added that unless the peoples' attitude towards coal ash changes little improve-

ment in regard to fly ash utilization may come about. Coal ash is not a waste material. It is a valuable mineral asset waiting to be recognized as such and turned into a useful resource.

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Appendix 1: Products/Processes utilizing Flyash

Product/Process	Conventional product in use	Likely Consumers/Users	Remarks
Group I			
BUILDING MATERIALS			
A (a) Fly Ash Bricks	Burnt Clay bricks/tiles for walling, flooring, ceiling; and roofing etc. IS specifications	Civil Engg. industry in general including specialized agencies such as CPWDs/PWDs, MES Housing Boards HUDCO, Urban/Private builders Land Developers, Rural development agencies etc.	Besides indigenous technologies developed and tried out by several Indian research organisations, a number of imported technologies are also being marketed.
(i) Lime-Fly ash bricks-IS 12894-1990	1077-1976		
(ii) Clay bonded flyash bricks	2180-1970		
(iii) Lime flyash gypsum bricks	2117-1991		
(iv) Flyash bricks with chemical additives.			
(v) Flyash stone powder cement bricks.			
(vi) Flyash red mud bricks			
(vii) Calcium Silicate flyash bricks IS 4137-1987			

	Product/Process	Conventional product in use	Likely Consumers/Users	Remarks
(b)	Insulation Bricks	Hollow cement concrete blocks or other insulating materials	Civil Engineering industry in general for specialized building construction	A low consumption item
(c)	Acid Resistant Bricks	Ceramic tiles or other acid resistant materials	Chemical Industry in general — more particularly Acids or other corrosive chemicals manufacturing units	Limited consumption item
B. Precast building units				
(i)	Flyash building blocks — hollow or solid	Burnt clay bricks or cement concrete precast blocks — solid or hollow to IS spec. 3590-1966.	Civil Engineering construction industry in general, particularly specialized housing agencies engaged in providing cheap housing in rural areas	Flyash saves on cement upto 20% in all cases besides lowering the construction cost.
(ii)	Lime fly ash cellular concrete building blocks, plain on reinforced	-do-	-do-	Lime-flyash cellular concrete lends itself to facile handling and easier workability during construction
(iii)	Precast flyash concrete products such as transmission poles, columns, beams door & window frames, lintels etc.	Plain cement concrete products	Civil Engineering Industry in general for use both in residential and Industrial buildings. Also state and private electricity supply authorities	Hastens construction work besides lowering ultimate construction cost.
C.	Flyash light weight aggregate for use in	Stone chips/crushed stone or gravel for use in cement concretes	Civil Engineering industry in general and other agencies engaged in the construction of housing, bridges and other cement concrete structures.	Offers maximum scope for bulk consumption of fly ash.
(i)	cement concrete, plain or reinforced			
(ii)	precast concrete components IS 9142-1979			
D.	Ready mixed fly ash concrete	Cement concrete construction works	-do-	Helps save on costs of labour and supervision
E.	Fly ash masonary mortars	Replaces cement partially in masonary mortars-IS 3464-1988	Construction industry in general but more particularly civil contractors PWD, MES, & other construction agencies both in urban and rural areas	—
F.	Mass concrete structures such as Dams, Hydraulic and other underground structures etc.	Flyash replaces pozzolonic materials/cement partially in the concrete	Civil Engineering industry in general. Irrigation and canal departments. Port trusts and Dockyards.	Helps prevent development of cracks in large/mass concrete structures
G.	Lime fly ash mortars	Lime pozzolana mixture IS 10772-1983	-do-	Lime flyash mixtures can also be used for casting building blocks.
H.	Clay fly ash terracing/flooring tiles	Burnt clay tiles or bricks	-do-	There is considerable saving of fuel used for burning when fly ash is mixed with clay
Group II				
CEMENT AND CEMENT PRODUCTS				
(a)	Fly ash as raw material for OPC clinker-IS 269-1967	Clay as a source of silica & alumina	Cement Industry in general but more particularly in areas where limestone of higher MgO content is to be used.	Produces high strength cement.
(b)	Manufacture of PPC with fly ash-IS 1489-(Part 1)1991	Pozzolana materials including calcined clay or natural volcanic materials. IS 1489 (Part II)-1991	Cement Industry in general	Requires the use of dry fly ash from ESP meeting the requirements of IS 3812-1966-(Part I)

	Product/Process	Conventional product in use	Likely Consumers/Users	Remarks
(c)	Oil-well cement with fly ash IS 8229-1986	Special quality cement suitable for use in oil wells under conditions of high temperature & pressure.	Oil Exploration and Oil production units	Imported product
(d)	Asbestos-cement sheets and other products such as drain pipes, louvres, joints etc.	Replaces OPC upto 30%-40%	Asbestos Cement Industry	Only selected fly ashes drawn from ESP stages 3 & 4 can be used.
Group III				
LAND RECLAMATION AND SOIL STABILIZATION				
A.	Land Reclamation with fly ash from thermal plants and other sources	Waste materials of non-toxic type, soil etc.	Mining sector in general including coal & ore mining organisations, quarry owners/licensees etc.	Requires no special characteristic for fly ash bulk utilisation
(i)	Mine fill	-do-	-do-	
(ii)	Structural fill	Solid wasttes, sanitary wastes, cinders and other general municipal wastes.	Urban land developing agencies, municipalities and civic bodies	Bottom ash can also be used
(iii)	Land fill	-do-	-do-	-do-
(B)	Soil amendment of acidic and heavy/sandy or other weak soils	Gypsum, Pyrites or other costly chemicals	Ministry of Agriculture, National Wasteland Development Board and other agencies engaged in land reclamation work	Not yet a fully established practice
(C)	Soil stabilization with lime-fly ash mixture	Granular materials and cement, heavy stone metal, water bound mecadam etc.	Central State PWDs, MES, Distt. Boards/Rural Development agencies, Civil aviation authorities, Railways and other road maintenance/construction agencies	Fly ash for soil stabilization must conform to IS 3812 Pozzolanic character of fly ash is important
(i)	Road Construction			
(ii)	Runway Construction			
(iii)	Railway tracks, and embankments			
(iv)	Canal embankments			
Group IV				
MINERALS/METALS EXTRACTION				
A.	Minerals			
(i)	Aluminia extraction	Bauxite	Aluminium Industry	Well established processes abroad. Not commercialized in India
(ii)	Magnetite extraction	Iron Ores	Steel Industry	-do-
B.	Cenospheres extraction	Variety of ceramic or other insulating materials	Chemicals and Ceramic Industry	Used for high tech applications
C.	Metals			
(i)	Extraction of Germanium	Naturally occurring ores	Metallurgical and other Industries	Considered economically unattractive, as yet. Flyash is said to be the only source of Germanium
(ii)	Extraction of Zinc			
(iii)	Extraction of Selinium etc.			
Group V				
GENERAL				
a.	Mineral Wool	Glass wool or other light weight insulation materials	Industry in general	Not attempted in India
b.	Distemper/Emulsion paints/pigments etc.	Various chemicals	Paint Industry	Not commercialized

	Product/Process	Conventional product in use	Likely Consumers/Users	Remarks
c.	Cleaning Powder for domestic use	Soda Ash etc.	Small Scale Chemical Industry	-do-
d.	Ceramics/Plastics		Ceramic/Plastic industry	-do-
e.	Plant Nutrients/Fertilizer	Fertilizers of different types	Agriculture departments/farms and Agricultural universities etc.	-do-

LIST OF ABBREVIATIONS

CBRI — Central Building Research Institute

CFC — Cement Fly ash Concrete

CFRI — Central Fuel Research Institute

CPRI — Central Power Research Institute

CRI — Cement Research Institute

CRRI — Central Road Research Institute

EDF/CDF — Electricitie de France Internationale/Group Charbomages de France

FIP — Federation International de la Precontraintes

LOI — Loss of Ignition

LWFA — Light Weight Fly ash Aggregate

MES — Military Engineering Services

NCCBM — National Council for Cement and Building Materials

NCR — National Capital Region

NLC — Neyveli Lignite Corporation

NPC — National Productivity Council

NSSO — National Sample Survey Organisation

NTPC — National Thermal Power Corporation

OPC — Ordinary Portland Cement

PPC — Portland Pozzolana Cement

SPWD — Society for Promotion of Wasteland Development

TIFAC — Technology Information Forecasting and Assessment Council

TNHRS — Tamil Nadu Highway Research Station

TPS/TPP — Thermal Power Station/Plant □

Business leaders are people who can achieve results through groups. Otherwise, they'd strike out their own and wouldn't put up with all the frustrations and difficulties of leadership in a company.

Brian Webster, Managing Director,
Bulmers Cider Limited

Feature

Development of Supplier Asset Base — Role of Different Strategies

M.K. Kolay

This paper has developed a framework for evaluating the effectiveness of different strategies adopted by an organization to develop its supplier asset base. For this purpose a methodology to assess the productivity level of the supplier asset base has been presented. The role of six different strategies towards the development of supplier asset base has been analyzed using system dynamics approach.

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Suppliers provide the necessary inputs on which an organization adds value for its survival and growth. While dealing with the suppliers, the organization gradually develops a close relationship with them in a bid to ensure smooth availability of required inputs. As the organization expands, to develop and nurture the relationship with the suppliers different strategies are adopted from time to time. Organizations invest in suppliers equip them with necessary knowledge, help them adopt new technology, thus making them feel an integral part. The suppliers, on the other hand, try to rise to the occasion to meet the changing needs of their customers. Development of such a relationship with the suppliers has assumed still greater importance in the present day competitive environment when rapid technological advances with changes in materials, products and processes, throw the best supplier out of place in no time. Every organization would be keen to assess the performance of its suppliers, whether such an external asset base, so vital for the organization, has been appreciating or depreciating over time. To what extent each strategy adopted by an organization contributes to the value of the supplier asset base is a matter of great concern to the purchase managers of the present day competitive environment.

To what extent each strategy adopted by an organization contributes to the value of the supplier asset base is a matter of great concern to the purchase managers of the present day competitive environment.

Productivity Level of the Supplier Asset Base

Efforts have been made by many researchers and practitioners to evaluate the performance of suppliers (Narsimhan, 1987; Soukup, 1987; Timmerman, 1986; Willis & Houston, 1990) with due consideration of a number of qualitative and quantitative factors. Some of these factors directly reflect the performance of the suppliers *viz.* timely availability of inputs, quality of inputs and the associated costs. On the other hand, some factors *viz.* the level of technology available, quality control method practised, financial stability etc. pertain to the strength and weakness of the suppliers and reflect the potential for performance rather than the performance. A few factors like the responsiveness and the level of commitment reflect the suppliers' attitude with consequent influence on the performance level but do not reflect the performance itself. While a few other factors *viz.* the level of interaction, the long term contract etc. reflect some of the strategies adopted by the organization in a bid to reinforce the supplier asset base but do not reflect the result of those strategies. In the absence of established relationships between the different causal variables and their effect on supplier performance, surrogate measures using a combination of different causal and end-result variables with arbitrary weightages assigned to them may be too subjective. The long term trend of the performance measure based on the end-result variables (those directly reflecting the performance) may perhaps reflect more accurately the appreciating or depreciating nature of benefits from the suppliers. Viewed from such a perspective, the performance of the suppliers may be assessed (Kolay, Forthcoming) incorporating the following factors:

- Total service level i.e. service level and its reliability
- Total quality level i.e. quality and reliability of supplies
- After-sales service level with its associated cost
- Effective price level

A framework for such an assessment of supplier's performance is presented in table 1.

Different suppliers supply items having different degrees of critically and importance to the customer organization. Most supplies are made at normal times but some might refer to crisis situation. Keeping all these factors in view, a framework for assessing the productivity index of the supplier asset base of an organization i.e. the relative functional value of the supplier asset base in terms of the likely returns vis-a-vis the relevant cost is presented in table 2.

Organizational Situation & the Supplier Asset Base

As the organization expands its business over time, the increased level of its input requirements, besides resulting in economy in handling bulk purchases, exert pressure on suppliers to improve their capability with consequent favourable impact on their performance. Better performance by suppliers means higher organizational productivity, thus facilitating further growth in business. Suppliers' improved capability and better performance have a positive feed-back effect on the demand position of their products to enable them to grow still further. On the other hand, higher capability and improved demand position escalate the bargaining potentials of the suppliers and might make the services deal with erosion in the performance level; however, the bargaining power would be limited because of its negative feed-back effect on the demand position of suppliers. Such a dynamic relationship of operating level of an organization on its suppliers performance and organizational productivity is reflected in Figure 1.

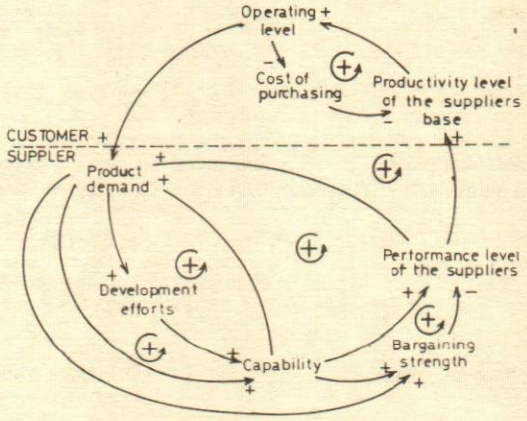

Fig. 1. Level of operations and the productivity level.

Timely payment of suppliers' bills is another important situational factor that has significant influence on the performance of the suppliers. Timely payment not only makes the suppliers fund position favourable but also enhances their commitment level towards their customers. High capability and commitment level result in better performance of the suppliers with consequent improvement in organizational productivity to enable the organization to continue to meet the suppliers bills on time. Better performance on the part of the suppliers improves their image in the market and correspondingly their product demand leading to their further growth and

Table 1. Performance index of a supplier for supply of an item

Measures	Constituent parameter	Reflected by	Meaured by
A. Total service index $\overline{T}_t$	A.2 Service level index $\overline{SV}_t$	A.1.1. Lead time in relation to lotsize of purchaisng of the number of days requirement i.e. relative lead time (LR_t)	$\overline{TS}_t = \overline{SV}_t \cdot \overline{SR}_t$ where $\overline{SV}_t$ being the weighted average sum of $1/\overline{LR}_t$ and $1/\overline{NR}_t$ and
		A.1.2 Lotsize of purchasing of the number of day requirement (NR_t)	$\overline{SR}_t$ being the weighted average sum of $1/\overline{VR}_t$ and $1/\overline{PS}_t$.
	A.2 Service reliability index ($\overline{R}_t$)	A.2.1. Percent variation in relative lead time (VR_t)	
		A.2.2. Gap between the actual and the desired delivery schedule in relation to the total quantity desired to be delivered i.e. proportional delay in delivery schedule (P_t)	
B. Total quality index ($\overline{TQ}_t$)	B.1 Quality level index $\overline{QL}_t$)	B.1.1. Percent of time quality standard attained (PA_t)	$\overline{TQ}_t = \overline{QL}_t \cdot \overline{RL}_t$ where $\overline{QL}_t$ being the weighted average sum of $(\overline{PA}_t/\overline{PV}_t)$, $1/\overline{PR}_t$ and $[1/(\overline{PD}_t \cdot \overline{PW}_t)$ and
		B.1.2 Percent variation of quality within acceptable quality range (PV_t)	$\overline{RL}_t$ being the weighted average sum of $1/\overline{VM}_t$, $1/\overline{VF}_t$ and $1/\overline{VL}_t$.
		B.1.3. Percent rejection (PR_t)	
		B.1.4. Percent defective (PD_t)]	
		B.1.5. Proportion of reworking cost (PW_t)	
	B.2 Reliability level index $\overline{RL}_t$	B.2.1 Percent variation in maintenance cost proportion (VM_t)	
		B.2.2 Percent variation in the expected failure rate (VF_t)	
		B.2.3 Percent variation in the expected life of the item (VL_t)	
C. Total after sales service index ($\overline{AS}_t$)	C.1 After sales service level index ($\overline{AL}_t$)	C.1.1 Timegap between the requisition of service and its reporting i.e. timelines of service ($\overline{T}_t$) C.1.2 Average time required to service the items (TS_t)	$\overline{AS}_t = \overline{AL}_t/\overline{CA}_t$ where, AL_t being the weighted average sum of $1/\overline{ST}_t$ and $1/\overline{TS}_t$ and $\overline{CA}_t = \overline{AC}_t$
	Cost of after sales service index ($\overline{CA}_t$)	C.2 Inflation adjusted cost of after sale service (AC_t)	
D. Effective price index ($\overline{EP}_t$)		D.1 Inflation adjusted unit price (UC_t) D.2 Discount rate (DR_t)	$\overline{EP}_t = EP_t/EP_o$ where $EP_t = NP_t + EC_t + SC_t$, $NP_1 = (1 - DR_t) \cdot UC_t$ and $EC_1 = NP_t \cdot CR_t \cdot OC_t$
		D.3 Credit (advance) term (CR_t)	
		D.4 Opportunity cost of capital to the customer (OC_t)	
		D.5 Additional charge levied (if any) for the proposed after-sale service (SC_t)	
E. Performance index ($\overline{PF}_t$)	E.1 Total service index ($\overline{TS}_t$) E.2 Total quality index ($\overline{TQ}_t$) E.3 Total after sale service ($\overline{AS}_t$) E.4 Effective price index ($\overline{EP}_t$)		$\overline{PF}_t$ being the weighted average sum of the three benefit indices i.e. ($\overline{TS}_t$), ($\overline{TQ}_t$) and ($\overline{AS}_t$) in relation to the effective price index i.e. ($\overline{EP}_t$)

development. This might affect their bargaining potentials with its adverse impact on the performance level which would limit the bargaining potentials. The nature of such a relationship is reflected in Figure 2.

Table 2. Productivity index of the supplier asset base of an organization

Measures	Constituent parameters	Reflected by	Measured by
F. Productivity index of the supplier asset base ($\overline{PO}_t$)	F.1 Performance index of the supplier asset base ($\overline{PS}_t$)	F.1.1 Performance index $\overline{PF}_{pqt}$ of p_{th} supplier for the supply of (a) proportional volume of q_{th} item (i) i.e. less/moderate/great extent having different (b) nature of the item (j) i.e. routine/non-routine/developmental (c) importance of the item (k) i.e. A/B/C category (d) critically of the item (m) i.e. V/E/D category under (e) different situations (n) i.e. normal/difficult/crisis i.e. weighted performance index $\overline{WP}_{pqt}$ F.1.2 summation of weighted performance index as above for all the supplier for the supply of all the items	$\overline{PO}_t = \overline{SP}_t / \overline{FC}_t$ where $\overline{SP}_t = \sum_{w=1}^{y} \sum_{p=1}^{x}$ $\overline{WP}_{pqt}$ (x being total number of supplier and y, total number of items supplied) $\overline{WP}_{pqt} = (W_{it} \cdot W_{jt} \cdot W_{mt} \cdot W_{nt} \cdot (\overline{PF}_{pqt})$
F.2	Purchasing function cost index $\overline{FC}_t$	F.2 Inflation adjusted cost of the purchasing function of the organization in relation to its volume of purchases (FC_t)	

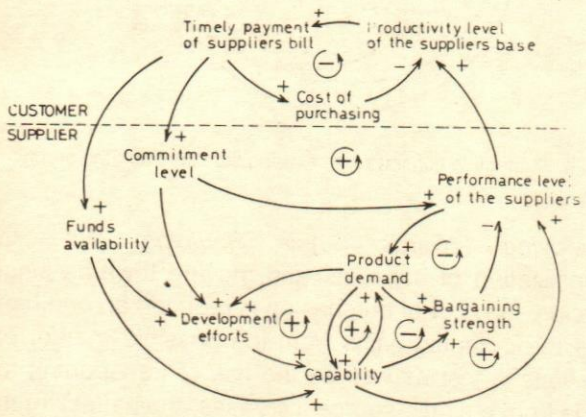

Fig. 2. Timely payment and the productivity level.

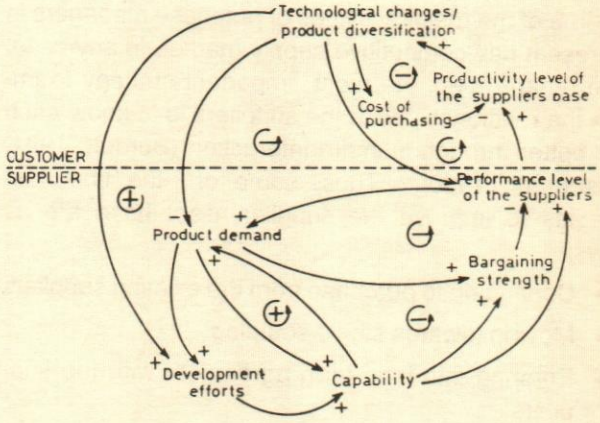

Fig. 3. Changes in technology and products and the productivity level.

Better performance on the part of the suppliers improves their image in the market and correspondingly their product demand leading to their further growth and development.

In today's competitive environment every organization has to attune itself to rapid technological advances and changes in the product market. Such changes with new and more stringent requirements from the organization cause an adverse impact on the performance of the suppliers with consequent impact on organizational productivity. The demand for the supply of existing se which inturn reduces their capabilities still further. New suppliers may have to be located and relationships with them may have to be developed afresh with associated costs and consequent adverse impact on organizational productivity. However, such changes force the capable suppliers to attune themselves to maintain and improve their performance level. Thus the initial erosion in the supplier asset base may be re-built in course of time. Such an impact of technological changes and product diversification on the supplier asset base of an organization is presented in Figure 3.

Thus, the different situational factors as a result of changes in the external environment and various policies adopted by the management of an organization in general may affect its supplier asset base.

Strategies Adopted & the Supplier Asset Base

The purchasing management of an organization in the course of dealing with the suppliers adopts various strategies over time. It is evident from practice as well as from the literature (Bermard, 1989; Burdett, 1991; Dumond, 1990; Lyons et al., 1990; Nelson Jambekar, 1990) that certain organizations prefer to continue to purchase from the same set of suppliers over the years and try to strengthen the relationships with them, whereas some others prefer to keep their suppliers under pressure and try out new ones. To ensure smooth availability of inputs from the suppliers, long term agreement are entered into with reputed suppliers. Supplier base is rationalized, ineffective suppliers deleted and some organizations even move towards single sourcing as a philosophy of purchase. To reduce the cost of inspection and meet the just-in-time requirements, quality certification programmes are launched (Nelson of Jambekar, 1990). Efforts to develop new sources and to nurture the existing ones with various forms of assistance are some of the major activities of purchase managers in the present day competitive supply market. In any case, for an organization, the most important strategy to improve the relationship with the suppliers is to know each other better through intimate interaction (Burdett, 1991; Lyons et al, 1990). Thus, some of the important strategies to improve the supplier asset base are as follows:

- Continuing to purchase from the existing suppliers
- Moving towards single sourcing
- Entering into long term agreement with the suppliers
- Launching quality certification programmes
- Encouraging source development efforts
- Encouraging more and more interaction with the suppliers.

Efforts to develop new sources and to nurture the existing ones with various forms of assistance are some of the major activities of purchase managers in the present day competitive supply market.

Continuing to Purchase from Existing Suppliers: with such a practice, the organization avoids locating new suppliers, thereby cutting down the variable cost of purchasing. However, retaining the same suppliers without further exploration of the market potentials means loss to the organization. On the other hand, steady demand of the organization's input requirements is likely to strengthen the capability of existing suppliers with favourable impact on their performances level which would inturn encourage the practice of continuing with the existing suppliers. Bargaining potentials of the suppliers might be increased due to their higher capability but its adverse impact on their performance would consequently restrict the same. The impact of such a strategy has been shown in Figure 4.

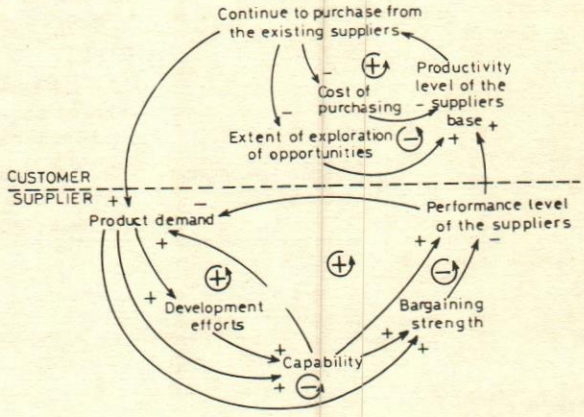

Fig. 4. Strategy to continue with existing suppliers and the productivity level

Moving towards Single Sourcing: With the rationalization of suppliers and moving towards single sourcing, the cost of purchasing is reduced on one hand while the potential gains from the possible market explorations is lost as well as the risk of transporting the goods from a single source increases, thus affecting the productivity level of the supplier asset base. As regards the impact of such a strategy on the suppliers, higher level of demand placed on a single supplier provides better opportunity to the suppliers to develop themselves. Increase in bargaining strength would, however, be restricted as in the case of previous strategies. Figure 5 reflects the impact of such a strategy.

Entering into Long-term Agreement with the Suppliers: As the organization enters into long term agreement with its suppliers, variable cost of purchasing is reduced: however, market explorations are less with possible loss of potential gains. Such a strategy enhances the commitment level and improves the performance. On the other hand, increased level of demand and capability including the long term agreement itself increases the bargaining strength of the suppliers. However, the impact of such an increase in the bargaining

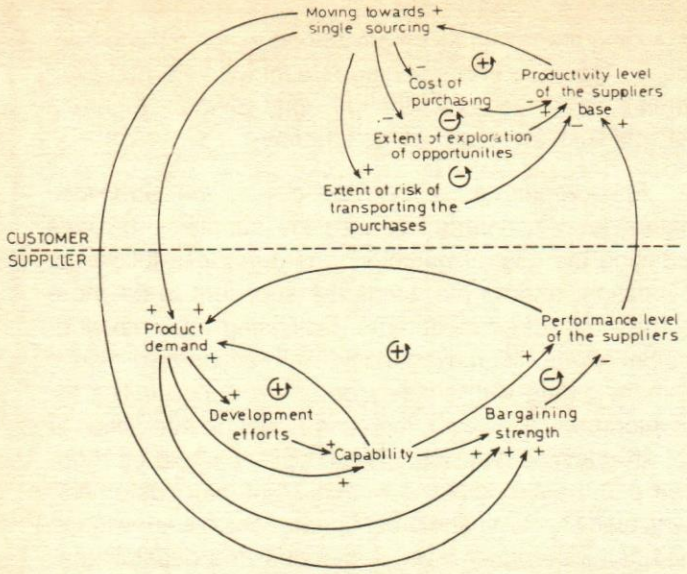

Fig. 5. Strategy to move towards single sourcing and the productivity level.

strength remains restricted as before. The impact of such a strategy is shown in Figure 6.

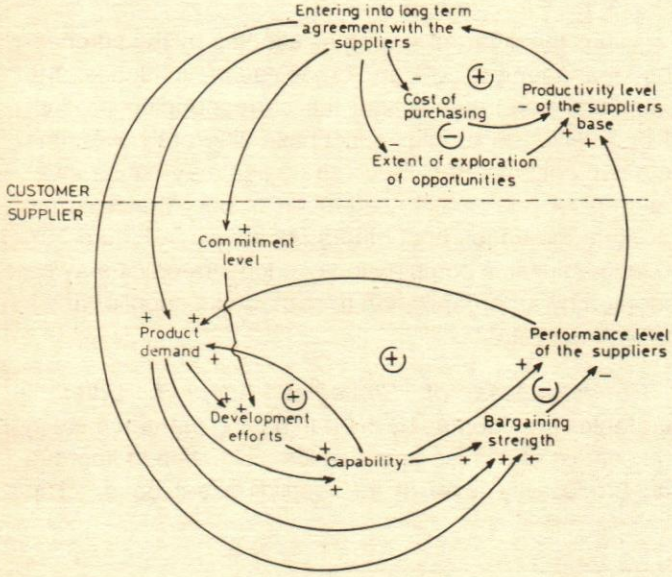

Fig. 6. Strategy to enter into long term agreement and the productivity level.

Increased level of demand and capability including the long term agreement increases the bargaining strength of the suppliers.

Launching Quality Certification Programmes: In a bid to reduce the inspection of incoming supplies and ensure ready availability to meet production requirements, particularly when the organization has adopted JIT philosophy, such a strategy improves the productivity of the supplier asset base. However, quality certification might restrict further exploration of developments in the supply market, resulting in possible loss. As regards its impact on the suppliers, demand for their products increases not only from the specific customers launching quality certification programmes but also from other potential customers due to quality certification. Increased level of demand continues to improve the performance of the suppliers, thereby favourably influencing the productivity level of the supplier asset base of the organization. The bargaining strength increased due to increased demand and consequent improvement in capability of the suppliers as well as due to quality certification, however, remain restricted as in the case of previous strategies. The impact of such a strategy has been reflected in Figure 7.

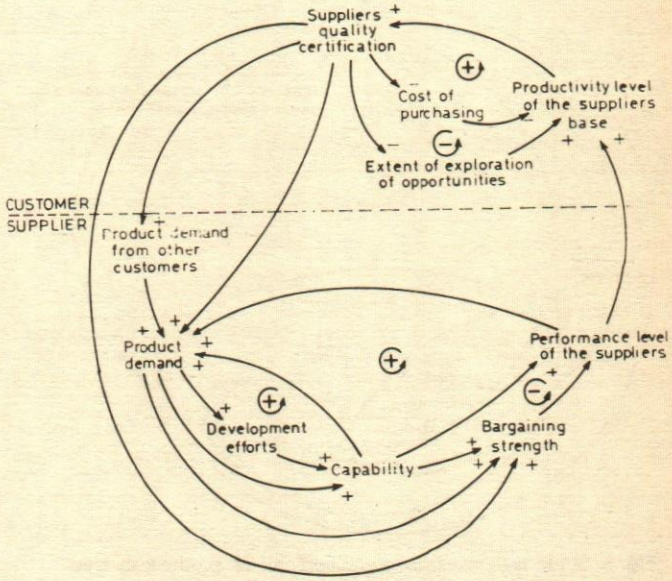

Fig. 7. Strategy to certify quality and the productivity level.

Source Development Efforts

Organizations adopt various measures to develop their new suppliers and to strengthen the existing ones by providing them with the necessary technical know-how of the processes, the quality control methods to be adopted, in-house research and development facilities for their product development and testing, besides financial support. Such support from the customers increases the commitment level of the suppliers which inturn not only improves their performance, but also encourages more developmental efforts. With higher stake on the suppliers, more orders are likely to be placed on them, thereby

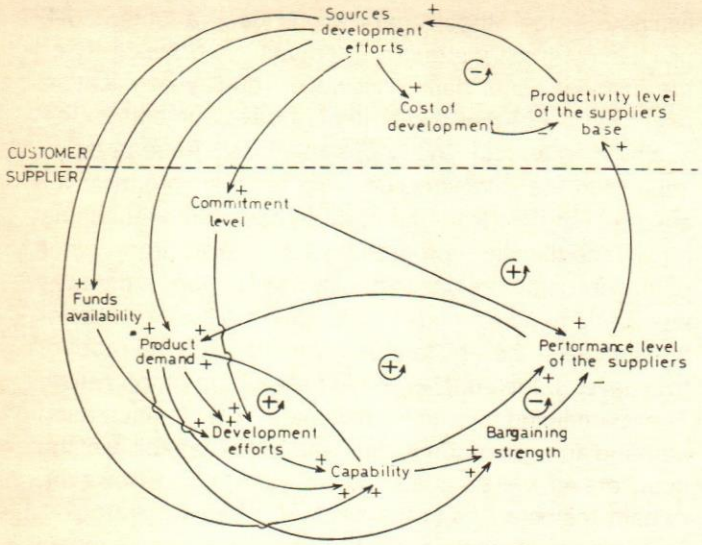

Fig. 8. Strategy to undertake sources development and the productivity level.

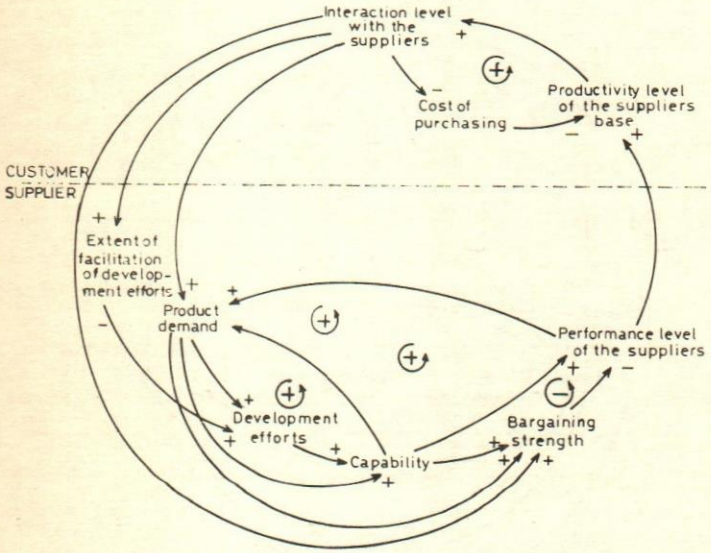

Fig. 9. Strategy to increase interaction and the productivity level.

providing them with still more opportunities for improvement. Increase in bargaining strength would, however, remain restricted as in the previous cases. Figure 8 reflects such an impact of the strategy.

Encouraging more Interaction with the Suppliers: Higher level of interaction with the suppliers, besides reducing the cost of purchasing through less follow-up, inspection, returns etc. helps the suppliers to be more intimate with their customers, facilitating their developmental efforts. Increased level of interaction also results in more orders with consequent more opportunities for development. However, increased level of interaction is not an unmixed blessing. The suppliers would be more aware of the strength and weakness of their customers, particularly the cost and profit figures. Such a knowledge together with higher level of demand and capability increases the bargaining power of the suppliers with possible adverse impact on their performance level, thus advocating avoidance of too much of interaction with suppliers. The impact of such a strategy is shown in Figure 9.

Thus the different strategies adopted by the purchasing management of an organization influence the suppliers' performance and the corresponding productivity level of the supplier asset base differently over time in a dynamic manner. Such strategies may not be independent of one another, adoption of one strategy may facilitate the adoption of others (as shown in Figure 10). In fact, a suitable combination of such strategies may be adopted by an organization to manage its supplier asset base effectively.

Effectiveness of Strategies Adopted: Different strategies are adopted by the purchasing management in the context of a given organizational situation to improve the productivity level of its supplier asset base. The

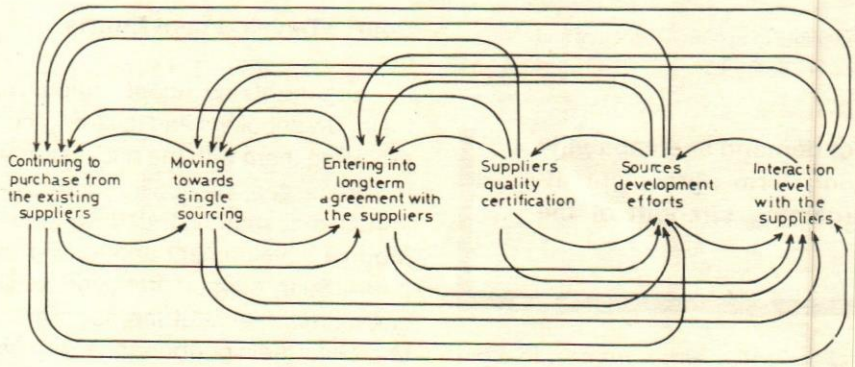

Fig. 10. Different strategies and their inter relationships.

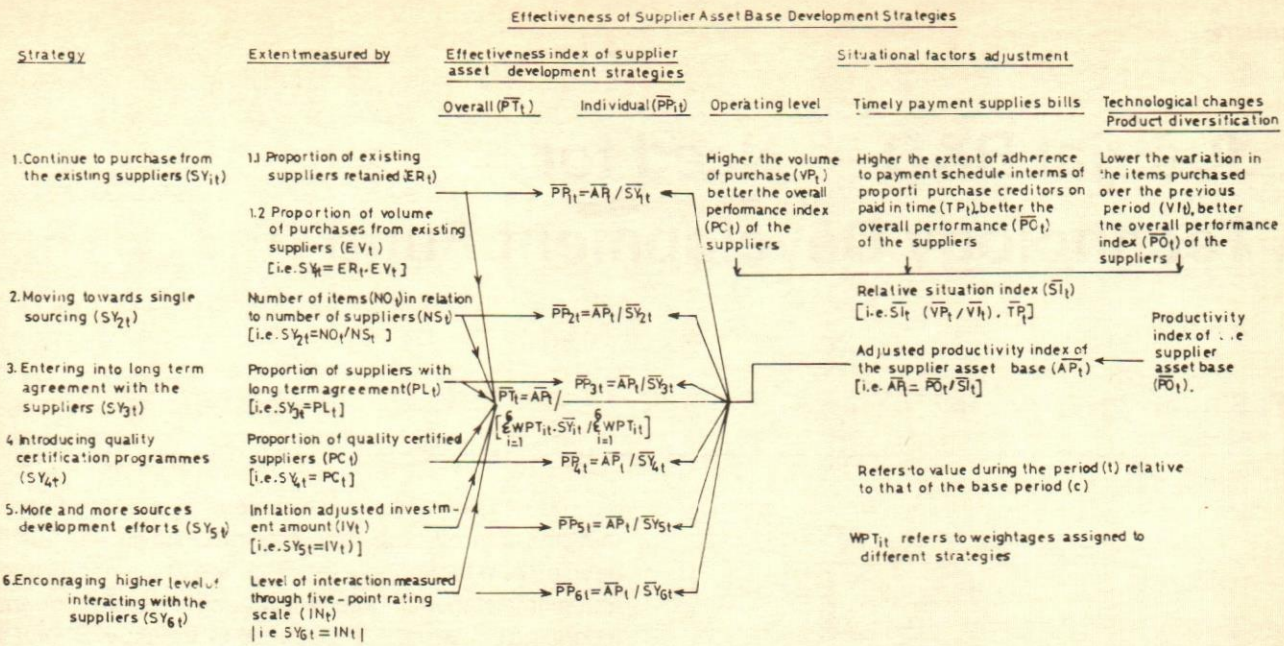

Fig. 11. Effectiveness of supplier asset base development strategies.

impact of situational factors outside the control of the purchasing management may have to be accounted for to reflect the outcome of the strategies towards the level of productivity achievements. The productivity level of the supplier asset base, duly adjusted for the impact of such situational factors, may have to be judged in relation to the extent of different strategies adopted through appropriate surrogate measures reflect the effectiveness of such strategies while managing the supplier asset base of the organization. A suitable framework to evaluate the effectiveness of the different strategies is presented in Figure 11.

Conclusions

Periodic monitoring of the productivity level of the supplier asset base and the extent of influence of different strategies on such a productivity level is a potent tool in the hands of purchase managers to strengthen the supplier asset base of their organizations. The different weightages that have been proposed to be assigned to assess the productivity level of the supplier asset base and to measure the overall effectiveness of purchasing strategies may be based on opportunity cost principle to reduce the subjectivity associated with the proposed methodology.

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Feature

Industrial R&D — Need for A Technology Development Fund

N.P. Singh

The paper argues for the creation of a cess-based Rs. 1000 crore Technology Development Fund for industry with a view to enabling India to emerge as a technological leader in the 21st Century, providing opportunities to its vast S&T manpower for creative work at home, and becoming a net exporter of technology. The Fund should be set up as a statutory body or body corporate, with participation from Industry, Scientific Agencies of Government and Institutes of higher education and research like Universities/I.I.T.s., etc. recommends the author.

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The views expressed in this paper are the author's own and do not necessarily reflect those of the organisation he serves.

Industrial R&D activity is necessary not only to maintain and improve our industrial productivity but also to develop new technoogies appropriate to our needs and to attain international competitiveness in a fast-chaning technological world. R&D work in industry involves a wide range of activities, including basic/oriented basic research, applied research, design, fabrication and setting up of pilot plants or assembly of prototypes, field testing of finished products/prototypes, effecting further changes in the designs of pilot plants/prototypes, etc., leading, finally, to the establishment of the first commercial plant in the country based on indigenous technology.

Risks in Industrial R&D

Most innovative R&D activity involves considerable amount of risks, ranging from failure of the technical processes to those on the marketing or commercial side, etc. These risks are usually much more than those in normal production activities based on proven technologies. However, experience relating to the development of new technologies indicates that the potential pay-offs are higher, the higher the element of risk involved. Indeed, unless such risks are undertaken on a calculated basis, no development of any new technologies would, at all, be possible.

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Till such time as a full-fledged commercial plant has been designed, fabricated, installed and commissioned

and made to operate successfully over a period of time, neither the entrepreneurs nor the financial institutions develop adequate confidence in the success of the indigenous technology. It is essentially this lack of confidence, which is largely responsibly for the hesitation on the part of our industry and the existing financial institutions to invest/lend money in/for industrial R&D activities or to accept know-how from national labs, which is not at the commercially proven levels. The result is that, today, over 80 percent of the R&D finance in the country continues to come from the Central/State Governments in the form of 'grants', with comparatively meagre returns in commercial terms.

Inadequacy of Finance for "Growth oriented" R&D

The expenditure required for laboratory scale research, pilot plant/prototype development and commercial activity usually follows a typical pattern of 1:3:10. While sufficient funds are generally available for laboratory scale research, the translation of the results of such research into pilot plant/ prototype development and commercial scale activity in India has been poor, mainly due to the following reasons:

- The resources needed for the latter purpose are much larger and individual industrial units, with their existing levels of operations and incomes, can hardly be expected to take up such risk-bearing activities.
- There are hardly any schemes available to insure the industries against the risks involved in the up-scaling of lab-scale technology to commercial level (except, to a very limited extent, the risk-finance scheme of the N.R.D.C.).
- The present climate in which the Indian industry has a comparatively free access to industrial technology from abroad is not conducive to the undertaking of growth-oriented innovative R&D activities by industry.

In the absence of the availability of requisite financial resources (supported by risk insurance/finance) for undertaking "growth-oriented" R&D activities[1] and the associated "venture capital" in sufficient measure to set up commercial plants based on indigenous technology, the country continues, and will perhaps continue, to remain heavily dependent on import of technology in the existing as well as newly emerging areas, and a substantial part of our vast reservoir of S&T talent continues to remain unutilised or, at best, only sub-optimally utilised.

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Need for Technoogy Development Fund

Against the above background, there is an imperative necessity to establish a **Technology Development Fund** of adequate magnitude at the national level, which should be supported and managed jointly by the industry having a stake in its future and by the Central Government and its Scientific Agencies. It is somewhat surprising that the recommendations made in this behalf by the erstwhile National Committee on Science and Technology in 1973, accepted by the concerned Ministries of the Government of India at the initiative of the Department of Science and Technology during 1973-76 and finally announced by the then Union Finance Minister Sri C. Subramaniam, in his Budget Speech in March 1976 and, again, reiterated by the then Technology Policy Implementation Committee (in the Cabinet Secretarial) headed by Prof. M.G.K. Menon in 1985, have still to be translated into a formal Government resolution or legislation. Instead, the much smaller fund created by the Union Finance Ministry for a similar purpose through imposition of a cess on payments on imported technology has been a highly inadequate response to the needs of this vast country and its immense technological potential.

The basic justification for the establishment of the proposed Fund arises from the fact that individual industrial units in India, at their present levels of operations and profitability, are — with new notable exceptions — unable to invest the requisite sums in R&D activity of a growth-oriented, risk-bearing nature to match similar investments being made in the industrially advanced countries for the development of modern technology, which is becoming increasingly complex and requires ever greater amounts of capital for its development. It, therefore, makes good sense to raise viable quantum of resources specially for purposes of financing industrial

[1] "Growth-oriented" R&D activity may be defined as the activity relating to the design/development of *new* machinery, products or processes, including the establishment of pilot plants and prototype development facilities on the basis of technical know-how available within the country or outside. This is distinguished from "defensive" R&D activity, which pertains to securing improvements. In productivity, cost reduction, import substitution, etc. directly related to existing needs, and requires comparatively less resources.

R&D activity on a project/product-oriented basis from industries themselves and to utilise such resources to provide the needed finances, primarily for translating the results of lab-scale research into actual commercial production in a planned manner and in accordance with well-laid down priorities. The relevance of the proposed Fund in the prsent situation is all the greater, when the Indian economy has been opened up to increased competition from foreign technologies and goods. The possible functions which could be assigned to a Technology Development Fund at the national level are suggested in table 1.

Table 1: Functions to be assigned to the proposed 'Technology Development Fund'

(i) To finance, through grants or loans, or promote in any other manner, RDD work of national or industry-wide importance, in accordance with such general or special directions, if any, as the Central Government may issue in this behalf;

(ii) To provide common service facilities for any scheduled industry or grop of scheduled industries, such as setting up of (new research centres)", pilot plants or prototype development centres, standardisation, testing or analytical facilities, etc.;

(iii) To set up a '*Risk Fund*' for meeting any possible losses that might be incurred by industries or other institutions in the process of translation of laboratory scale know-how into commercial production;

(iv) To provide '*Venture Capital*' for setting up industries based on the use of indigenous technology *for the first time* in the country;

(v) To provide specialised training, where necessary, of scientific and technical personnel (including technicians) working on or required for the on-going/proposed RDD projects connected with any such industry or group of industries;

(iv) To reimburse the whole or part of the expenditure incurred by any scheduled industry on the successful completion of those RDD projects which fall within such areas of national or industry-wide priority as may be notified from time to time, provided that the said industry (i) undertakes to abide by Government policies regarding sharing and utilisation of the results of its RDD efforts with other industrial units and (ii) satisfics such guidelines as may be notified by the Central Government for purposes of this clause on such other terms and conditions (not inconsistent with these guidelines) as the Governing Council of the 'Fund' may impose on the industry in this behalf;

(vii) To meet a portion of expenditure of all existing Cooperative Research Associations/Institutions which are currently being funded by industries on a voluntary basis. (The remaining portion of their expenditure would continue to be met by the CSIR or other supporting organisations, as hitherto);

(viii) To meet all expenses of the Development Councils set up under Section 6 of the IDR Act;

(ix) To pay collection charges at the rate fixed by the Central Government to the designated collection agency;

(x) To meet all expenses incurred in the exercise of its functions as well as those of its Research Direction Committees; and

(xi) To perform such other functions as may be assigned to it by the Government from time to time.

The basic justification for the establishment of the proposed Fund arises from the fact that individual industrial units in India, are unable to invest the requisite sums in R&D activity of a growth-oriented, risk-bearing nature. The relevance of the proposed Fund in the prsent situation is all the greater, when the Indian economy has been opened up to increased competition from foreign technologies and goods.

Size of the Fund

The Inter-department Working Group set up by the Govt. of India under the Chairmanship of Prof. Yashpal, former Secretary, Department of Science and Technology, Govt. of India, in its report submitted in February, 1985 observed that, even as early as 1981, most of the major industrially advanced countries in the world were incurring an annual R&D expenditure in the neighbourhood of 2.0 – 2.5 per cent of *their* GNPs, whereas, we in India — during 1982-83 — spent just about 0.8 per cent of *our* GNP on this activity. Industry's share of the R&D expenditure, in 1982-83, was only about 20 per cent of this total R&D expenditure incurred in India in that year and a major chunk of this was believed to have been spent largely on "defensive" R&D activities, with relatively negligible funds devoted to R&D of a "growth-oriented" nature in comparison with the international scene. The actual size of a Technology Development Fund for the country has accordinlgy to be determined not only with reference to the various objectives and functions that are sought to be assigned to it (vide table 1) but also keeping in view the fact that it has to support the commercialisation of the results of research over a wide spectrum of industrial areas, which, at present, do not have any funds with similar development and promotional objectives.

Prof. Yashpal's Working Group had estimated that the quantum of resources required for upscaling the results of lab-scale research through pilot plants/prototype development into commercial production over the period of the 7th Plan would be in the neighbourhood of Rs. 160 crores per annum at 1984-85 prices as against the CSIR's actual expenditure on pilot plant activity during 1982-83 of just Rs. 85.07 lakhs. However, after taking note of the fact that the capacity to spend the needed resources on the proposed "growth-

oriented" R&D activities in many industrial areas has to be built up over a period of time, the Technology Policy Implementation Committee had recommended that the minimum viable size of the Fund to fulfil its intended objectives during the Seventh Plan may be reasonably placed at Rs. 500 crores (corresponding to an average expenditure of Rs. 100 crores per annum over this period). The same requirement at current prices could be easily placed at around Rs. 1000 crores over the 8th Plan period.

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Sources of Finance

The methodology to be adopted for raising the needed resources for this Fund would depend upon its size. The preferred source should be such that it would yield resources of the desired magnitude, without being subjected to the difficulties and vicissitudes of resource allocations by the Ministry of Finance in the face of many other competing, and often more pressing, short term priorities, from year to year. In this background, while a small sum of Rs. 10-20 crores per annum for purposes of this Fund could be easily met from the normal budgetary resources, a larger amount of, say Rs. 100 crores per annum or more, which would also have to go on increasing year after year in accordance with the volume of industrial production, will be difficult to find from the existing resources.

Looking at the minimum viable size of this Fund and the need to involve the industry in resource mobilisation task with a view to making it more research conscious, Prof. Yashpal's Working Group had recommended that the resources required for setting up the proposed Fund could be raised in one or more of the following manner:

- Levy of a general R&D cess in the industrial and mining sectors, at a rate not exceeding 1 per cent of the production turnovers of all scheduled industries/mining undertakings, subject to exemptions being granted to appropriate cases according to well-laid out criteria. Initially, the rate of levy of this cess can be kept at a relatively low rate at 1/4 percent uniformly for all scheduled industries/mining undertaking, except for the exempted categories and increase in the rate of the cess upto an upper limit of 1 per cent could be brought about gradually over a period of time, depending on the actual needs and capacity to absorb the funds;
- Imposition of surcharge on Customs duty on the imports of industrial machinery/equipments, other capital goods and consumer durables;
- Imposition of surcharge or cess on all payments of royalty and premia made by Indian entrepreneurs to their foreign collaborators in cases where imports of technology are allowed.

After discussing the matter in detail, the Technology Policy Implementation Committee headed by Prof. M.G.K. Menon concluded that a general cess on industrial and mining production (in the form of a duty of excise leviable under Section 9 of the Industrial Development and Regulation Act) would be the most appropriate means of supporting the Fund of a viable size on a continuing basis. It was felt that a surcharge or cess on C.G. tariff or technology payments would unnecessarily go to increase the cost of imported goods or technologies, which were not indigenously available and had, therefore, in any case to be imported; besides, the base being narrow, the incidence of any such levy would have to be high. It has been estimated that the total resources that could be raised through the levy of a general R&D cess @$\frac{1}{2}$% per annum, on the production turn-overs of industries and mining undertakings in the country would currently amount to Rs. 150-200 crores per annum.

The "Cess Mechanism", if enacted through amendments to the IDR Act, would have the special advantage of providing for a guaranteed legislative connection between the purposes of levy of the cess and its utilisation for the intended purpose; making the industries more research conscious; and creating a source of funds, which, being largely *ad valorem* would automatically rise in accordance with future needs.

Utilisation of the Fund

In order to fulfil the intended objectives of the Fund, there has to be a great deal of flexibility in regard to the terms and conditions of disbursements therefrom. The Fund, it has to be noted, has been envisaged primarily as a 'financial bridge' between the successful lab-scale research on the one hand and full-scale commercial operations (restricted to the first commercial/demonstration

plant in each major area) on the other. Disbursements therefrom will thus have to be made not only for financing R&D activity per se, but, more importantly, for the provision of 'risk finance' to industry and 'venture capital' for the establishment of the first commercial plant or part thereof based on indigenous technology in any major field in the country. Depending upon the nature of the activity to be financed/supported and the assessment of the potential risks involved, the disbursements from the Fund could accordingly be in many forms, such as grants, loans at varying rates of interest, equity participating, subsidy or guarantee payments, etc. However, the Fund should remain fully accountable for the money it spends in terms of tangible and visible results, although, with the best of intentions and precautions, there would still be some bad debts, as in any banking system. The objectives of the Fund, while being commercialy-oriented to some extent should nonetheless remain essentially promotional, although, in the long run, one could expect positive returns therefrom through royalty and premia collections; interests on successful investments; dividend payments; and other such sources.

The Fund, has been envisaged primarily as a 'financial bridge' between the successful lab-scale research on the one hand and full-scale commercial operations on the other.

Fund Administration

The basic mechanism for administering the proposed Fund should consist of a Central Authority to centrally plan and co-ordinate the projects and programmes to be financed in accordance with the functions assigned to it and in consonance with the overall Government policies in this area; an appropriate number of expert Sectoral Groups to be known Research Direction Committees (RDCs), with adequate delegated powers to manage the on-going, day-to-day activities in these sectors; and a nodal Ministry to provide necessary link between the Government and the Fund.

The Research Direction Committee (RDCs), to be set up on a broad sectoral basis, would take decisions not only on matters relating to the financing of individual R&D projects in the concerned sectors (within the overall financial outlays to be allocated to each sector by the Central Authority), but would have to monitor their progress against time-bound targets with the help of the secretariat of the Central body.

Apart from direct funding, through grants or loans or in any other appropriate manner, of R&D work of national or industry-wide importance, the functions of the Fund would also include the provision of 'risk capital' for meeting the possible loses that might be incurred by industries or other institutions in the process of translation of laboratory-scale know-how into commercial production as well as the provision of 'venture capital' for setting up industries based on the use of indigenous technology for the first time in the country.

A major fraction of the total proceeds of the "cess" derived from any particular sector of industries should be reserved for utilisation through the RDCs for promotion of R&D activity and its commercialisation in that sector. The balance of funds, after defraying the collection charges to the designated collection agency and meeting its own administrative expenditure and setting aside moneys to fulfill other specified functions of the Fund shall be reserved for use by the Central Authority for financing R&D projects of national or inter-sectoral importance, which hold promise for the development of technologies having relevance to the Manufacturing (including Energy), Mining and Services sectors (both of the present and the future).

A major fraction of the total proceeds of the "cess" derived from any particular sector of industries should be reserved for utilisation through the RDCs for promotion of R&D activity and its commercialisation in that sector.

While a major portion of the cess proceeds shall be used for financing R&D projects in recognised in-house R&D establishments of industries (both in the public and private Sectors), there need be no bar on the use of these funds for financing some or all components of approved projects in other research/academic institutions or agencies possessing competence in the relevant areas, Universities, I.I.Ts and Scientific Agencies of the Govt. along with industry could thus be involved actively in technology generation and its commercial exploitation in the country.

The selection of R&D projects for purposes of financing through the Fund should be based on a process of

competitive selection among industries and other institutions possessing competence in the selected fields.

It is desirable to set up the Fund in the form of statutory body (or body corporate) by virtue of law rather than as a registered society or a non-profit-oriented company; under Section 25 of the Companies' Act. Whatever be the ultimate legal form the paramount objective ought to be to make the administrative mechanism of the Fund a highly technical and promotional structure, with the requisite autonomy and accountability, within the overall guidelines to be laid down for the purpose.

Elsewhere in the World, even giant industrial enterprises are looking formergers and R&D collaborations with other well-placed industries in order to meet the high costs which development of modernindustrial technology now requires.

Conclusion

The Japanese example of "collaboration in research, but competition in production" is worth emulating to accelerate technological efforts in the industrial sector and reduce costs. The MITI continues to play the role of industry's friend, philosopher and guide in promoting these efforts by Japanese Industry to maintain its technological leadership. Elsewhere in the World, even giant industrial enterprises are looking for mergers and R&D collaborations with other well-placed industries in order to meet the high costs which development of modern industrial technology now requires. In this context, it is somewhat unfortunate that, in India, despite the tremendous potential of its scientific and technological manpower, the Government policy makers, Industrialists and scientific community have yet to agree on a common model to mount a systematic technological effort of any worth-while magnitude, even after the lapse of nearly 20 years since the erstwhile National Committee on Science and Technology (NCST) had first mooted in 1973 the idea of a cess-funded Technology Development Fund at the national level. If we, wish to attain technological leadership at least in a few selected sectors in the 21st Century, avoid repetitive imports of technology and secure faster absorption of and improvements over imported technologies, achieve fuller utilisation of our increasing S&T manpower and accelerate our movement towards technological self-reliance and, hopefully, become a net exporter of technology, the creation of a 'Technology Development Fund' of a viable size for industry is imperative. Any continued delays would be detrimental to our long as well as short term technological interests and make us vulnerable in a World where import of technology not only carries a heavy price, but is also getting increasingly constrained by political and other strategic considerations. □

Learning from Living

As long as you live, keep learning how to live.

—Seneca

Feature

Evaluating Technological Performance: Issues & Challenges

T.R. Madan Mohan

Measurement of technological performance of organizations is difficult for lack of conceptual clarity and a suitable framework. Review of measurement on both technological inputs and outputs reveals a host of shortcomings. The paper critically examines the problems associated with the measurement of technological performance and provides a more comprehensive basis for evaluating it.

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Evaluation of how well a firm performs on its technological front has become important to combat technological competition. The technological performance of a firm reflects its effectiveness in resource allocation and utilization in new product introduction and adaptation to meet varying customer preferences. (Dodgson, 1989; Sahal, 1985). However, despite more than three decades of research, measures of technological performance are still most unsatisfactory — for both conceptual and empirical reasons more in economies with import substitution-industrialization strategy as in India for many reasons: Firms may invest in establishment of production and modify the imported technology substantially and tracing all the changes in the technological systems in such situations is difficult, if not impossible.

Status of Technological Evaluations

Efforts in developing economic criteria to promote the effectiveness of technology have already gone through two disappointing stages: The science and technology indicators developed in 1970's used R & D output and patents as output surrogate measures of technical progress. The measurements of R & D outputs suffer from drawbacks of their own. While patent statistics can meet certain explicity defined criteria of originality and feasibility, they are often difficult to use to weigh patents in order to aggregate them. Importantly, for a large number of reasons innovations are often not patented and patents do not capture the incremental forms of technical change that will often be of central significance.

Another highly used output measure — productivity also has major limitations because improvements in product quality are often ignored (Rosenberg, 1982). Exports (at times technology exports) have been used in some studies as an output measure, although it has been recognized that exports may be the result of factor cost

differences or of successful technological change. To the extent that the former is the clase, export will be an inadequate indicator of technological change. Further, change in exports may be result of changes in international or national circumstances rather than technical change as such.

Input measures also face several limitations because they are most often used alone, rather than in conjunction with another measure such as output in the case of productivity. Input measures such as R & D investment, science and technology personnel have been used by Fransman (1984) and Kim (1985) to provide an indication of technical change since it is the effectiveness in input to output transformation that is significant. With their emphasis on gross aggregate relationship, there is ample basis for questioning whether the reported economic effects of technological innovations are largely attributable to these particular components of the wide array of factors affecting such outcomes at the level of the firms as well as of industries.

The other approaches of technological measurement like hedonic approach expounded by Court (1939), further developed by Lancaster (1966) and Rand approach by Alexander and Nelson (1973) with underpinning from Dodson (1970) 'State of the Art (SOA)' have attempted to capture technological performance at the firm level. Studies have also proposed productivity measures such as output to man-hour, cost per unit number of patents, new products designed, projects completed, and return on laboratory funds employed (ROLFE) to compare the performance of the firm's technological efforts at two points of time and/or with the industry standards (Whitley & Frost, 1971; Ayers, 1985; Knight, 1985; Mayer, 1985; Triplett, 1985; Krogh, 1987; Brown & Svenson, 1988). However, it has been realised that these are in fact nominal indicators of technology and their utility depends upon the extent to which they can be related to the object specific or real indicators of technical change. It is held by researchers that consumers employ multiple measures for technology/product evaluation (Lancaster, 1966), and thus measures are at best narrow indicators of technological performance (Rosenberg, 1982; Gold, 1985). Most importantly, these measures do not discuss explicity what makes particular measures important at different stages of technology development (Sullivan, 1991). This fact has significant implications for corporate strategy, technology planning and organizational analysis.

Appraising Technological Performance

The central part of technological performance measurement is, whether a product or service has been altered/developed *factually*, the standard being its physical existence or proved workability. Most studies of technological performance concentrate on three forms of contributions: improvements in the capabilities and quality of existing products and processes, including modifications to facilitate wider applications, development of new products or processes yielding future improvements in products or processes and advances in knowledge likely to yield future improvements in products of processes. It may be practical and even necessary to include three additional kinds of technological efforts: reduction, or minimization, in the cost of producing existing products, reducing technological lag behind competitors and establishing designs and factor-price adaptations. The actual activities of most industrial technological efforts encompass all the above contributions. The objective of assessing the technological performance, thus is to capture the firms's effectiveness in utilizing the resources and opportunities.

The central part of technological performance measurement is, whether a product or service has been altered/developed *factually*, the standard being its physical existence or proved workability.

Let us now turn to measurement of technological performance of firms with import-substitution-industrialization strategy. Consider a firm adopting an imported technology. If during the establishment of production some problems occur, the firm may have to modify the process parameters and/or product characteristics or raw materials. While these changes are critical from the point of view of early adoption, capturing the scale of experimentation is often difficult. Measurement of technological efforts directed towards product adaptations also poses problems. While changes in product efficiency and form may be easily captured, a feature addition may involve changes in process also. Most often these process changes are not recorded. Additionally, difficulty also lies in verifying the 'newness' of the new products and processes in most of the organizations. New products are often next-generation of existing technology and embody in themselves attributes similar to the existing technology. Additionally, an adaptation of scale or feature may be complex enough to treat the product as new. For example, a firm manufacturing 2100 kV trans-

former introduces higher range, substantial investment may be needed in R & D product/process configurations, etc. Even more difficult is to estimate the optimal level of success in each of these endeavours. Efforts to maximize the contributions of adaptation or innovation efforts would require focusing on the gains available to all firms on that particular technological trajectory. What then could be the optimal ratio of success? Thus managerial perception of the optimal technological exploitation over the broad range of alternatives that could have been traversed, assumes significance.

The effectiveness of a firm's technological performance may also be appraised through comparisons with the competitors. One basic requirement of such assessments involves comparing the R & D intensities (R & D investment/Sales) with the relative diversity of their products in order to allow for differences in the range of technological improvements opportunities and pressures to be dealt with (Nelson & Winter, 1982). But comparative evaluations of the relative effectiveness of the over-all technological performance of major competitors are still in their infancy. Additionally, while R & D intensity may be a useful measure of a firm's R & D commitment, assessing where the investments are made and with what outcomes will be more meaningful in comparative analysis. Consider, two firms A and B with R & D intensities of 1.2 each. If firm A invests largely in process improvements from cost considerations, B may invest in modification of the product. Comparison of such firms based on corrected R & D intensities may not be appropriate.

The effectiveness of a firm's technological performance may also be appraised through comparisons with the competitors.

Measurement of aggregate performance is difficult partly due to the absence of effective measures of the benefits of several criteria, and partly due to assessing the relative importance of the dimensions of technological progress. Importantly, there is a strong need to develop measures capturing the changes due to technology itself, i.e., whether the technological trajectory is standardized (Abernathy & Utterback, 1978) and/or mode of technology infusion into recipient organization. Consider, for example, a firm adopting a lab scale technology from an external research lab — it may have to invest large resources towards product and process technology standardization. A similar situation occurs in firms acquiring technology different modes, i.e., blue prints, know-how, technical and financial collaboration or packaged form.

Challenges

In relation to a given technology, firm may attempt product-centered changes based on replicative copying, specification changes and minor improvements. Similarly cost-reducing changes through effective production scheduling, quality control may also be attempted. Thus, technological performance of the firm refers to changes in its existing products and process including modifications, scale and functional variants to meet varying customer demand and new products and processes. Measurement of technological performance can be devised in respect of the objectives as defined by management (Crawford, 1979). These include:

- The nature and magnitude of results relative to targets
- Time and cost estimates
- Implementation efforts

Technological performance of the firm refers to changes in its existing products and process including modifications, scale and functional variants to meet varying customer demand and new products and processes.

Implicit here is that the goals really exist, that there was consensus about them and that their definition and interpretation was not changed afterwards. There are many different aspects of measurement, depending on the respective stage of the technology development process. The central idea of measuring the technological performance is that during the course of the technology development process within a firm the relative effectiveness of these can be assessed by the changes in the technology of product, process and operations. By changes in the technology of the product we mean modifications in product characteristics such as scale effects, addition of features, ergonomic changes, and product cost. Changes in the technology of the process may concern layout, material handling integration, process flexibility, rejections, reliability etc. Lastly, changes in operations encompass changes in the sequencing

and the number of operations, quality, improvements in productivity (work redesign), flexibility, etc. The changes in technology of production, process and operations are not only dependent upon the managerial capabilities of the firm, but also on the stage of development and technological content at adoption. Based on the appreciation of technology life cycle (Abernathy & Utterback, 1978) shifts in paradigms of managerial accounting from and cost-based system to activity based accounting (Johnson, 1991), we propose some measures of technological performance.

In assessing firms at adoption stage, planning for the technology (selection in the case of acquisition from external sources and invention management in the case of internal generation) and developmental efforts (in the case of acquired technology through collaborations efforts for establishing production) may have to be captured. During the planning stage, measures of judgement of the advantages of the technology, number of ideas/alternatives, evaluation of ideas, evaluation of product characteristics by customers and marketing managers comprehensive of selection may be considered. Regarding the developmental efforts a firm undertakes, it is important to recognize that changes may not be only due to technological bottlenecks but can also be due to organizational and market contexts. Firms may incorporate changes in the handling of new materials, manufacturing process, quality management, etc. There could also be organizational changes in the form of training and management of technical manpower and sometimes a novel marketing penetration strategy may be required. Because the management concern at this stage is market acceptance of the end product, the competition will not be based on manufacturing cost and it is unlikely that labour and capital productivity would be the critical determinants of success. The proposed measures during adoption are time and cost overruns for adoption, number of changes in process, process control, organizational changes required to establishing production, and market promotion effectiveness.

It is important to recognize changes may not be only due to technological bottle necks.

The economic effect of the introduction of new technology may also be considered at this stage. Although spreading the effects of the technology investments over the period is one of the problems, measurements of turnover or turnover fluctuations, quantitative sales or changes in them, or market share fluctuations and ousting of competitors, etc., after a reasonable period (empirical studies have estimated two-lag periods to 3-lag periods, Brauch, 1974; Pegels, 1991), do show whether the technology was received by the market. If the new technology is very successful in this sense, the measurement of cost is insignificant.

When the product is accepted by the market, the primary corporate task is to maximize its market share and pre-empt competition. At this stage, corporate concern will be primarily to ensure adequate growth in the rate of production capacity. In this stage, performance as it relates to customer needs is crucial, and strategic segmentation may be necessary. The technological changes at this stage are predominantly changes in technology of process and operations, but in few cases may involve changes in technology of product too. Depending on the nature of the end product, price and cost may also be important determinants of market growth. Thus output has to be increased, which may involve scaling up production, modifications of designs from ergonomic and economic viewpoints, usage/search for alternate raw materials, manufacturing systematization, scheduling, etc. Such trends have been noted by Enos (1962) in petrochemicals, Hollander (1965) in rayons, Lieberman (1987) in chemical products. They have observed that scale of existing plants are stretched when faced with indivisibilities, high capital intensity, and difficulty in modifying the scale of production through additional investments.

The technological efforts at the growth stage may be changes in raw materials (replacements efforts also), changes in scale such as capacity, inventory, manufacturing system improvisations (reliability, quality, order-management, lost sales), ratio of number of operations changed to total number of operations in initial design, product modifications (ergonomic, cost reduction, etc.,) and changes in marketing too. These changes could be captured on objective cost estimates in manufacturing cost, market penetration cost, material costs, etc., or subjective ratings by both managers and the customers.

When the technologies mature, improvements that are due to economies of scale are likely to have already been exploited, and further cost reductions can only be brought about through process innovations and activity management. Management strategies for high performance during this stage are achieving the lowest delivery cost, coupled with acceptable quality and pricing policy to

gain volume and market share. At this stage, firms attempt changes in technologies of product and process aimed at increasing the factor productivity of labour, materials and capital. Firms aim at improving the quality, changing the physical properties or increasing the reliability, or integration of their product. Successful innovations were generally in the maturity stage but a large number of them can also be in the growth stage (Gerstenfeld & Wortzel; 1977). Such trends have been noted by Sahal (1981) in tractors and Malerba (1985) in electronics industries. These tasks are likely to continue to be important through the subsequent period of technology obsolescence. In the mature stage, measures of the firm's ability to maximize productivity, as well as to minimize costs will be critical. The measures may be indirect costs such as set up cost per unit, output per man-hour, manufacturing cycle effectiveness, value added per operation, and capital utilized per employee, subjective measures such as success of new product variants, product robustness, etc. The measures can also include subjective estimates of process improvements — incremental innovations on the operating technology such as reliability, flexibility, control systems.

Table 1: Prescribed Performance Measures

Stage	Measures
Adoption stage	Evaluation of technology selection, ideas time and cost overruns, Entry cost variance Number of changes in process and product New/improved channels, Skill acquisition Increase in sales/turnover (2 or 3 lag periods) Number of changes in raw materials
Growth stage	Number of changes in operations Number of changes in P.P.C Scale enhancements Changes due to ergonomics, value engineering Inventory effectiveness Increase in product quality, reliability Reduced time in order-schedules
Maturity stage	Set up cost per unit Output per manhour/machine time Manufacturing cycle effectiveness Value added per operation Capital utilised per employee Plant productivity Number of significant process improvements Number of patents Number of product variants — scale & function
Obsolete stage	Price differential with competitors Exit cost/operating cost Increase in channel investment

When technologies near the obsolesence stage, competition is based on cost alone. Management emphasis is on pursual of the product line with acceptable profit margins. Firms may change the characteristics of product in order to reach a new group of customers. Depending upon the industry traits and nature of competition the strategies vary from an immediate exit or increased investment. When the demand is heterogeneous firms may learn to differentiate their products to new customers. The measures at this stage need to be measures of changes in technologies of operations such as reduction in delivery cost, secondary inventory effectiveness, etc. Table 1 shows the proposed measured of technological performance.

In the mature stage, measures of the firm's ability to maximize productivity, as well as to minimize costs will be critical.

Conclusions

The central problem in evaluating technological performance is that measures are not comparable. It is apparent that actual achievements may be evaluated on two levels: Performance could be evaluated relative to managerially approved targets or relatively the effectiveness of the firm's response to the market pressures. Typically, managers can identify specific areas where performance is inadequate, but in most cases they cannot determine either how critical this is for the firm or what priority they should accord to one problem over another. The study has proposed both objective and subjective measures which are not particularly difficulty to implement, especially given the enormous capabilities and decreasing cost of information technology. Most important, it should be recognized that these measures need to be considered in tandem with corporate strategy and product-market characteristics to develop an effective technology strategy. While the efforts required to develop and implement these measures are substantial, they would definitely aid in tracking new technological opportunities and new businesses.

Measures need to be considered in tandem with corporate strategy and product-market characteristics to develop an effective technology strategy.

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Feature

Public & Private Sector Industries in India: A Comparative Analysis

T.L.N. Swamy

The dismal performance of public sector enterprises has evoked strong criticisms and socialist planners are advocating privatisation as the measure to combat the problems. The present study examines some of the issues involved by comparing the relative performance of the public and private sector enterprises and concludes that suitable steps should be taken to restructure the former so that they become more productive rather than resorting to full scale privatisation.

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When the public sector was given a leading role in the First and Second Five Year Plans for setting up basic industries and infrastructure facilities, the socialist planners hailed its emergence as a powerful media to translate the idea of the socialistic pattern of society — removing socio-economic disparties and crushing monopoly growth. However, in recent times the public sector has received strong criticism from various quarters on the ground that it has not been able to generate investible resources for expansion, diversification and modernization. Further, some argued for transfer of loss making public sector units to the private sector on the conviction that the malaise paralysing such units would be dispelled under the able nursing of private enterprise. In consolance with this view, the Government has taken various measures for liberalising the economy through its recent industrial policy. But it is important to know whether public sector industries are really inefficient compared to the industries under private sector. And if they are, whether the remedy of this inefficiency lies in full scale privatisation or something else. The present study examines some of these issues using the ASI factor Sector data for the period 1980-88. The relevant price data have been obtained through the recent Economic Survey Report of 1992-93.

It is important to know whether public sector industries are really inefficient compared to the industries under private sector. And if they are, whether the remedy of this inefficiency lies in full scale privatisation or something else.

One can examine the performance of manufacturing sector during the plan period in India by taking the period

as a whole as well as by sub-periods. We have the first sub-period of 1951-65 during which rates of growth were generally high, and the second sub-period of 1956 onwards during which the rates of growth were generally low. The second period may be further divided into the 1966-74 when the rates are generally low, and the 1975-89 when the rates while low (in comparison with the rates of the 1951-65 sub-period) have been increasing. Hence the period 1980-88 has been chosen for the present study with a view to cover the recent trends in the performance of both public and private sector industries in India.

Table 1 presents the changing industrial structure of the country in terms of the proportion of capital, employment and value added at constant prices. It is evident that capital investment in respect of public sector industries has shown a slight decline from 72.12 per cent to 71.98 per cent. But it is higher compared to that of private sector industries and accounts for more than half of the total capital invested in manufacturing activity in India during the reference period. While employment has shown a decline from 71.61 per cent to 67.44 per cent in respect of private sector industries, it is higher compared to that in the case of public sector industries and accounts for more than half of the total employment generated in the manufacturing sector in India. Similarly private sector industries account for more than half of the total value added generated although their share declines from 70.07 per cent to 61.65 per cent implying that they have generated more employment and value added with low capital base compared to public sector industries in India. But it may be noted that although, public sector industries account for a less share, they have improved their position in terms of employment generation and value added over the study period.

Table 1: Shares of Industries under Different Ownership in India 1980-88 (At constant prices)

Category	Capital (Rs)		Employment (nos)		Value Added (Rs)	
	1980	1988	1980	1988	1980	1988
Public Sector	2019913 (72.12)	2036471 (71.98)	2048806 (28.39)	2287281 (32.56)	335209 (29.93)	680878 (38.34)
Private Sector	780970 (27.88)	792798 (28.02)	5168586 (71.61)	4736954 (67.44)	784835 (70.07)	1094745 (61.66)
Total	2800883 (100.00)	2829269 (100.00)	7217392 (100.00)	7024235 (100.00)	1120044 (100.00)	1775623 (100.00)

Note: Figures in parentheses are percentages to total
Source: Based on ASI Data

Private sector industries account for more than half of the total value added generated.

In order to examine the efficiency of both public and private sector industries, partial, i.e., Labour Productivity (LP), Capital Productivity (CP) and Total Factor Productivity (TFP) ratios along with capital intensity have been estimated and presented in table 2. Kendrick's Index (Kendrick, 1961, 1973) has been employed for estimating TFP series. This can be written as

$$A_t = \frac{V_t}{W_o L_t + R_o K_t}$$

where A_t refers to TFP in year (t), V_t is value added, Wo is the base year wage rate and R_o is the base year return on capital. Both value added and capital are corrected for price changes by using the Whole Sale Price index for manufactured products and machinery and machine tools, respectively. Total emoluments are obtains at constant prices by using the All India Consumer Price Index for Industrial Workers. LP is obtained by dividing the value added by the total employees and CP is estimated by dividing the value added by the fixed capital whereas, capital intensity ratio is estimated by dividing capital by the total employees.

Table 2: Estimate of Productivity and Capital Intensity for Indian Industries 1980-88

Year	Partial Productivity				TFP (Kendrick Index)		Capital Intensity	
	Capital		Labour					
	Public	Private	Public	Private	Public	Private	Public	Private
1980	0.16	1.00	0.16	0.15	1.00	1.00	0.98	0.15
1981	0.22	0.99	0.21	0.15	1.06	1.40	0.95	0.15
1982	0.25	1.09	0.23	1.84	1.12	1.52	0.95	1.69
1983	0.26	1.21	0.24	0.19	1.19	1.58	0.89	0.15
1984	0.24	1.19	0.19	0.19	1.20	1.34	0.82	0.16
1985	0.27	1.21	0.25	0.25	1.23	1.66	0.92	0.17
1986	0.28	1.24	0.26	0.26	1.27	1.74	0.93	0.17
1987	0.30	1.27	0.27	0.27	1.28	1.79	0.90	0.16
1988	0.33	1.38	0.30	0.30	1.40	1.99	0.89	0.17
Average	0.26	1.17	0.23	0.23	1.19	1.56	0.91	0.33

Source: Computed from ASI reports

It is evident that LP has increased from 0.16 to 0.30 in public sector industries during the study period but its average (0.23) is less than that of private sector in-

dustries. Similarly. CP has also increased from 0.16 to 0.33 in the case of industries under public sector but its average (0.26) is much lower than that of (1.17) in respect of private sector industries. While TFP has also shown an increase from 1 to 1.4 in these industries its average (1.19) is also lower than that of (1.56) in the case of private sector industries reflecting the fact that although productive efficiency of public sector industries increased during the study period, they are less efficient compared to private sector industries. The results further indicate that factor inputs have increased substantially in respect of public sector industries but they have not generated sufficient value added compared to private sector industries. In order to examine this issue in detail, we have estimated multiple regression of the form $V = \alpha + \beta K + E$ by using the ordinary least squares method and results are presented in table 3.

Table 3: Relative Efficiency of Factor Inputs in Indian Industries 1980-88

Categories	Equation	R
Public Sector	V = –3247.00 + 16.1096 K** – 0.1387 E (3.4236) (0.1767)	0.83
Private Sector	V = – 1955.00 + 26.0320 K** + 0.0002 E (3.7136) (0.0060)	0.95

Note: **Signification at 1 per cent confidence level
figures in parentheses are values of standard errors
Source: Computed from ASI reports

It is clear that capital input alone has contributed significantly to the growth of value added in respect of both public and private sector industries but its contribution is much higher in the case of the latter. One unit increment of capital leads to 24 per cent variation in value added in the private sector whereas the same leads to only 16 per cent variation in the case of public sector industries.

Capital input alone has contributed significantly to the growth of value added in respect of both public and private sector industries but its contribution is much higher in the case of the latter.

It may also be noted that employment has contributed negatively to the growth of value added in the case of public sector industries since its coefficient is negative and not statistically significant. It is positive but not statistically significant in the case of private sector industries giving evidence to the fact that factor inputs particularly employment has not been efficiently utilised in both of public and private sector industries.

Factor inputs particularly employment has not been efficiently utilised in both of public and private sector industries.

Concluding Remarks

It is evident from the preceding analysis that private sector industries have generated more employment compared to public sector industries accounting for more than half of the total employment generated in manufacturing sector in India. In relation to capital investment, public sector industries have registered higher capital investment accounting for more than half of the total capital of the manufacturing sector. In terms of value added, private sector industries have generated more value added accounting for more than half of the total value added generated in manufacturing industries during the study period. Higher degree of capital investment in respect of public sector industries seems to have failed to generate employment opportunities and value added (although they improved slightly over the period) considerably in comparison to private sector. In other words private sector industries appear to be capable of generating more employment and value added with low capital base compared to public Industries in India.

It is also evident that private sector industries have exhibited higher rate of LP, CP and also TFP on an average compared to public sector industries indicating that they are more productive. However, public sector industries have improved their productive efficiency over the reference period. One may also note that public sector industries are financially more strong in relation to private sector indutries since they have exhibited higher rate of capital intensity, perhaps due to the direct participation by the Government. However the substantial size of capital investment in the case of public sector industries has not been followed by corresponding improvements in efficiency. Similarly, employment has also increased in these industries but it has not contributed significantly to the growth of value added compared to that in the case of private sector industries. One may tend to believe on the basis of these observations that factor inputs have not been efficiently utilized in respect of public sector industries compared to private sector industries. There has probably been a striking gap between installed capacity and utilized capacity. Some

parts of capital has been unutilized which might have led to, cost escalation. This may be one of the reasons for losses in respect of many public sector undertakings. Since our analysis deals with industries at aggregate level, we can not list out the loss making units but studies (Agarwal, 1991) show that only a select group of enterprises such as Bharat Heavy Electricals. HMT and Bharat Earth Movers which are in competitive areas turned reasonable profit ratios. A total of 131 enterprises earned an overall net profit of Rs. 5741 crores and 98 suffered a net loss of Rs. 1959 crores during 1989-90. There are many loss making units even in the private sector such as ABL unit. Hence, the remedy for the malfunctioning of public sector industries may not lie in full scale privatisation in view of the experiences of Bangladesh and Nigeria. Suitable steps should be undertaken to restructure public sector industries to become more productive rather than attempting full scale privatisation. This may be done by upgrading technology particularly in the case of Steel, Coal and Power generation industries where we have outdated technologies. It may be mentioned here that South Korea began steel making barely two decades ago and is now producing more steel than India and at a much lower cost even though India possesses some of the world's best iron ore reserves and has cheap labour. Similar is the case with coal, electricity generation and oil industries. India's energy costs are currently among the highest in the world and make exports non-competitive (Agrawal, 1991). There is need to impart more competition to spur efficiency and productivity of public sector units. Moreover, a professional cadre of managers needs to be created, and given more autonomy in decision making. There is also need for improving industrial relations and curbing over-employment. If these measures are implemented, a significant improvement in the performance of public sector industries may hopefully be envaisaged in the near future.

The remedy for malfunctioning of public sector industries may not lie in full scale privatisation in view of the experiences of Bangladesh and Nigeria.

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Integrity in the Moment of Choice

Quality of life depends on what happens in the space between stimulus and response.

Feature

Industrial Productivity Trends: Statewise Analysis

Shilpa M. Vora

A large number of studies have been carried out to examine the change in productivity levels and its impact on the growth of Indian Economy. This paper carries out a statewise and industrywise analysis of the trends in capital productivity for the years 1980 to 1989. The main conclusions of the study are that it is not the industry mix but the capital productivity within industries which has accounted for the stagnant levels of productivity. The ability to service capital is also declining over time and does not augur well for future industrial growth. The study recommends that the barriers to improving capital productivity need to be investigated at state, industry and enterprise levels and be substituted by incentives for improving productivity. And appropriate policy reforms are needed for this to happen.

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The near stagnant capital productivity levels in the Indian industry over four decades have always been a cause of concern. A large number of studies have been carried out to monitor the change in the productivity levels and its impact on the growth of the Indian economy. Rajkrishna and Mehta (1968) analysed the major trends in macro level productivity of large scale Indian industries for the years 1946 to 1963. They found that the productivity of capital as measured by the value added per unit of capital had declined by about 18 per cent while the capital intensity or total capital per employee had nearly doubled between the six year period 1948-53 and 1958-63. This raised the average cost of production in large scale industries during the two decades 1946 to 1966. According to them, one of the policy implications of this analysis was that planners should assume an increasing capital output ratio. Therefore, the capital requirements of a given rate of growth of industrial output must be larger than in the past or conversely any given plan outlay should be expected to yield a much lower rate of industrial growth. To increase the growth rate, they recommended that attention should be given to the recovery of productivity.

Capital Productivity

Raj (1984) making observations on the economic growth of India over the period of 1952-53 to 1982-83 states the following: "There were noticeable shifts in the pattern of investments that have taken place within the large scale industrial sector, in favour of industries with relatively high capital output ratios such as chemical fertilizers and electricity from the middle of the 60's and petroleum, coal, steel and nonferrous materials in more recent years. While not denying the possibility of marginal capital output ratios getting raised through mistaken choices or inefficient use of investments in fixed capital, underutilization of capacity and needless additions to

inventory holdings, what it sought to emphasize was that the rise in these ratios could also be reflecting shifts towards industries which for technological reasons happen to require large amount of fixed capital relative to output." Therefore, each state needs to promote an appropriate industry mix which yields high productivity of scarce capital.

Ahluwalia (1990) examined productivity trends in the Indian industry over a quarter of a century from 1960-61 to 1985-86. Total factor productivity declined at a rate of 0.4 per cent per annum upto 1982-83. But the long spell of virtual stagnation in this respect was broken after 1982-83. Total factor productivity increase was on an average nearly 4 per cent per annum in the subsequent 3 years. For most industries before 1982-83, the trend in capital productivity was dominantly downward. Contrary to the general belief that the rising capital output ratios in manufacturing may be due to increasing proportion of investments in manufacturing being directed to more capital intensive industries, her results show that the increase in weight of capital intensive industries had only a small effect on the capital output ratios of individual industry groups.

A recent effort in this direction was made by Dholakia (1989) in his study on regional aspects of industrialization in India. He studied the time periods 1979-80 and 1984-85. During this period, he found that all southern states grew at a rate lower than the national growth rate in terms of net value added in industry. The northern states except Rajasthan and Punjab on the contrary grew at a rate higher than the national growth rate in industry. The southern region (plus West Bengal and Assam) has a considerably above average capital productivity in manufacturing but has a significantly less capital intensity as compared to the national average. The northern region had high capital intensity but was far below the national average in capital productivity. Only Maharashtra and Gujarat had capital productivity and intensity well above the national average. He recommended that the industrial base should be diversified in the north and specialisation be encouraged in the south to increase capital productivity.

Hence it is necessary to examine the period between 1980 to 1989 to study whether there has been any major change in capital productivity since 1982-83. To study these trends both statewise and industrywise analysis have been carried out in this paper.

Data Sources & Methodology

The data for the analysis was collected from the Annual Surveys of Industries for the years 1980-81, 1984-85 and 1988-89. The ten major states considered are Andhra Pradesh, Bihar, Gujarat, Karnataka, Madhya Pradesh, Maharashtra, Punjab, Tamilnadu, Uttar Pradesh and West Bengal.

The seven major industries which have been considered are:

- Manufacture of food products
- Manufacture of beverages, tobacco and tobacco products
- Manufacture of rubber, plastic, petroleum and coal products
- Manufacture of chemical and chemical products (except products of petroleum and coal)
- Basic metal and alloy industries
- Manufacture of Electrical Machinery, apparatus, appliances, supplies and parts
- Electricity

As usual, the capital productivity index is defined as the ratio between the net value added and invested capital.

$$\text{Capital Productivity Index (CP)} = \frac{\text{Net Value Added (NVA)}}{\text{Invested Capital (K)}}$$

where, as per definitions of Annual Surveys of Industries

- Invested capital is defined as the total book value of fixed capital and physical working capital;
- Net value added is the increment to the value of goods and services that is contributed by the factory and is obtained by deducting the value of total inputs and depreciation from value of output; and
- Total emoluments are the same as wages but paid to all employees plus imputed value of benefits in kind i.e. the net cost to the employer on those goods and services provided to employees free of charge or at a markedly reduced cost which are clearly and primarily of benefit to the employees as consumers.

On account of lack of required data, we have not made any price adjustments to the estimates of capital stock as reported by Annual Surveys of industries. As a result, we have also taken the Net value added at current prices only.

Differential Capital Productivity among States

Capital productivity indices for ten states for all industries together for the years 1980-81, 1984-85 and 1988-89 are summarised in table 1. The capital productivity has marginally increased for India as a whole. The state with the highest capital productivity was Maharashtra in 1980-81. Tamilnadu in 1984-85 and Maharashtra again in 1988-89.

Table 1: Statewise Capital Productivity

State	Capital Productivity (C.P.)		
	1980-81	1984-85	1988-89
Andhra Pradesh	0.1962	0.2983	0.2059
Bihar	0.1074	0.1700	0.3041
Gujarat	0.2449	0.2868	0.2645
Karnataka	0.2644	0.3289	0.2759
Madhya Pradesh	0.1938	0.1633	0.2446
Maharashtra	0.3458	0.3398	0.3464
Punjab	0.1876	0.1894	0.1766
Tamil Nadu	0.3131	0.3594	0.2873
Uttar Pradesh	0.1644	0.1600	0.2082
West Bengal	0.3242	0.2884	0.2313
All India	0.2413	0.2595	0.2605

States where capital productivity has declined from 1980-81 to 1984-85 but increased between 1984-85 and 1988-89 are Maharashtra, Uttar Pradesh and Madhya Pradesh. In contrast, states where capital productivity increased from 1980-81 to 1984-85 but declined between 1984-85 to 1988-89 are Gujarat. Punjab, Tamilnadu, Andhra Pradesh and Karnataka. Surprisingly, capital productivity in Bihar consistently increased while in West Bengal it consistently declined over this period. The fact that the capital productivity has marginally increased for India as a whole implies that the capital productivity gains in some states were largely neutralised by declines in others. However, some states which are doing well during 1980-81 to 1984-85 worsened after 1984-85 while other states reversed the earlier declining trend.

The capital productivity gains in some states were largely neutralised by declines in others.

Industry Mix Effect

The changes in capital productivity could be attributed to:

- A change in the industry mix called the industry mix effect
- Gains due to productivity within the specific industries called the industry productivity effect.

To separate the effect of these two factors, we use the following method. Suppose the parameters are defined as in table 2. Assuming the time period to be between 1980-81 (period 1) to 1984-85 (period 2) we find two intermediate values, say:

Table 2. Explanation of Parameters Used

Year	1980-81	1984-85	1988-89
Net value added	V_1	V_2	V_3
Net value added for J_{th} industry	V_{1J}	V_{2J}	V_{3J}
Invested capital	K_1	K_2	K_3
Invested capital for J_{th} industry	K_{13}	K_{2J}	K_{3J}
Capital productivity	V_1/K_1	V_2/K_2	V_3/K_3
Capital productivity for J_{th} industry	V_{1J}/K_{1J}	V_{2J}/K_{2J}	V_{3J}/K_{3J}

Note:

Subscript J	Name of Industry which J represents	Industry code
1	Manufacture of Food Products	20-21
2	Manufacture of Beverages, Tobacco and Tobacco Products	22
3	Manufacture of Rubber, Plastics, Petroleum and Coal Products	30
4	Manufacture of Chemical and Chemical Products (except products of Petroleum and Coal)	31
5	Basic Metal and Alloy Industries	33
6	Manufacture of Electrical Machinery, apparatus, appliances, supplies and parts	36
7	Electricity	40
8	Other Industries	

I1 : This value represents the value of capital productivity which would have been obtained if the industries in the year 1984-85 had been operating with their industry mix but at the productivity levels of 1980-81 i.e. as the productivity levels of 1980-81 have been kept as constant the difference between the values of I1 and the value of the capital productivity of the year 1980-81 would be entirely the effect of the industry mix.

I2 : This value represents the value of capital productivity which would have been obtained if the industries in the year 1984-85 had been operating at their productivity levels with the industry mix of

1980-81 i.e. as the industry mix of 1980-81 has been kept as constant, the difference between the capital productivity value of the year 1984-85 and 12 would entirely be the effect of industrial productivity.

Moreover the difference between I2 and I1 would represent the "Interaction effect" (also called Residual) which is the combined effects of the industry mix effect and the industrial productivity effect.

i.e. V1/K1 $\longrightarrow$ I1 $\longrightarrow$ I2 $\longrightarrow$ V2/K2
(1) (2) (3) (4) (5) (6) (7)

Where,

(1) = capital productivity of the state in the year 1980-81

(2) = industry mix effect between 1980-81 to 1984-85

(3) = capital productivity of the state at the productivity levels of the year 1980-81

(4) = interaction effect

(5) = capital productivity of state obtained by using the industry mix of 1980-81

(6) = Industrial productivity effect between 1980-81 to 1984-85

(7) = capital productivity of the state in the year 1984-85

A sample calculation of Andhra Pradesh is shown in table 3.

Similar calculations can be carried out for the year 1984-85 (period 2) to 1988-89 (period 3).

The disaggregated analysis for the ten states is shown in table 4. This analysis shows the following:

First, the effect of change in industry mix was almost always favourable for increasing capital productivity, for all states except for West Bengal from 1980-84 to 1984-89 and Tamilnadu from 1984-85 to 1988-89. However, the Industrial productivity effect varied from 1980-81 to 1984-85. This effect on overall capital productivity was positive in both time periods only for three states namely Karnataka, Gujarat and Punjab. In the remaining states it was negative. But the trend in industrial productivity reverses after 1984-85. It seems that the combined effects of industrial mix and industrial productivity have pulled down the capital productivity in all states except Bihar, Maharashtra and Uttar Pradesh.

Table 3. Explanation of the Disagggregated Analysis for Andhra Pradesh
For the state Andhra Pradesh: (Rs. in Crores)

Industry	1980-81		1984-85	
	C.P.	INV. Cap.	C.P	Inv. Cap.
* Manu. of food products	0.2984	129.26	0.2489	374.17
* Manu. of beverages, tobacco, tobacco products	0.3529	92.34	0.5776	194.71
* Manufacture of rubber, plastics, petroleum etc.	0.1401	82.64	0.0777	346.54
* Manu. of chemical. chemical products	0.1262	370.33	0.1273	534.65
* Basic metal and alloy industries	0.2044	140.99	0.1216	291.23
* Manufacture of electrical machinery, apparatus, appliances et.	0.2374	219.84	0.8880	395.61
* Electricity	0.1048	917.66	0.2089	1350.68
* Other industries	0.3244	596.45	0.3524	1313.49
All Industries	0.1962	2549.45	0.2983	4801.08

We find the value of I1 i.e. when the industries in 1984-85 operate at the productivity levels of 1980-81 with the industry mix of 1984-85. To find V_{2j} we use the above values of K_{2j} (invested capital for the j_{th} industry in 1984-85) and V_{1j}/K_{ij} (capital productivity for j_{th} industry in 1980-81). Therefore,

Sum (V_{2j}') = Sum (K_{2j}) *(V_{1j}/K_{1j}) j = 1..8 = 1017.388219

and Sum (V_{2j}') /K2 = 1017.288219/4801.08 = 0.2119

We find the value of 12 i.e. when the industries in 1984-85 operate at their productivity levels with the industry mix of 1980-81. To find V_{1j} we use the above values of K_{1j} (invested capital for the j_{th} industry in 1980-81) and V_{2j}/K_{2j} (capital productivity for j_{th} industry in 1984-85). Therefore,

Sum (V_{1j}') = Sum (K_{1j} *(V_{2j}) / K_{2j}) j = 1..8 = 753.3094

and Sum (V_{1j}')/K1 = 753.3094/2549.45 = 0.2955

The industry mix effect = 0.2119 – 0.1962 = 0.0157

The interaction effect = 0.2955 – 0.2119 = 0.0836

The industrial productivity effect = 0.2983 – 0.2955 = 0.0836

Thus, the analysis so far has highlighted the need for the states to improve productivity within industries. Contrary to the popular belief. Industry mix effect has been significantly positive.

Ability to Service Capital

Many authors have observed that increase in labour productivity in India can be largely attributed to increasing capital intensity (for instance Ahluwalia, 1990). Therefore, it is necessary that sufficient surpluses are generated both to pay for invested capital and for new investments. Let *R* denote the ability to service capital as follows:

$$R = \frac{\text{Net value added} - \text{Emoluments}}{\text{Invested Capital}} = \frac{NVA - EMO}{K}$$

Table 6 shows the values of *R* for each state. Table 7 shows the values of *R* for each industry.

Table 6. Values of R for the States

State	1980-81	1984-85	1988-89
Andhra Pradesh	0.0968	0.1626	0.1029
Bihar	0.0259	0.0764	0.1836
Gujarat	0.1287	0.1704	0.1708
Karnataka	0.1239	0.1571	0.1326
Madhya Pradesh	0.1137	0.0751	0.1533
Maharashtra	0.1841	0.1691	0.1963
Punjab	0.1128	0.0935	0.0814
Tamil Nadu	0.1624	0.2086	0.1641
Uttar Pradesh	0.0611	0.0588	0.1076
West Bengal	0.1041	0.0698	0.0540
All India	0.1166	0.1270	0.1422

Table 7. Values of R for the Industries

Industry	1980-81	1984-85	1988-89
Manufacture of Food Products	0.1187	0.2056	0.2073
Manufacture. of Beverages, Tobacco and Tobacco Products	0.2818	0.4232	0.3996
Manufacture of Rubber, Plastic, Petroleum and Coal Products	0.1528	0.1693	0.2725
Manufacture of Chemical and Chemical Products	0.1386	0.1860	0.1874
Basic Metal and Alloy Industries	0.0781	0.0484	0.1388
Manufacture of Electrical Machinery, Apparatus, Applicances, Supplies and Parts	0.2196	0.3234	0.2533
Electricity	0.0509	0.0523	0.0554
Other Industries	0.1822	0.1687	0.0680
All Industries	0.1166	0.1270	0.1422

The changes in R broadly follow the pattern of changes seen in the earlier analysis of capital productivity. Thus, it can be argued that higher capital productivity has generally implied higher ability to service capital.

Statewise Disaggregated Analysis of R

Many states are attracting Indian or foreign investment for industrial development. In the long run both the ability of the state to attract new investment or service capital will depend on improving values of *R*.

Two major factors which might effect *R* are

- Changes in the industry mix (Diversification Effect)
- Changes within industries (perhaps due to higher value addition called the Specialisation Effect)

Diversification & Specialisation Effects

To separate the effects of specialisation and diversification for each state, we use the following methodology.

From the data on Net value added (NVA), Emoluments (EMO), and K (Invested Capital) for each industry in each state we compute the ratio R_j where

$$R_j = (NVA - EMO)/K \text{ for the } j_{th} \text{ industry, } j = 1..8$$

We also define F_j as the fraction of Net value added obtained from the j_{th} industry.

Now suppose we keep the industry mix for a particular state as constant i.e. in 1984-85 we use the values of F_j for 1980-81. We use the current ratios R_j of the year 1984-85 to compute an intermediate R as

$$IR1 = \text{Sum } (F_j * R_j)\ j = 1..8$$

where, F_j = Fraction of NVA obtained for the j_{th} industry in 1980-81

R_j = Ratio representing the ability to service capital in 1984-85

Then this intermediate R represents what the value of R would have been in the current period had it been operating at the industry mix of the previous period. Therefore, as the industry mix has been kept as constant, whatever change is observed between IR1 and R for the previous period would be entirely due to the effect of change within industries (specialisation effect).

Now suppose we use the ratios R_j of 1980-81, i.e. keep R as constant and use the industry mix of 1984-85 (we use the values of F_j for 1984-85). Then, we compute an intermediate R as:

$$IR2 = \text{Sum } (F_j * R_j)\ j = 1..8$$

where, F_j = Fraction of NVA obtained for the j_{th} industry in 1984-85

R_j = Ratio representing the ability to service capital in 1980-81

Then this intermediate R represents what the value of R would have been in the current period had it been operating at the levels of R of the previous period. Therefore, as the values of R have been kept as constant whatever change is observed between R and IR2 would be entirely due to the effect of change of industry mix (diversification effect) and the difference between IR2 and IR1 would be the "Interaction Effect" or the combined effects of specialisation and diversification.

Therefore,

$R_1 \longrightarrow IR1 \longrightarrow IR2 \longrightarrow R_2$
(1) (2) (3) (4) (5) (6) (7)

Where,

(1) = Value of R for the state for the year 1980-81

(2) = Specialisation effect between 1980-81 to 1984-85

(3) = Value of R obtained by using the industry mix of 1980-81

(4) = Interaction effect

(5) = Value of R obtained by using the ratios R of 1980-81

(6) = Diversification effect between 1980-81 to 1984-85

(7) = Value of R for the state for the year 1984-85

Similarly, we can find the intermediate R's for periods 1984-85 to 1988-89. Table 8 presents the disaggregated analysis for R for the states.

It is interesting to note that the industry-mix or diversification effect on ability to service capital was almost always negative for both periods 1980-81 to 1984-85 and 1984-85 to 1988-89. We had earlier found that the industry-mix effect on capital productivity was almost always positive. Therefore, one can argue that industrial growth has occurred in industries with relatively favourable capital productivity but this has not necessarily been translated into higher ability to service capital be-

Table 8. Disaggregated Analysis for R for the States

	R												
State	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
Andhra Pradesh	0.0968	0.0921	0.1889	–0.0776	0.1113	0.513	0.1626	–0.0377	–0.1249	0.0924	0.2173	–0.1144	0.1029
Bihar	0.0259	0.0734	0.0993	–0.0545	0.0448	0.0317	0.0765	0.1474	0.2239	–0.1123	0.1116	0.0722	0.1838
Gujarat	0.1287	0.0314	0.1601	–0.0152	0.14-9	0.0255	0.1704	–0.001	0.1694	0.004	0.1734	–0.0026	0.1708
Karnataka	0.1239	0.0802	0.2041	–0.053	0.1511	0.006	0.1571	–0.0122	0.1449	0.0734	0.2183	0.0857	0.1326
Madhya Pradesh	0.1137	–0.0023	0.1114	0.0302	0.1416	–0.0665	0.0751	0.0838	0.1589	0.0062	0.1651	–0.0118	0.1533
Maharashtra	0.1841	0.0167	0.2008	0.021	0.2218	–0.0527	0.1691	0.0441	0.2132	0.023	0.1902	0.0061	0.1963
Punjab	0.1128	0.0141	0.1269	0.0782	0.2051	–0.1116	0.0935	0.0573	0.1508	0.0293	0.1801	–0.0987	0.0814
Tamil Nadu	0.1624	0.0558	0.2182	–0.0255	0.1927	0.0159	0.2086	–0.0121	0.1965	0.0333	0.2298	0.0575	0.2873
Uttar Pradesh	0.0611	0.1126	0.0515	0.0182	0.1308	–0.072	0.0588	0.0871	0.1459	–0.052	0.0939	0.0137	0.1076
West Bengal	0.1041	0.0352	0.1393	–0.007	0.1323	–0.625	0.0698	–0.0025	0.0673	0.0782	0.1455	–0.0915	0.054
All India	0.1166	0.0426	0.1592	–0.0098	0.1494	–0.0224	0.127	0.004	0.131	0.0319	0.1629	–0.0207	0.1422

Note:

(1) = Value of R for the year 1980-81
(2) = Specialisation effect between 1980-81 to 1984-85
(3) = Value of R obtained by using the industry mix of 1980-81
(4) = Interaction effect
(5) = Value of R obtained by using the ratios R 1980-81
(6) = Diversification effect between 1980-81 to 1984-85
(7) = Value of R for the year 1984-85
(8) = Specialisation effect between 1984-85 to 1988-89
(9) = Value of R obtained by using the industry mix of 1984-85
(10) = Interaction effect
(11) = Value of R obtained by using the ratios R of 1984-85
(12) = Diversification effect
(13) = Value of R for the year 1988-89

cause of relatively higher emolument in these industries. Otherwise, the overall R values would have shown greater increase.

During the period 1980-81 to 1984-85, the value of R increased for all industry groups except basic metal and alloys and other industry groups (table 7). However, this trend is not maintained between the period 1984-85 and 1988-89. The ability to service capital improved for basic metal and alloy industries reversing the earlier trend. It also increased significantly for rubber, plastic, petroleum and coal products. But R value declined for electrical manufacturing and beverages and tobacco industry groups. There was no significant change in chemicals and food product groups. Overall ability to service capital has somewhat improved in the Indian Industry.

Securing Competitive Advantage

States are now competing with each other for industrial development. As Porter (1990) states "The central goal of government policy toward the economy is to deploy a nation's resources (labour and capital) with high and rising levels of productivity. Productivity is the root cause of a nation's standard of living. To achieve productivity growth an economy must be continually upgrading. This requires relentless improvement and innovation to existing industries and the capacity to compete successfully in new industries. Successful industries and industry clusters frequently concentrate in a city or region and the bases for advantage are intensely local. Geographic concentration is important to the genesis of competitive advantage and it amplifies the forces that upgrade and sustain advantage. While the national government has a role in upgrading industry, the role of state and local government is potentially as great or greater."

States can seek competitive advantage in two ways: by improving productivity in current industries or by targeting industries to move towards appropriate industry mix. It was seen before that for Maharashtra R declined between 1980-81 to 1984-85, but it increased between 1984-85 to 1988-89. For Tamilnadu R increased between 1980-81 to 1984-85 and reversed to a decline between 1984-85 to 1988-89. So it would be worth examining whether Tamilnadu could benefit by using the same industry mix as Maharashtra.

Consider the year 1980-81. Suppose we denote the value of R for Maharashtra as R_1 and that of Tamilnadu as R_2, then we can find the intermediate ratio IR = Sum $(F_j * R_j)$ j = 1..8 where

F_j = Fraction of NVA for j_{th} industry in Maharashtra

R_j = Ratio R for j_{th} industry in Tamilnadu

Both these values are for the year 1980-81. Then, Sum $(F_j * R_j)$ j = 1..8 represents the value of R for Tamilnadu if it operates at the same industry mix as Maharashtra (as fraction of NVA for Maharashtra is kept as constant). So,

$$R_1 \xrightarrow[(1)]{} IR = \text{Sum}\,(F_j * R_j)\ \ j = 1..8 \xrightarrow[(2)]{} R_2$$

(R for Maharashtra in year 1980-81) (R for Tamilnadu in year 1980-81)

(1) = Changes within industries

(2) = Changes in industry mix

Similarly, one can find the intermediate ratios for 1984-85 and 1988-89. Table 9 shows what would happen if Tamilnadu operated at the same industry mix as Maharashtra and if Karnataka operates at the same industry mix as Uttar Pradesh (for all the three time periods). It can be seen that Tamilnadu could have surely benefited by using the same industry mix as that of Maharashtra but it appears to have lost due to changes in industry mix. Similarly, if Karnataka had operated at the same industry mix as Uttar Pradesh, it would have benefited until 1984-85, but subsequently its own industry mix becomes more favourable. Thus states should not use securing large investments as their major instrument for competition or as the indicator for their success. Rather they should pay attention both to industry-mix effects and on continually improving ability to service capital through increasing capital productivity.

States should not use securing large investments as their indicator for their success. Rather they should pay attention to industry-mix effects and on continually improving ability to service capital through increasing capital productivity.

Conclusions

From the disaggregated analysis of changes in capital productivity for states it can be seen how the gain or loss in productivity and changes in industry mix can affect

Table 9. Interstate Analysis

(A) If Tamil Nadu operates at the same industry mix as that of Maharashtra					
Year/R	(1)	(2)	(3)	(4)	(5)
1980-81	0.1841	0.0527	0.2368	–0.0744	0.1624
1984-85	0.1691	0.0621	0.2312	–0.0226	0.2086
1988-89	0.1963	0.0066	0.2029	–0.0388	0.1641
(B) If Karnataka operates at the same industry mix as that of Uttar Pradesh					
Year/R	(1)	(2)	(3)	(4)	(5)
1980-81	0.0611	0.0711	0.1322	–0.0083	–0.1239
1984-85	0.0588	0.1358	0.1946	–0.0375	0.1571
1988-89	0.1076	0.0133	0.1209	0.0117	0.1326

Note:
(1) = Value of R for the State Maharashtra in (A) and for Uttar Pradesh in (B)
(2) = Effect of changes within industries
(3) = Intermediate ratio (IR)
(4) = Effect of changes due to industry mix
(5) = Value of R for the State Tamilnadu in (A) and for Karnataka in (B)

the levels of capital productivity and how one state can do better in certain circumstances by adopting the industry mix of another state.

The ability to service capital is an important indicator because it takes into account the emolument levels. As seen the ability to service capital is influenced by specialisation and diversification and one can recommend whether to specialize or diversify or whether to target particular industries within each state.

At the All India level there is an urgent need to improve productivity of capital. It is not the industry mix but the capital productivity within industries which has accounted for near stagnant levels of productivity. The ability to service capital is also declining over time and does not augur well for future industrial growth. The barriers to improving capital productivity needs to be investigated at state, industry and enterprise levels and be substituted by incentives for improving productivity. Policy reforms are needed for this to happen because as Porter argues "One can significantly influence the bases of competitive advantage if one adopts the correct policy".

Acknowledgement

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Restructuring Public Enterprises

Nand Dhameja

The performance of public enterprises has come in for considerable criticism on account of their alleged low productivity and dismal return on capital. The author analyses the causes behind the malaise and concludes that the restructuring option cannot comprise one single approach, be it full privatisation, partial privatisation or simply commercialisation but each case should be dealt with on an individual basis.

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The Industrial Policy Statement of July 1991 has the objectives including:

> "Government will endeavour to abolish the monopoly of any sector or any individual enterprise in any field of manufacture, except on strategic or military considerations and open all manufacturing activities to competition.
>
> "The Government will ensure that the public sector plays its rightful role in evolving the socio-economic scenario of the country. Government will ensure that the public sector is run on business lines...."

In the light of the above statement, industrial licencing has been abolished for all projects except those of security and strategic importance and the list of industries requiring industrial licensing has been pruned to cover just eighteen. Other measures of liberalisation include amendment of MRTP Act, permission for foreign technology agreements in high priority industries, liberal provision for hiring foreign technicians, and enhancing the limit of direct foreign investment.

Similarly, all manufacturing activities except those of strategic and military considerations, have been opened to competition and industries reserved for public sector have been reduced to eight. Chronically sick public sector units like those in private sector have been referred to the Board for Industrial and Financial Reconstruction (BIFR) for formulation of revival plans. Boards of public sector units are to be made professional and given greater powers. The Memorandum of Understanding (MOU) system is to be given greater thrust to grant greater autonomy to hold them accountable. Equity holdings of the government in the public sector units have been offered to banks, financial institutions, and public sector mutual funds to raise resources and to introduce competitiveness in the working of public sector units.

Public Enterprises: Size & Growth

Public sector in India has witnessed a phenomenal growth during the last four decades since independence and public enterprises at the Centre have increased from five units involving an investment of Rs. 30 crore in 1950 to 246 units with investment of Rs. 1,35,879 crore and employment of 22.86 lakh people 1992. Public enterprises are involved in all sectors of the economy and contribute the entire output in respect of petroleum, lignite, copper and primary lead, about 98 percent of coal, well over 80 per cent of zinc, more than half of steel and aluminium, and about-one third of fertilisers.

However, the involvement of the public sector in all sectors has come in criticism in the recent years due to their low productivity and dismal return on capital employed (table 1). Public enterprises showed a profitability (return on capital employed) of 11.7 percent as against 15.7 per cent in the private sector. Such comparisons have to be made with caution; firstly, as public enterprises are also expected to fulfill certain social objectives and secondly as public enterprises comprise profit-making as well as loss making units including loss making private sector units taken over by the state. Such private sector-taken-over-sick units account for approximately one-third of the total losses of the central public enterprises. Further, petroleum sector public enterprises (fourteen in number accounting for seventeen percent of total capital employed and contributed one-third of the total profits) had a high profitability of 21 percent while sick public sector units contributed heavily to the cash deficits of the government. In other words, public enterprises had a dismal performance as they included loss making sick units, or also due to the low turnover of capital employed — a ratio reflecting poor productivity of sales to capital employed. For example sales to capital employed ratio for private sector units was 1.47, while for the public the enterprises, the corresponding figure was 1.15; Petroleum sector and disinvested units, however had comparatively high ratio reflecting low ratio for other sectors.

The poor performance of public enterprises can be due to poor project management, overmaning, inadequate attention to R&D and human resources development, and the policies of the government. In the words of Vernon (1988): "For one thing, state-owned enterprises in developing countries were changed principally with building up the modern infrastructure of those countries, an activity that is, as a rule, highly capital intensive. The cash needs of the enterprises were increased by the fact that their governments commonly used them as conduits for the distribution of subsidies, such as subsidies for staple food and transportation to urban dwellers or for electrical power and transportation to rural areas. In addition, in both developed and developing countries,

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Table 1: Economic Profile of Public Enterprises: 1992-92

(Rs in Crore)

	No	Capital Employed (CE)	Gross Sales (S)	Gross Profit (EBIT)	Employees (000)	Ratios		
						S/CE	EBIT/CE %	EBIT/CE %
Total*	237	118,492	135805	13857	2279	1.15	11.69	10.2
Petroleum Sector	14	20,406 (17.2)	48,081	4183 (30.2)	128	2.36	20.51	8.7
Non-Sick, Non-Petroleum Manufacturing Sector	101	60,289 (50.88 %)	51,120	5937 (42.8)	152	0.85	9.85	11.6
Non Sick Service Sector	62	39,059	33,084	4623	283	0.85	11.84	14.0
Sick Manufacturing Sector	50	855	2,771	–748	274	NA	NA	NA
Sick Service Sector	10	–407	749	–138	73	NA	NA	NA
Disinvested	30	46,818	56,734	5164	NA	1.21	11.03	9.10
Private Sector**	1175	92,502	135,857	14,495	NA	1.47	15.67	10.6

*Excludes PSU enterprises under construction
**CMIE

state-owned enterprises were often expected to mount rescue operations for privately owned factories and shipyards that were about to close their doors. In brief, the deficits of the state owned enterprises were much more easily traced to the policies of their governments than to their own inherent inefficiencies".

The role of public enterprises has undergone close scrutiny in the developing countries particularly in the 1980's. Many governments seem to have concluded that public enterprises were not the ideal hybrids they had been made out to be, only rarely did they combine the strengths of the public and private sectors, as originally expected, and occasionally they combined the worst of both. According to the World Bank Report on Reform of Public Sector Management (1991), the State in a developing country has tried to do too much through the public sector or has assigned to public agencies tasks for which they were ill-suited, or has retained activities in public sector when conditions justifying public management have changed. Infrastructure investment and GDP growth are found to have positive and significant relationship; public sector share in total investment upto 40 percent has been found to have a positive economic rate of return, while share beyond 40 percent, becomes a burden to the economy.

Commercialisation

To be cost effective and to improve performance public enterprises have to run on business like principles and adopt the principle of 'commercialisation' in their operations. This would require laying down commercial goals and targets, introducing competitiveness and providing autonomy for operations and making managements accountable. To quote from the World Bank Report (1991), "Experience demonstrates that public enterprises" performance can be improved without changing ownership — by assigning the firms clear commercial goals, imposing a hard budget constraint, giving managers the means and power to attain these goals, exposing the enterprises to competition, rewarding the managers who achieve objectives and sanctioning those who do not allowing persistent poor performers to go out of business". This process of 'commercialisation' subjects public enterprises to roughly the same conditions and signals as to a profit maximising firm operating in a competitive market.

To be cost effective and to improve performance public enterprises have to run on business like principles and adopt the principle of 'commercialisation' in their operations.

Public enterprises can be broadly categorised under two heads in relation to the Industrial Policy Statement of the Government: Enterprises Reserved for public sector on strategic and national defence considerations contain eight industries comprising defence production, atomic energy, coal and lignite, mineral oils, mining of iron ore, gold and diamond, copper, lead, zinc, tin, railways, etc. The Reserved list is somewhat akin to that of 'core sectors' identified by the Arjun Sengupta Committee Report to Review Policy for Public Enterprises (1984). Enterprises not in the Reserved list: can be categorised as non-core sector industries and be further classified as:

— Profit Making enterprises

— loss making enterprises including those private sick units taken over by the state.

Loss Making Enterprises

Restructuring of loss making enterprises including sick private units taken over by the State is of national significance and is relatively a difficult exercise. Such units are a drain on national resources and require budgetary support every year; besides having socio-economic dimensions in terms of 3,50,000 people employed with an annual wage bill of Rs. 2800 crore approximately. There is an urgent need to have plans for the revival of the viable units either as ESOP or their merger with a unit having market potential; and for the closure of unviable ones. National Renewal Fund (NRF) set up for the training and development of employees of such units is an encouraging step.

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The Industrial Policy Statement provides for the referral of such units to an institution like BIFR for for-

mulation of revival/rehabilitation schemes. However, attempts in this direction have not been yielding encouraging results. Earlier, the attempt to handover Scooters India Ltd, a sick central public enterprise, to a private sector unit met with severe resistance from the labour and has not been successful. On the other hand the case of Allwyn Nissan Ltd (ANL) in Andhra Pradesh is a successful one of divestiture and privatisation, and the unit was transferred to Mahindra & Mahindra. The recent bid to rehabilitate and modernise Indian Iron and Steel Co. (IISCO) by transferring it to a private unit, is an example to emulate for many other sick public enterprises. The Government has decided to transfer 80 percent of IISCO's restructured capital at a cost of Rs. 225 crore to Mukand Group, while the remaining 20 percent of the stake will be retained by the parent company, SAIL. There is an urgent need for decisions, though not politically palatable, on restructuring of loss making units by involving the concerned employees either by sale or by closure, though the former is preferred.

With the financial deregulation and opening up of the economies, enterprises are open to market forces and need to improve their performance. Competitive environment can be created even among enterprises reserved for the public sector. For example, defence production units in India are facing competition for their various products from the private sector units and are reportedly exploring the domestic and foreign markets for their products; similarly private air taxi companies have ushered in competition for the domestic air travel.

Festinger's social comparison theory (Mahmood & Seveno, 1987) that 'people most strenuously seek to evaluate their performance by comparing themselves to others, not by using absolute standards' applies to public enterprises as well, and publicising information on comparative performance among public enterprise managers would create an environment of competitiveness. Export, even of small amounts would put a competitive pressure. Similarly, relying on banks, financial institutions or even capital market for finances in the form of loans, or bonds, or even sale of equity, to private sector, discussed latter, would bring in publicity regarding the performance of the enterprise and would introduce competitiveness.

Managerial Autonomy & Accountability

Do public enterprises managers have autonomy to take decisions freely on merit on economic considerations? Is their accountability laid out in terms of well defined criteria? Autonomy refers to delegation of decision making power to the managers and the extent of control by the government. Government supervision and guidance has been reported to be 'often excessive and not based on well established rules and conventions' Public enterprises no doubt are autonomous and have their Board of Directors as their policy making body, but are subjected to various types of controls including different forms of audits and also parliamentary control. To quote from the Arjun Sengupta Committee Report," It is recognised by all that, on paper, managements of public enterprises enjoy large autonomy, sometimes much more than even by the private sector management. However, in practice, informal and formal involvement of Ministries and Departments take place in areas wholly within the decision making powers of public enterprises."

Since in India the Parliament is supreme and the executive is responsible to it, it is unrealistic to think that public enterprises could be made completely autonomous and independent from government supervision. Ayub and Hegstad (1987) referred to the similarity in the organisational framework of private sector enterprises and public sector enterprises. A private sector enterprise is run within three different frameworks: ownership, strategic and operating. While owners define the business charter, set overall business objectives, appoint and remove directors, approve annual accounts and declare dividends on the recommendations of the Board; the Board comprising professionals and experts has a strategic role to decide on plans to achieve the objectives, to monitor performance and to appoint the chief executive; while the chief executive along with his management team has an operating role to manage business in accordance with the agreed objectives and plans. Public enterprises have similar organisational structures. However, the governments, as owners 'invariably encroach on the strategic and operational functions' and that is the cause of much of the poor performance of the public enterprises. "In several sample countries, boards of directors have to seek ministerial approval for relatively small investments, hiring and firing of staff, wage setting, decisions on working capital, procurement policies, foreign travel, and much else. It may sometimes be justified by governments to involve themselves in decisions that private firms would handle at the board level. But involvement in operational matters is time-consuming for an already overstretched bureaucracy; the ministries lack the information and the business perspective to make the correct decisions; and most important it absolves the management of its responsibility and accountability for how a company performs". (Ayub & Hegstad, 1987).

On involvement of government on public enterprise operations, Arjun-Sengupta Committee recommended

that "it is necessary to evolve a set of rules and conventions by which the Government can help in the better functioning of public enterprises by reducing the points of intervention without minimising the Government's right to have needed information for evaluating performance. The Government should primarily be concerned with overall strategic planning and policy, rather than with day-to-day functioning of the enterprises".

The Government should primarily be concerned with overall strategic planning and policy, rather than with day-to-day functioning of the enterprises".

The system of Memorandum of Understanding (MOU) adopted in 1986 on the recommendation of the Arjun Sengupta Committee, was designed to improve the performance of public enterprises by giving operational autonomy and by enforcing accountability commensurate with authority for results. An essential part of MOU is the enumeration of a number of agreed indicators and targets to arrive at a composite performance score for evaluation of performance. The MOU's are being claimed as major instruments of the rollback of state involvement in running of the public enterprises during 1990-91, 23 public enterprises signed MOUs with their administrative ministries, of which 14 were categorised as excellent, eight as very good and one as poor; while during 1991-92 and 1992-93, the number of enterprises signing MOUs was 71 and 120 respectively. Has the financial performance of public enterprises improved over the years? Perhaps not, and the problems of autonomy and accountability remain.

> "The experience with the MOUs in the past has not been very positive. A change of attitude in the new era of liberalisation may lead to some improvement in results in the years to come, but much more is needed than MOUs to distance the government from the actual running of the public enterprises". Ahluwalia, (1993).

Public enterprise evaluation system in Sweden is one of the most decentralised systems and is a good example of managerial autonomy. Different variants of the system are found in Norway and Korea. In Sweden, a professional supervisory agency, called a 'Unit for State Participation', as a part of Ministry of Industry has been delegated by the Cabinet the responsibility to execute the ownership role of the state industries. The Unit for State Participation does not maintain a databank of financial or operational data, does not keep a roster of management candidates, and does not perform any management services. Executives of the supervisory agency are directors only on a limited number of boards; as board members they act in the best interests of the enterprise and not overpower the board with their ownership role — only in times of crisis and when public enterprises require state financial support, the supervisory agency increases its involvement in decision making.

To minimise government intervention in enterprise operation and to provide autonomy to the management, the following suggestions merit consideration. These are extensions of the decentralised system to evaluate public enterprise performance in Sweden:

I. A Supervisory Board of professionals and experts should be vested with the responsibility to perform the role of ownership of public enterprises, viz to set overall business objectives, to appoint directors and to monitor performance. The Supervisory Board should report to a Committee of elected representatives belonging to various political parties, the Committee in turn should report to the Parliament. Such a Supervisory Board will serve the dual purpose of protecting the directors and management from undue political manoeuvering and also exercising effective control over public enterprises.

II. Appointment of Chief Executive, full time directors, and certain levels below the Board, at present are vested in the Government in consultation with the Appointment Committee of Cabinet (ACC) and the Public Enterprises Selection Board (PESB). The Supervisory Board should be vested with the responsibility of making such appointments, or dismissals. Accordingly, part-time directors may also be appointed by the Supervisory Board in Consultation with the Chief Executive.

III. Tenure of the chief executive and full time directors should be long enough, say, five years, to enable them to show results and to have some security; this is against the tenure of two years at present.

IV. Systems of wage fixation should be such as to provide autonomy to enterprises, keeping the overall wage policy in view.

V. Liberalisation and competitive environment would also require a reconsideration in the remuneration package of chief executive, directors and other management personnel, particularly when there has been enhancement in the managerial remuneration in private sector enterprises.

VI. In order that the board of directors and top management are manned by professionals and experts and have autonomy, the Government should hire top-quality entrepreneurs and managers and should design the organisation in such a way as to shield these people from undue political and bureaucratic interference.

The recommendations of the Arjun Sengupta Committee were similar to suggestions II, III, and IV.

Financial Autonomy Accountability

Enterprises in the Reserved list of public sector are a part of National Plan and have to interact with the Government with respect to matters relating to investments, price fixation and financing. Their investment proposals are as per the laid down procedure, viz clearance by PIB, and their financing is a part of national treasury. However, within the plan framework, they can have financial autonomy in terms of raising of resources from the market or disinvestment of their equity or the so called partial privatisation.

On the other hand, enterprises not reserved for public sector should have financial autonomy in terms of raising resources from banks, or capital market. Their finances may be a part of national treasury and may not be subjected to government clearance. As such, they would be subject to competition and market forces, "their plans be integrated into the National Plan only in indicative sense and such units would continue to be governed by the indicative and regulatory framework of planning as application for all similar private sector units". (Arjun Sengupta Committee, 1984).

Financial autonomy entails laying down financial objectives, capital structure, social objectives, and subsidies, and performance measurement.

Financial autonomy entails laying down financial objectives, capital structure, social objectives, and subsidies, and performance measurement. Financial ratios can be developed and integrated with the performance measurement indicator. However, there is a need to have clear social objectives and priorities among those objectives. Examples of social objectives may be; creating employment, balanced regional development and redistributing income. Price controls or subsidies intended to benefit the poor may end up benefitting the well-to-do or high income group, and so there is a need for regulating the authority to examine whether the social objectives or subsidies are serving the purpose.

Privatisation or Divestiture

Change of ownership from state to private sector entails steps like: commercialisation, corporatisation, reorganisation, and divestiture. In other words, shares of public enterprises are sold to private individuals. Thus ownership and control of the enterprise are passed on to the private sector and this brings in market forces, introduces competitiveness and gives autonomy to the management. Divestiture and full privatisation as a process of restructuring public enterprises depend upon the economic policy of the government, nature of industry whether reserved for public sector, and require planning which is a long drawn process. However, as an immediate and short term measure, there can be steps to introduce the principle of 'commercialisation' and to insulate public enterprises from bureaucratic and ministerial control; and later on there may be planning towards full privatisation.

For enterprises reserved for public sector, there can be partial privatisation, whereby a certain proportion of equity owned by the government is sold to the private sector so as to raise resources to meet budgetary deficits, and to bring in competitiveness in the enterprise. During the last two years the Government has offloaded shares of 30 public enterprises and has raised about Rs. 4800 crore, with the target to disinvest, upto 20 percent of equity. Shares offloaded are listed on stock-exchanges and thus share market prices would exert a pressure on the management of the enterprise, though such disinvestment may not warrant autonomy to the managements.

However, in order that an enterprise enjoys autonomy, and is free from bureaucratic and ministerial control, government equity holding beyond 50 percent should be sold so that the enterprise ceases to be a government company, like Maruti Udyog and like a private sector company is free from parliamentary questioning.

In short, full privatisation would bring in market forces, introduce competitive environment, provide autonomy, bring in funds for the Government. It entails that government business is not to run businesses; but to regulate and monitor the enterprises privatised. On disinvestment of shares, the Rangarajan Committee recommended to "set up specific resources for continued government ownership of enterprises except in sectors which are reserved for public ownership. In all other

sectors, government should justify its continued holding of equity on considerations as an investor and not as an owner. The government may hold more than 26 per cent of the total equity in enterprises with outstanding prospects, but the investment needs to be justified on the basis of growth potential and the scope for larger realisation and not on the basis of desirability of government control".

Concluding Remarks

To sum up, there can be no one approach towards restructuring of public enterprises, whether full privatisation, partial privatisation, or simply commercialisation. Choice of restructuring option depends on the economic policy of the government, nature and health of the enterprise, and the time frame of restructuring.

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Effective leaders take the important decisions and delegate the rest.

— Henry Ford

Feature

Rural Poverty in India — Time Trend, States' Share & Policy Implications

Pundarikaksha Mukhopadhaya

This paper examines the time trend of rural poverty in India the period 1957-58 to 1987-88 relying on the basic calculations by several authors. The study suggests a better model of poverty measure to analyze the states' share to the total rural poverty of India which, though simple, is additively decomposable with population share as weights. The study finds a counter intuitive relationship between states' share of rural poverty and the rate of growth of food grain production. The thesis suggests a simple development path towards economy wide increases in productivity, output and employment.

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In his study of the time trend of rural poverty during the 1960s, Bardhan (1974) chose the official poverty line of Rs. 15 monthly consumption expenditure at 1960-61 prices and deflated it by Consumer Price Index for agricultural labourers. His approach was adopted by Ahluwalia (1978), who used 14 observations derived from NSS data for the whole period from 1955-57 to 1973-74 (with some observations missing : (1962-63, 1969-70, 1971-72, 1972-73). He found no long term upward or downward trend in the incidence of rural poverty at the all India level, although the absolute number of poor increased on average by 5 million per year.[1] There was, however, a statistically significant increase in poverty in 7 out of 15 states he studied (in Assam, Bihar, Karnataka, Orissa, Rajasthan, Uttar Pradesh, West Bengal), and only Andhra Pradesh registered a significant decline.

Trends in Rural Poverty

Tyagi (1981) compared the NSS consumption estimates with the CSO income estimate, data on food availability and the composition of consumption basket between 1960-61 and 1973-74. He concluded that the former over estimated poverty in 1970-71 and 1973-74 by at least 10 per cent.[2] This conclusion was confirmed by Dandekar (1986) for 1972-73, who compared the NSS data with the per capita NDP in the organised sector. The NSS estimates for 1977-78 and 1983, however, were in reasonable agreement with the letter.

Ahluwalia (1985) extended his time series at the all India level to 1977-78 and inserted the missing values for

1. His view was criticised by Griffin & Ghose (1979) and Saith (1981), who truncated the time series used by Ahluwalia in order to obtain an increase in poverty.
2. During NSS-round for 1973-74, data were collected for 9 months only (October 1973 to June 1974), which may have led to distortions additional to those due to price index and measurement errors (Tendulkar & Jain (1990)).

1971-72 and 1972-73. He found his earlier results confirmed. The latest NSS estimate available in published form is from 1983. It shows a decrease in rural poverty from 39 per cent in 1977-78 to 33 per cent (Ghose (1989)). This decline is lower than that suggested by the Planning Commission figures, which were inflated artificially by adjusting for the difference between the NSS and the CSO data (Government of India, 1987).[3] Adding the observation for 1983 to Ahluwalia (1985) time series analysis leads to the emergence of a significant and negative overall time trend of rural poverty (Ghose (1989)). Ghose (1989) went on to stylise the time trend in an exercise apparently based on visual intuition, so that the kink leading to a downward trend seemed to occur in 1977-78. Prasad (1985), on the other hand found that the difference in the annual rate of decline of poverty during the whole period after green revolution (1967-68 to 1983) compared to the period from 1967-68 to 1977-78 was statistically not significant. His Chow-test, however, does not seem to be extremely revealing, since he does not apply it to two succeeding sub-periods within the phase after the green revolution. But because aggregate data on poverty after 1972-73 are confined to 3 observations, there is no point is testing statistically whether the regression linescan be fitted for the periods between 1967-68 and 1973-74 (or 1977-78) and 1983.

Inter Regional Variations

There are wide inter-regional variations in the incidence of rural poverty. In 1961-62 and in 1970-71 the highest incidence of poverty was found in the belt stretching from West Bengal, Orissa, Bihar in the East, over Central Madhya Pradesh to Maharashtra and some areas of Gujarat and Rajasthan in the West. The regions with the lowest share of poor in their rural populations included Punjab, Haryana and some areas of Rajasthan and Madhya Pradesh. In 1977-78 there was a considerable decrease in the head-count ratio in almost all states except Assam (cf. tables 1 and 2). But besides Maharashtra, Orissa and Uttar Pradesh the poverty gap ratio was seen to have increased for all the states under consideration. During this period the maximum decrease in head-count ratio was recorded in Punjab which was followed by Haryana where poverty gap ratio increased by 150 per cent over this period. During this period West Bengal ranked first with highest poverty in terms of head-count ratio whereas in terms of poverty gap ratio Orissa occupied first place. In 1983 all the states except Bihar showed decrease in poverty in terms of head-count ratio and poverty gap ratio. Decrease in poverty in terms of head-count ratio was most in Assam but Maharashtra showed the largest decrease in poverty in terms of pover-

Table 1. Head Count Ratio (HCR) and Poverty Gap Ratio (PGR) for selected states in selected years cut-off point Rs. 50 (1973-74 = 100) and deflator: CPIAL.

	1961-62		1970-71		1977-78		1983		1986-87	
	HCR	PGR	HCR	PGR	HCR	PGR	HCR	PGR	HCR	PGR
AP	47.2	6.1	41.0	3.3	31.7	5.5	18.3	2.8	15.9	2.7
Assam	29.4	4.2	35.3	3.7	46.2	5.7	26.2	2.9	27.4	3.2
Bihar	49.9	10.6	59.0	17.6	55.2	12.5	56.5	12.6	40.5	6.6
Gujarat	39.7	4.3	43.8	5.5	35.1	6.2	15.1	1.9	25.3	4.4
Haryana	—	—	27.9	1.2	19.5	3.0	11.7	1.4	11.0	1.4
Karnataka	35.4	5.8	47.2	8.9	41.0	8.9	29.1	5.4	29.1	5.4
MP	40.0	5.9	52.9	12.2	51.9	12.9	34.5	7.1	31.5	5.9
Maharashtra	43.6	12.1	46.6	14.7	58.7	13.2	34.9	6.0	35.5	6.0
Orissa	49.3	16.4	65.0	18.9	49.1	18.3	33.4	10.0	32.7	8.5
Punjab	22.3	1.5	16.5	1.8	9.8	1.9	7.8	0.96	6.4	0.94
Rajasthan	33.0	2.6	41.8	5.5	26.2	6.0	24.1	5.2	18.3	3.3
TN	51.0	10.9	57.3	9.8	52.3	11.3	47.1	10.4	34.3	6.7
UP	35.4	4.7	40.6	7.4	37.6	7.1	35.8	6.8	25.3	4.2
WB	58.3	15.2	70.1	15.2	60.3	16.0	50.7	12.9	30.1	6.1

Source: Kakwani & Subbarao (1990), Rohini Nayyar (1991).

3. For a detailed critique of the Planning Commission procedure cf. Minhas et al (1990) and Gaiha (1991). Dandekar (1986) calculated a small decrease from 51.9 per cent to 48.9 per cent, which widen, however, to a decline from 49.5 per cent 44.4 per cent after adjusting for changes in consumption patterns. The different estimates are presented in table 2. A decline of the order between 5 per cent and 8 per cent seems to be the most probable value.

Table 2. Simple Growth rates (in Percentage) of Head Count Ratio and Poverty Gap Ratio for different years in selected states.

	1961-62 to 1970-71		1970-71 to 1977-78		1977-78 to 1983		1961-62 to 1986-87	
	HCR	PGR	HCR	PGR	HCR	PGR	HCR	PGR
AP	−13.14	−45.90	−22.68	66.67	−42.27	−49.09	−66.31	−55.74
Assam	20.07	−11.90	30.88	54.05	−43.29	−49.12	−6.80	−23.81
Bihar	18.24	66.04	−6.44	−28.98	2.35	8.00	−18.84	−37.74
Gujarat	10.33	27.91	−19.86	12.73	−56.98	−69.35	−36.27	2.33
Haryana	—	—	−30.11	150.00	−40.00	−53.33	—	—
Karnataka	33.33	53.45	−13.14	0.00	−29.02	−39.33	−20.62	−6.90
MP	32.25	106.77	−1.89	5.74	−33.53	−44.96	−21.25	0.00
Maharashtra	6.88	21.49	25.97	−10.21	−40.14	−54.54	−18.58	−50.42
Orissa	31.84	15.24	−24.46	−3.17	−31.98	−45.35	−33.67	−48.17
Punjab	−26.01	20.00	−40.61	5.55	−20.41	−49.47	−71.30	−37.33
Rajasthan	26.67	111.54	−37.32	9.09	−8.02	−13.33	−44.55	26.92
TN	12.35	−10.09	−8.74	15.31	−9.94	−7.96	−32.75	−38.53
UP	14.69	57.45	−7.39	−4.05	−4.79	−4.23	−28.53	−10.64
WB	20.24	0.00	−13.98	5.26	−15.92	−19.38	−48.37	−59.87

Note: Derived from the data of table 1.

ty gap ratio. If the states are arranged in descending order (cf. table 3) of poverty with respect to headcount measure Bihar comes first followed by West Bengal, Tamilnadu, Uttar Pradesh, Maharashtra, Madhya Pradesh, Orissa, Karnataka, Assam, Rajasthan and Andhra Pradesh. On the other hand in respect to poverty gap ratio, the states in the same order are West Bengal, Bihar, Tamil Nadu, Orissa, Madhya Pradesh, Uttar Pradesh, Maharashtra etc. In 1986-87 though there is a considerable decrease in head-count ratio in Andra Pradesh, Punjab and Haryana the poverty gap ratios for these states remain more or less the same. Again in Orissa though there is a considerable decrease in poverty gap ratio, the headcount ratio gives more or less the same result.

The highest incidence of poverty was found in the belt stretching from West Bengal, Orissa, Bihar in the East, over Central Madhya Pradesh to Maharashtra and some areas of Gujarat and Rajasthan in the West. West Bengal ranked first with highest poverty in terms of head-count ratio whereas in terms of poverty gap ratio Orissa occupied first place.

It is clear that when we concentrate on the contribution of different states to the total rural poverty of India, the single process of head-count measure or poverty gap ratio will not give a comprehensive picture. The flaws of common head-count measure and the widely used process of P-measure of Sen are broadly discused topics. But for the Indian context over the period 1957-58 to 1987-88, the P-measure closely approximates the head-count ratio. The coefficient of variation of Gini-coefficient of consumption is very small over this period. Ghose (1989), Bhattacharya et al (1991) and Ghosh (1992) have demonstrated this graphically for India as a whole as well as for some states separately.

If one wants to relate the decrease in incidence of rural poverty at the state to that at all India level, one has to calculate the contributions of each state to this decline. For this calculation we should have a measure of poverty which will not only smooth out the above explained divergence but also relate sub-group poverty to total poverty in this form of analysis. At the very least, one would expect that a decrease in poverty level in one sub-group, ceteris peribus, would lead to less poverty for the population as a whole. At best, one might hope to obtain a quantitative estimate of the effect of a change in sub-group poverty on total poverty.

One way to satisfy the above criteria is to use a poverty measure that is additively decomposible. Of the measures that are accepted by Sen Criteria none is decomposible (Foster, Greer & Thorbecke, 1984)). Sen's measure, relaying on rank order weighting, fails to satisfy the basic condition that an increase in sub-group poverty must increase total poverty[4].

Methodology

We need a very simple poverty measure that is additively decomposible with population share weights, need not satisfy the basic properties proposed by Sen—as this measure will be applied for Indian data for the period 1957-58 to 1986-87 when the inequality has not changed considerably and smoothes out the divergence between head-count measure and poverty gap ratio. This poverty measure can be defined as a product of poverty gap ratio and head-count measure. Easily it can be proved that the measure is a very simplified version of generalised Foster, Greer, Thorbecke's (1984) P_α when value of α is equal to 1.

Suppose $Y = y_1' y_2' \cdots \cdots y_n)$ is a vector of household income in increasing order, and $z = 0$ is the predetermined poverty line, where $g_i = z = y_i$ is the income shortfall of the i_{th} household, $q = q(y ; z)$ is the number of poor households (having income no greater than z), and $n = n(y)$ is the total number of households. Now our poverty measure is

$$P = H \cdot I = \frac{q}{n} \cdot \frac{\sum_{i=1}^{q} = g_i}{qz} = \sum_{i=1}^{q} \frac{g_i}{zn} = \frac{1}{n} \cdot \sum_{i=1}^{q} \frac{g_i}{z}$$

Foster, Greer, Thorbecke's p_α can be given by

$$p_\alpha (y;z) = \frac{1}{n} \sum_{i=1}^{q} \left(\frac{g_i}{z}\right)^\alpha$$

So we can write our P as $FGTP_1$. It is to be noted that this measure satisfies the Monotonicity axiom of Sen (1976, 1979) but not the transfer axiom of Sen (1979) or Transfer Sensitivity axiom of Kakwami (1980)[5]. Further, $FGTP_1$ satisfies sub-group monotonicity (Foster, Greer, Thorbecke, 1984), and for any income vector y broken down sub-group income vectors y^1, ... y^k

$$FGTP_1 (y;z) = \sum_{j=1}^{k} (n_j / n) \cdot FGTP_1 (y^j;z) .$$

The decomposition allows a quantitative, as well as qualitative, assessment of the effect of changes in state level poverty on total poverty. In fact, increased poverty in a state (i.e.,a sub-group) will increase total poverty at a rate given by the population share n_j/n; the larger the population share the greater the impact. The quantity $L_j = (n_j/n)$. $FGTP_1 (y^j ; z)$ may be interpreted as the total contribution of a state to overall country level poverty. $100L_j/FGTP_1 (y ; z)$ will be the percentage contribution of state j.

In tables 4 and 5 the poverty measure $FGTP_1$ is applied to the data collected from NSS several rounds by Rohini Nayyar (1991) and Kakwani and Subbarao (1990) to have a picture of the contribution of selected states on the overall poverty of India. (Population data were collected from Government of India, CSO, Statistical Abstract, various issues). It is clear from table 4 that during 60's and 70's North India gave a moderate (rather low) contribution to the total rural poverty of India. In the south, during 1961-62 the share of Andhra Pradesh was the largest in the country which considerably decreased in the next 20 years. In the south Karnataka had a little contribution to total rural poverty out 60's and 70's, and the share of Tamil Nadu was very high. In the eastern part of the country the states (Bihar, West Bengal and Assam) showed a gradual increase in share over the period. Focusing on the west the share of Gujarat and Rajasthan was quite low through out the period whereas Madhya Pradesh showed an increasing share from low to moderate but the contribution of Maharashtra remained very high.

4. Let the population be divided into a collection of households $j = 1, ...,$ k with ordered income vector y^j and population sub-groups, the following axiom may be taken as a basic consistency requirement:

The axiom : let $\hat{y}$ be a vector of income obtained from y by changing the incomes in sub-group j from y^j to $\hat{y}^j$, where n_j is unchanged. If $\hat{y}^j$ has more poverty than y^j, than $\hat{y}$ must have a higher level of poverty than y.

When incomes in a given sub-group change (the rest remaining fixed), this axiom requires subgroup and total poverty to move in the same direction. By this criterion the Sen's measure and its variants (Anand 1977; Kakwani 1977, 1980; Takayama 1979; Thon 1979; Von Ginneken 1980) are not well suited for poverty analysis by sub-group, since they violate the consistency requirement in certain cases. For instance, where $y = (1, 6, 6, 7, 8, 12)$, $\hat{y} = (3, 3, 6, 7, 8, 13)$ and $y^1 = (1, 6, 12)$, $y^2 = (6, 7, 8)$, $\hat{y}^1 = (3, 3, 13)$, $\hat{y}^2 = (6, 7, 8)$ and $y^2 = \hat{y}^2$ we have more poverty in y^1 than $\hat{y}^1$ by the Sen's measure as long as $Z > 13$ and yet $\hat{y}$ has more poverty than y using the same measure. Note that the mean incomes of y^1 and $\hat{y}^1$ are the same in this example. This example can be found in Cowell (1984) who applied it to the Gini inequality measure.

5. **Monotonicity Axiom**: Given other things, a reduction in the income of a poor household must increase the poverty measure.

Transfer Axiom: Given other things, a reduction in the income of a poor from a poor household to any other household that is richer must increase the poverty measure.

Transfer Sensitivity Axoim: If a transfer to income takes place from a poor household with income y_i to a poor household with income y_i + d (d o), then the magnitude of the increase in poverty must be smaller for larger y_i.

Table 3. Banking of states according to Head Count Ratio (HCR) and Poverty Gap Ratio (PGR) of the selected years.

Ranks	1961-62		1970-71		1977-78		1983		1986-87	
	HCR	PGR	HCR	PGR	HCR	PGR	HCR	PGR	HCR	PGR
1	WB	Orissa	WB	Orissa	WB	Orissa	Bihar	WB	Bihar	Orissa
2	TN	WB	Orissa	Bihar	Maharashtra	WB	WB	Bihar	Maharashtra	TN
3	Bihar	Maharashtra	Bihar	WB	Bihar	Maharashtra	TN	TN	TN	Bihar
4	Orissa	TN	TN	Maharashtra	TN	MP	UP	Orissa	MP	WB
5	AP	Bihar	MP	MP	MP	Bihar	Maharashtra	MP	Orissa	Maharashtra
6	Maharashtra	AP	Karnataka	TN	Orissa	TN	MP	UP	WB	MP
7	MP	MP	Maharashtra	Karnataka	Assam	Karnataka	Orissa	Maharashtra	Karnataka	Karnataka
8	Gujarat	Karnataka	Gujarat	UP	Karnataka	UP	Karnataka	Karnataka	Assam	Gujarat
9	Karnataka	UP	Rajasthan	Gujarat	UP	Gujarat	Assam	Rajasthan	Gujarat	UP
10	UP	Gujarat	AP	Rajasthan	Gujarat	Rajasthan	Rajasthan	Assam	UP	Rajasthan
11	Rajasthan	Assam	UP	Assam	AP	Assam	UP	AP	Rajasthan	Assam
12	Assam	Rajasthan	Assam	UP	Rajasthan	AP	Gujarat	Gujarat	AP	AP
13	Punjab	Punjab	Haryana	Punjab	Haryana	Haryana	Haryana	Haryana	Haryana	Haryana
14	—	—	Punjab	Haryana	Punjab	Punjab	Punjab	Punjab	Punjab	Punjab

Note: Derived from table 1.

During 60's and 70's North India gave a moderate (rather low) contribution to the total rural poverty of India.

As the definition and process of computation differ in the data source of table 3 and 4, there is a lack of compatability of data. But this incompatability does have any effect on the analysis of the change of contribution of

Table 4. Percentage contribution to total poverty for selected years of selected states.

	1961-62	1971-72	1977-78
Andhra Pradesh	23.205	7.600	10.874
Assam	1.734	1.872	4.013
Bihar	11.705	21.162	14.685
Gujarat	2.176	2.852	2.496
Karnataka	2.685	3.585	3.846
Madhya Pradesh	2.593	5.211	6.408
Maharashtra	13.849	13.669	15.547
Orissa	8.296	7.886	7.447
Punjab	0.376	0.932	0.635
Rajasthan	0.17	0.987	0.557
Tamil Nadu	18.749	13.106	13.229
Uttar Pradesh	7.462	8.515	7.582
West Bengal	8.244	13.621	13.806

Note: Calculated from the head-count ratio and poverty gap ratio presented in Nayyar (Norm: 2000 cal/capita/day) (1990) table 3.12b and 3.8b).

Table 5. Percentage contribution to total poverty of selected states for selected years.

	1977-78	1986-87
Andhra Pradesh	2.743	2.012
Assam	1.082	1.686
Bihar	15.707	20.217
Gujarat	1.963	3.014
Karnataka	4.076	5.553
Madhya Pradesh	11.222	10.390
Maharashtra	14.443	13.919
Orissa	10.694	8.238
Punjab	0.101	0.084
Rajasthan	1.636	1.933
Tamil Nadu	9.461	10.042
Uttar Pradesh	9.537	12.694
West Bengal	17.388	10.213

Note: Computed from the head-count ratio and poverty gap ratio presented by Kakwani & Subbarao (1990) (cut off point Rs. 40 (1970-71 = 100), deflator CPIAL) table 8.

different states in the overall rural poverty level. In table 5 we see that the share of north (Punjab and Uttar Pradesh) i.e., 9.638 per cent is lower than the share of south (Andhra Pradesh, Karnataka, Tamil Nadu) i.e., 16.28 per cent in the year 1977-78. The corresponding figures for 1987-88 were 12.778 per cent (i.e., increased) and 17.607 per cent (i.e., more or less same). East contributes nearly half the share of the rural poverty in India in 1977-78 (44.9 per cent) which decreased to 40 per cent approximately in the year 1986-87 (Assam, Bihar, Orissa

and West Bengal are the states in which Bihar contributes an increase of 129 per cent). There was a stable situation in the share of rural poverty of the western part of India (covering Gujarat, Madhya Pradesh, Maharashtra, Rajasthan) constituting nearly 30 per cent in both the years.

Foodgrain Production & Poverty

Now let us see how the increase in food grain production of different states affects the change in contribution of share of poverty to total poverty of India. The green revolution in the mid-60's accelerated the growth rate of food production significantly in comparison to the period of stagnation in Indian agriculture, which lasted from about 1960-61 until 1966-67. However, it only rearranged the growth pattern which had prevailed in 1950s by substituting area expansion for yield increase as the main source of growth (Chakrabarti, 1982.). Until the mid 1970s, increased agricultural growth rate remained largely confined to wheat production in the North-Western states of Punjab. The green revolution did not improve the per capita food availability in India, since it was used by the Government as a means of replacing food imports and building up stocks to suitable prices (Das Gupta, 1977; Lipton & Longhurst, 1989).

From 1977-78 to 1981-82 there was virtually no growth in average food grain production at the all India level. Neither, however, was there a significant deceleration since the mid 1970s, as has been suggested by various observers (Sewant, 1983). The co-efficient of variation of food grain production increased after the mid 1970s. This should be a matter of equal concern as the growth rate, especially if one conceptualizes poverty as vulnerability. (Mehra, 1981; Hazell, 1982; Ray, 1983; Bardhan, 1984; Rao et. al, 1988; Lipton & Longhurst , 1989). If one, however, assumes that the higher instability is due to the spread of green revolution into environmentally less favourable areas, its consequences for the poor are not necessarily adverse (Rao 1989, Rao, Ray & Subarao, 1988).

During the post green revolution period, Punjab, Maharashtra, Andhra Pradesh and Gujarat performed above average. Punjab and Andhra Pradesh were the only states with a consistently good performance, whereas Gujarat was subject to fluctuations. Maharashtra, which suffered from heavy droughts in 1970-71 and 1972-73, achieved the highest growth rate among all states over the entire post green revolution period. Growth rates remained stagnant in Orissa and Madhya Pradesh and were very low in Assam, Bihar and West Bengal (table 6). There were marginal increases or even decrease in yield levels in the four eastern states between 1970-73 and 1982-83 (Bhalla & Tyagi, 1989). Annual compound growth rates of agricultural output in Bihar, West Bengal and Orissa stagnated during this

Table 6. Comparison between change in share of poverty (CP) and compound growth rate of food grain production (FP) for selected states at different years.

	1961-62 to 1971-72		1971-72 to 1977-78		1977-78 to 1986-87	
	CP	FP	CP	FP	CP	FP
Andhra Pradesh	–67.24	3.50*	43.08	5.03*	–26.65	3.92*
Assam	7.96	0.93	114.37	1.17	55.82	0.50
Bihar	80.79	0.83	–30.61	0.83	28.75	–0.79
Gujarat	31.27	0.23	–12.48	–2.52	53.54	3.84*
Karnataka	33.52	2.04*	7.28	1.70	36.23	2.52
Madhya Pradesh	100.96	0.90	22.97	–0.53	–8.13	–0.76
Maharashtra	–1.30	3.54	13.74	1.21*	3.62	2.38**
Orissa	–4.94	–1.11**	–5.57	–0.93	–22.96	2.38*
Punjab	149.20	4.15*	–32.23	2.88*	–16.83	7.55*
Rajasthan	480.58	2.16	–43.57	–0.44	18.15	–2.42
Tamil Nadu	–30.10	0.44	0.93	–2.49**	6.14	2.46
Uttar Pradesh	14.11	0.11	–93.3	–0.49	33.13	2.43**
West Bengal	65.22	1.42	1.36	0.88	–41.26	–1.75**

*Significant at 5% level
**Significant at 10% level
Note: (1) Change in the share of poverty is the simple percentage total growth (Data source: table 4 & 5).
(2) Growth rates of food grain production is the percentage growth rate based on triennial averages of production with central years (Data source: Government of India, CSO, Statistical Abstract, various issues).

period. Assam registered a medium growth rate of 2.01 per cent, which was, however, still lower than it had experienced between 1962-65 and 1970-73. Between 1968-69 and 1986-87, the growth rates accelerated significantly after 1977-78, compared to the earlier part of the decade, in Punjab, Uttar Pradesh and Orissa. They decelerated significantly in Rajasthan, West Bengal and Madhya Pradesh and stagnated in Assam and Bihar.

The most recent evidence suggests that the green revolution has spread to the Eastern states and to crops other than wheat (Rao, 1989). Comparisons between the periods from 1967-68 to 1977-78 and from 1978-79 to 1988-89 reveal that the growth rate of food grain production went up, especially for rice, pulses and oil seeds in the rainfed and dry areas of the four eastern states and Madhya Pradesh.

When we try to establish a relationship between change in share of poverty of different states with rate of growth of food grain production, we face a counter intuitive result. As shown in table 7 out of 39 pairs of share of poverty and growth rate of food grain production, only 12 cases give negative relationship. Surprisingly between the period 1971-72 to 1977-78 though Tamil Nadu registered a statistically significant growth in food grain production its share of rural poverty increases (though a little extent). When the period 1977-78 to 1986-86 is taken the same type of surprising result is noted for Andhra Pradesh, Orissa and Punjab.

Table 7. Direction of change of share of poverty and growth rate of food grain production (Derivation of table 6).

	1961-62 to 1971-72		1971-72 to 1977-78		1977-78 to 1986-87	
	CP	FP	CP	FP	CP	FP
Andhra Pradesh	(–	+	+	+	–	+
Assam	+	+	+	+	+	+
Bihar	+	+	(–	+)	(+	–)
Gujarat	+	+	–	–	+	+
Karnataka	+	+	+	+	+	+
Madhya Pradesh	+	+	(+	–)	–	–
Maharashtra	+	+	(+	–)	–	–
Orissa	–	–	–	–	(–	+)
Punjab	+	+	(–	+)	(–	+)
Rajasthan	+	+	–	–	(+	–)
Tamil Nadu	(–	+)	(+	–)	+	+
Uttar Pradesh	+	+	–	–	+	+
West Bengal	+	+	+	+	–	–

Recommendations

Thus whatever result was taken a decreasing trend of poverty in India was observed. Government of India has realized the significance of alleviation of poverty apart from development strategies and has attended to the problem of poverty, both institutional and economic by instituting a wide variety of specific anti-poverty programmes. But as the scale of the programmes is very small in relation to the magnitude of the problem they are supposed to tackle, the impact is not very significant. The policy prescriptions should not only emphasize the eradication of poverty but one of its aims should be development also. Historically, the absorption of surplus rural man power has followed a definite pattern of development in advanced countries during their phases of economic development. Serious overcrowding and urban unemployment characterise most Indian cities. A solution for rural unemployment lies in the overall development of the economy in the longrun and through undertaking rural works programmes and to create employment for the existing unemployed in the shortrun. Creation of work programmes is also an integral part of Indian Five Year Plans. But the implementation failure poses problem to these programmes. Allocation of funds according to the share of poverty of different states to total poverty is necessary. Though under the scheme of NREP, RLEGP, TRYSEM and several community development programmes, creation of production and durable community assets, building of infrastructure for rapid growth of rural economy etc. were some of the issues, stress was given only on income generation of rural poor (although this income generation is through employment creation the development aspect loses its importance in all respects).

Developing a strategic sector at the periphery of rural and urban economy will give employment to the rural poor. This sector will also help in developing community assets and can give regular supply of inputs to both rural and urban sectors in the form of both means of production and skilled labour. This sector will further help in forming a domestic market for both agrarian and non-agrarian economy.

Some countries are making special efforts to stimulate rural industrialisation — for example, the rural industrial development centres, village polytechnics and technical institutes in Keneya. Those efforts are not likely to amount to much, however, unless the efforts to expand production capabilities by technical assistance and training are matched by an expanding demand for a widening range of products of modest but growing sophistication that can be produced by firms of that nature. The sharp increase in fuel prices, hand in hand with the cost of tractors and spare parts, seem to have a dampening

effect on the enthusiasm for the direct transfer of mechanical technologies from the richer developed countries. By the same token, these conditions are sharpening interest in possibility of resolving labour bottlenecks. The timeliness and precision with which farm operations can be performed by improving animal powered equipment. The gradual spread of many other types of inexpensive equipment are expected to increase the productivity of farm labour and at the same time stimulate progress along the agriculture-industry linkage leading to increases in productivity, output and employment.

Remark

While computing the states' share to the total rural poverty in India for different years we consider only 14 states which have the largest contribution to the total mass of the country. But this process does not give an accurate result. Further detailed study may be carried on using the discussed procedure considering each and every states and union-territories.

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The Peace of the Results

We know not of the future, and cannot plan for it much. But we can hold our spirits and our bodies so pure and high, we may cherish such thoughts and such ideals, and dream such dreams of lofty purpose, that we can determine and know what manner of men we will be whenever and wherever the hour strikes that calls to noble action.... No man becomes suddenly different from his habit and cherished thought.

— *Joshua L. Chamberlain*, General Commander,
20th Maine, Union Forces, Battle of Gettysburg.

Productivity, Expansion & Sustainability Factors in Sericulture

S. Gregory

The factors affecting expansion naturally have their impact on sustainability too, either directly or indirectly. And productivity which is also affected by similar and related factors is itself one of the crucial factors in expansion and sustainability. The factors involved in sericulture can be categorised into material, maintenance, service and personal factors. The paper analyses their intervention with the view to maximise the outcome and increase the returns.

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There is a unanimous opinion among the people who have some knowledge of sericulture, whether they themselves are sericulturists or not, that sericulture is highly profitable and rewarding, provided the risks are minimised and the resources are optimised. The returns in other crops is definitely lower than that from sericulture. And yet one of the major reasons that has often been cited for the displacement of mulberry has been the dismal performance of the last batches of rearing of the respective dropouts. It is also to be noted that there is a higher proportion of dropouts among the new entrants who never took off from the start. This calls for greater attention on the factors of productivity. The experience from the Beneficiary Assessment (BA) studies[1] in Tamil Nadu shows that no clear pattern is discerned along the lines of land size groups regarding the level of productivity. Such an observation could only point out to the possibility of the other intervening factors, operating in the process of cocoon production.

Sericulture is highly profitable and rewarding, provided the risks are minimised and the resources are optimised.

In many of the relatively older sericulture areas, while the area under mulberry is expanding considerably over the years, the number of actual sericulturists has not increased proportionately. Considering the discipline and devotion entailed in sericulture, any aggravation in any one of the factors considered could probably lead to

1. Beneficiary Assessment is a method involving a modified form of participant observation and serving as a people-oriented research-cum-feedback mechanism. For further explanation, see Acharya (1993).

the displacement of mulberry. When productivity is less promising and uncertain and the sustainability of the sericulturists is dithering, expansion becomes its natural victim. It is not uncommon to find in the sericulture villages in Tamil Nadu a low proportion of the sericulturists as compared to the total number of the irrigated land owners.

The factors involved in this phenomenon have been identified as material factors, maintenance factors, service factors and personal factors. The present paper analyses these factors based on the empirical studies of beneficiary assessment, carried out between 1990 and 1993, in different clusters in Tamil Nadu.

Material Factors

These are very basic, essential and crucial factors in any economic enterprise. The same is true in sericulture too. The main motivation of the farmers in taking up sericulture has always been the economic consideration though the other factors follow closely. However, the accessibility of the individuals to the basic economic factors and the required economic capacity needed for the respective enterprises become critical in taking up such initiatives successfully. The factors that are under consideration here include land and irrigation, labour, credit and capital, rearing infrastructure and supportive inputs.

Land and Irrigation: Access to land and irrigation is essential to the undertaking of sericulture. Even if someone has access to both, the suitability of the soil and the adequacy of available water for mulberry cultivation has to be ascertained. Soil type and the level and nature of the irrigation have been widely reported as important factors in contributing to differential yields. The experience of the farmers shows that red soil may be better suitable for mulberry provided adequate water is available. However, the red soil areas in many cases are without adequate sources or irrigation. On the other hand, the water availability is comparatively high in the black soil lands which are believed to be less suitable for mulberry. Moreover, while the water retention capacity is high in black soil areas, the water in these areas is of saline taste which seems to reduce quality of the leaf. Some feel that soil testing could help, in improving the soil conditions. But getting the soil tested involves a cumbersome procedure and also are very difficult to obtain the results.

Mulberry requires multiple proportions of water as compared to any other crop except perhaps paddy and sugarcane. Even if someone has the facility of water throughout the year, not many could afford to take up sericulture within their available water source, not to talk of the other constraints. Well sharing which is most common in Tamil Nadu poses considerable problems especially when all the sharing parties do not possess a mulberry garden. Some farmers are reluctant to take up or have already given up sericulture due to reasons like water constraint, poor soil fertility, far away lands from their dwelling place and the difficulty faced especially during rainy season in transporting the leaf from such distant gardens to the rearing shed.

Labour: Labour is another major concern in sericulture. Even if labour is abundantly available in some areas, not many prefer to do sericulture. In case, when the sericulturists are large or medium farmers, they have been successfully tackling this problem by engaging regular or assured contract as well as casual labour by advancing them loans free of interest. However, family labour, especially one among them should be the main sericulturist to participate or supervise and manage the labour with an expertise in sericulture. The lack of availability of such a person in the family works to be a constraint for those farmers who could afford to take up sericulture. Moreover, even the regular sericulture labourers show least interest in their work though they feel compelled to continue due to their financial constraints.

Credit and Capital: Even the minimum investment needed to take up sericulture is higher than many other crops. For instance, in one of the villages of BA study, the estimated initial investment as claimed by some of the farmers in a relatively progressive sericulture area, is to the tune of Rs. 10,000 even at the minimum level, with a mulberry garden of about 60 cents (one 'kuzhi'). This investment is in addition to the possession of rearing shed with adequate space. This may be the case if one goes for a high cost technology. Thus, the high initial investment obviously restricts those who cannot afford, especially the weaker sections from taking up sericulture.

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What about the credit facilities? The institutional credits have been restricted so far only to the land holders while the non institutional credits of this scale are acces-

sible only to the well-off sections of the society. This rules out the possibility of the landless people taking up sericulture. In spite of these constraints, if someone from the weaker section is fortunate enough to avail the credit facility, there is again undue delay in procuring it, not to tell the amount he has to spend and the difficulties he has to undergo before he could procure it. Further, due to the involvement of collateral and other complications in the event of sanctioning a higher amount, the bankers tend to take a soft option by clearing a smaller amount without much insistence on collateral. Thus, the amount sanctioned is far below the actual need for the purpose. Consequently, by the time the amount is on hand, the farmer is already on his way to losing interest due to crop losses, just waiting only to procure the full credit before he could displace mulberry.

As for the bankers, they do not show much interest in extending credit service to the sericulturists due to the poor recovery rate and lack of repayment linkages. While it is true that many a time the farmers are not prompt enough to repay the loan. It is also true that there is least initiative by the bankers themselves to recover the same. The attitude of the farmers is mainly due to the expectation of a possible loan waiver while that of the latter is mainly due to the fear of political overtones. It is entirely another matter whether the credit amount is always put to use for the intended purpose.

Rearing Infrastructure: Adequate space for rearing the silk worms is a must to take up and sustain successfully in sericulture. For most of the people belonging to the weaker sections, this is not possible as they hardly have any sufficient place even to live satisfactorily. It is a paradox that at times they may have to construct a pukka shed for the silk worms under some credit assistance while they have to accommodate their children and live in a dilapidated hut. The requirement of a pukka rearing shed with adequate space for keeping all the equipment, makes sericulture unfit to become a 'poor man's enterprise'. Thus, this factor either acts as a constraint in going for sericulture or results in poor maintenance and consequently in poor yield.

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Supportive Inputs: The assessment of the poorer performers in the study areas indicate in many cases a poorer application of farm yard manure due mainly to its scarcity and high cost. In some cases, even the awareness level is low regarding the relative significance of this particular input for a better yield performance. In comparison, the application of chemical fertilizer is relatively high though it is still less than the advocated dosages. Some sericulturists do not go for regular disinfection or do it in a casual way due mainly to their lack of awareness. Some others fail to do it because of the non availability of the disinfectants when they are in need of them. All these could result in low productivity.

Maintenance Factors

These are mainly related to the effective utilisation of the available infra structural facilities and prompt attention to the environmental factors. In silkworm rearing, efficient maintenance of the mulberry garden and of the rearing shed as well as proper attention to the growth of the worms and timely identification and control of disease symptoms become the major concerns in enhancing the level of productivity.

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Garden and Rearing Maintenance: Productivity could also reflect the level of garden and shed maintenance. Mulberry gardens well maintained with adequate spacing of the plants, free of weeds and regular irrigation go a long way in converting efforts into high yield returns. In most of the recent plantations of mulberry, this aspect is well taken care of, though the shortcomings have not been completely overcome. A good number of sericulturists in the studied clusters, either own a separate shed or a separate room for rearing. However, variant picture could be discerned, in providing the sheds with adequate ventilation and keeping the surroundings clean which is reflected in the yield levels. Here again, the casualty is the weaker sections. The shortcoming in this respect could well be taken care of with a little effort in educating the concerned sericulturists about their adverse effects

which they themselves experience but not adequately aware of.

In some areas, these aspects are well taken up. In fact, some of the leading sericulturists in the progressive areas even possess a separate space for keeping the trays and chandrikes safe. Such maintenance which is part of a 'high cost technology', demands adequate space and investment which sometimes act as a major constraint especially for the weaker sections to take up sericulture.

Disinfection, Disease Control: This is an important factor that contributes to the yield performance. Efficient disinfection of the shed, the timely detection of disease and appropriate application of disinfectants could definitely enhance the yield performance. There seems to be a clear correlation between the level of disinfection practices and the yield level. As for the disinfectants, the better yield level farmers mostly go for fumigation of formalin in the rearing shed before taking up any rearing. Some stop with washing the room with bleaching powder. Some resort to the white washing of the room after a failure or after every 3 batches.

During rainy season if there is continuous rain, the preservation of the leaf becomes a problem; to dry them, almost all of them use fans. Experience and know-how in sericulture naturally lend some credence in the performance level as they increase the competence of the rearers.

Service Factors

These are essentially the institutional efforts in extending the service on specific aspects in developing sericulture. The major aspects that are found to be crucial in the present context and considered here are the laying supply, market facility, training and extension.

Laying Supply: Government grainages have been established for the benefit of sericulturists. With the coming of more and more private grainages, their service is expected to be at the competing level. However, the farmers are not satisfied with the quality of the laying supplied by these grainages. It is a constant complaint that the poor quality of the laying causes them considerable strain, resulting in poor returns. Whichever may be the source of supply, differential quality of the layings has been the experience of almost all sericulturists. Even the layings of the same lot have shown differential quality resulting in highly varied performances as evidenced in the field level data.

For instance, one particular lot of a particular source has produced a good yield for Rajan and Raman who are medium level sericulturists. However, Balan and Murugan who are successful sericulturists for years, noticed disease symptoms at the second instar itself. They took the worms for testing and it was found to be prebrine-infected and subsequently the whole lot was rejected.

Though such instances are not uncommon and the sericulturists are aware of it, they generally base their choice, apart from their own individual performance, on that of others during the same period of time and particularly for the same lot. However, due to the uncertainties of the laying performance as seen above, the farmers wait for some more batches before making any change of source. At other times, in spite of fairly good yields of one source, one could still prefer another for the next batch, may be because of its perceived better quality as proved in the cases of many neighbours or friends or due to the overall scarce situation of the laying, or merely as a matter of convenience, as for example if one could combine the marketing of cocoons and the procuring of layings (called dfls or disease free layings).

In some cases, in spite of every precaution, the switch-over itself has turned out to be a 'bad time' or 'bad luck' as it has only ended in moving from bad to worse, only to give up sericulture itself. As one of the rearers emphatically asserted, if only the sericulture department pays adequate attention in providing quality laying, there would be future for sericulture.

It has been felt by some that the poor quality laying is due to more than one crossing or due to the unsuitability of the seed cocoons of some other area to the grainage area. Some have expressed concern over the mode of transporting the seed cocoons to the grainage which could lead to secondary contamination. If greater care could be extended to the preparation of the laying, atleast to a certain extent it would reduce the risk factor and thereby the crop loss to a great extent and thus provide relative surety for an ensured crop. While this could definitely contribute for greater sustainability, it would also motivate many more to take up sericulture.

If greater care could be extended to the preparation of the laying, atleast to a certain extent it would reduce the risk factor provide relative surety for an ensured.

In this context, the rearers expect further effective measures to contain the silkworm diseases. They also point out the need for further revitalisation of the research mechanism to come out with still better hardy races which would be less vulnerable to silkworm diseases. Further, they feel the need for an intensive research that would improve the technology for removing or atleast reducing the unwarranted hardships and also the unnecessary cost of production and labour. The rearers also would like to see that they get quality laying on time even during the demand season. As there is also variation in the performance of the different races in different areas, this factor is also to be taken into consideration in the supply of layings. As one of the rearers, emphatically asserted, if only the sericulture department pays adequate attention in providing quality laying, no one need to have any apprehension about the future for sericulture.

Marketing: Another significant service provided by the department is the provision of marketing facility. The sericulturists in this village go to different markets sometimes even outside the state (though there seems to be a decline in this trend in recent times), depending on the following aspects:

- Price conditions
- Quantity of cocoon produce
- Combining other needs like procurement of DFLs etc.
- The urgency for cash (wherever there is immediate cash payment, that market is preferred)
- The company of other parties (like a pleasure trip)

Some sericulturists have expressed that in some of the local markets, the number of reelers are not in proportion to the quantity of cocoons available in the area and so, this reduces the competition and the subsequent price level.

The price of the cocoon in the first part of 1992 went upto Rs 200 which was heartening to the sericulturists though the dfl price also shot up to about Rs 750 as in the case of private sources. Just a few months earlier to that, the dfl price was just around Rs 110 and the average cocoon price around Rs 100. However, there was a sudden fall in the price of cocoons to a record low of Rs 50 while the dfl price was still up with Rs 350 or so. This made the sericulturists panicky and threatened. They argued that while the price of other agricultural crops were still a record high, how could one except the sericulturists to continue their enterprise at this rate. Though this could be on an exaggeration, the fear itself is found to be genuine. Fortunately, within a short span of time they could come out of their shock though not fully as there was a normalisation of prices to the level of about Rs 80 to 100. As the sericulturists perceive, at the prevailing price index if one could draw some gratification out of sericulture, the prices of cocoon should cross atleast Rs 130. This, they feel, with the quality laying would definitely boost the image of sericulture and thereby further expansion without any displacement.

Training: Equipping oneself with the knowledge of sericulture is essential for its successful accomplishment. The best way the Sericulturists acquire their know-how is through their own experience coupled with their own observation of, and interaction with, their friends or relatives sericulturists and from the guidance received from some committed extension staff. However, this may not suffice or be applicable in all cases. To supplement the self learning, the Department of sericulture extends its help by way of conducting training in sericulture for potential and needful sericulturists. There should be right identification of the trainees who should at the first instance, have a motivation for it. There is ample evidence to show that the impact of the training on the sericulturists is very positive and substantial. However, demonstration of the advocated packages has a better appeal and has to be evolved into the curriculum of the training wherever it is absent. And any training will have its intended effect only when it is followed up with practical solutions in the existing conditions. The training should also impart to the trainees, the ability to adopt to the local conditions what has been learnt in the formal forums.

Equipping oneself with the knowledge of sericulture is essential for it successful accomplishment.

Extension: The performance level of the sericulturists in an area should normally reflect the efficiency of the field staff. The latter's role is considered to be crucial especially for the poorer performers and the new sericulturists. The extension staff should be equipped with adequate training and practical tips to guide and convince the sericulturists whenever it is needed.

The experienced sericulturists perceive the extension staff as redundant and their visits as a mere routine. The view of other sericulturist too, is not much different either. However, the old sericulturists do recollect the good services of the extension staff they received by way of advice and guidance when they were in the infancy in sericul-

ture. Even today, if the extension staff has anything new or innovative to convincingly offer, they would be welcomed. But unfortunately, the extension staff today seems to be taxed with so many impertinent task and target oriented objectives that they sometimes miss the actual focus. What is needed most is a change in the whole strategy replacing the sericulture-specific approach to a family-based and a holistic approach. The extension should also learn to listen sometimes to understand the traditional wisdom of the farmers which many a time proves to be right. They should also develop a selective approach towards the weaker resource and poor performing groups.

It should be noted here that there is always a kind of expectation by the sericulturists of the benefits from the government by way of credits and other programmes. Programmes like training, sometimes, become handy for the field officials to pacify the interests of some such sericulturists to sustain them in sericulture and keep up their smooth relationship with them. In this process, the actual intention of the programmes, at times, gets distorted. While it is entirely justified to provide some sort of incentives for the successful sericulturists to keep them encouraged and to make others motivated, it should not be at the cost of the programmes with different and distinct objectives. Similarly, care should be taken in initiating new entrants into sericulture so that monetary related programmes like training and credit assistance alone should not be the sole motivating factors for taking up sericulture. Generally, the sericulturists do not show any hostility towards the extension staff lest they lose any favours that might come through the department. And also they realise that they need the favour of the extension staff in procuring laying especially during the demand season.

In many areas, the farmers have expressed a need for a worm testing centre at a nearby place, preferably in the village itself where there is considerable number of sericulturists. This would facilitate, they feel, in rejecting the diseased laying at the initial stage itself. If the extension staff could help them in getting the worms tested at the initial stage itself, in case of disease symptoms, that would be very much appreciated by the sericulturists.

Above all, there should be a sympathetic approach towards the extension staff. They should be provided with adequate incentives and given proper recognition. They should also be encouraged to air their views on different things like the problems in the identification of the right beneficiaries. And also they should be taken into confidence in setting any targets if the targets are to be realistic.

Personal Factors

This would include the personal traits like age, sex, education etc., personal interest and involvement, technical efficiency and the individual's health compatibility. These factors play a crucial role in the success of sericulture.

Personal Traits: This could include the various characteristics and personality features of an individual which could play a major role in the successful performance of any enterprise. Sericulture is not an exception to this. In fact, more than in anything else, this factor has proved to be crucial especially in sericulture and in its performance. An observation of the field data shows that it is always the youngsters between the age group of 20 and 30, who plunge into sericulture and the spirit subsides as they grow in age. This is reflected in their yield performance too.

Educational level is also seen as having considerable influence in the level of sericulture performance. One can discern a better performance by relatively higher educated individuals though it may not be absolute. In many of the clusters, sericulture provides an attraction to the secondary and college educated or drop outs. The personal interest is also a matter of fact that reflects in the performance level of the rearers.

Interest and Involvement: The nature of sericulture work is such that it demands a personal interest and involvement of atleast one member in the family to make it a successful enterprise. The personal involvement is necessary in attending to the rearing with care and in time. The involvement also entitles a certain amount of sacrifice and to give up certain commitments or leisure. This cannot be expected from hired or contract labourers unless the entrepreneur himself works along with them or behind them. This has been realised by almost all sericulturists and even by non-sericulturists too. In almost all sericulture households, there is one person who takes special care of sericulture work and in fact, even in those households where contract labourers are employed, the chawkie stage or atleast till the first moult is personally taken care of, before changing hands to the labourers. Further, their own supervisory and personal involvement role continues. However, due to various reasons, the degree of involvement may vary resulting in varying yield levels. One may not take up sericulture at all for the same reason and another, in changed cir-

cumstances, may get out of sericulture for the same reason either by his own realization of his inability or forced out, due to its manifestation in the poor yield performance.

Technical efficiency: This is very important for the right pursuance of the enterprise. The level of efficiency would definitely reflect in the yield performance. Efficiency could be gained through experience, training and a healthy interaction with neighbours and the extension staff. For all these one should also possess a critical mind, humility and curiosity to learn. Many of the successful sericulturists are testimony to this character.

Health Compatibility: This is another critical factor that comes in the way of expansion and sustainability of sericulture. Silk worm rearing involves certain health implications, like breathing problem, asthmatic complaints etc., to certain body types which also come in the way of expansion and sustainability.

Conclusion

People tend to choose a crop which is less labour intensive, risk free, cost effective and higher yielding. They also base their choice on the existing or emerging status of different crops. There is no doubt that sericulture yields high returns and has proved to be a successful enterprise. But, at the same time it has got handicaps as well, on its own and also in its relevance to the weaker sections which need to be considered and looked into. Unless sericulture proves to be highly remunerative to combat its heavy odds, it can not continue to be a very attractive enterprise for all ages. While efforts should be on to expand sericulture, the attention should not be any less in combating the productivity constraints and consolidating the existing sericulture.

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Industrial leaders must communicate. The gulf must be bridged between what management knows, because they have access to a lot of information, and what employees believe, often in ignorance.

—Sir Marcus Sieff, Chairman
Marks and Spencer

Feature

Production & Marketing of Milk in Organised Sector

T.R. Shanmugam

In India, the growth of milk production is five per cent per annum and it is largely because of concerted efforts made by the organised sector during the last two decades. However the milk marketing is uneven in India because private sector handles 85 per cent of the output. For even distribution of milk it is necessary to enlarge the role of organised sector by vertically integrating production and marketing of milk, recommends this study.

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India is in the second largest milk producer in the world about 54 million tonnes of milk per annum. The annual growth rate of milk production in the country is currently five per cent. With this growth rate, it is expected that the milk production in India would overtake that of United States by 2000 A.D. However, India's per capita consumption is not so high (65 kgs per year) when compared to the world average of 100 kgs per year. The growth of milk production has been remarkably high over the last two decades due to concerted efforts made by the organised sector but the marketing of milk is not even in India. Studies show that the top 10 per cent consume 30 per cent of milk while the bottom 30 per cent manage with 10 per cent of milk. The milkmen and vendors handle about 85 per cent of the marketed milk leaving only the remaining 15 per cent to the organised sector and dairy plants. It is necessary to procure, process and market milk through the organised sectors to feed the larger population in the cities and to provide remunerative prices to the rural milk producers. It is in this context that the present study deals with the economics of milk production and marketing in the organised sector.

The growth of milk production has been remarkably high over the last two decades due to concerted efforts made by the organised sector.

Methodology

A survey was conduced in Erode Taluk, Periyar District of Tamil Nadu State. Five co-operative milk producing societies were selected randomly. All the five societies are vertically integrated with Tamil Nadu State Milk Producers Union. In each society, ten member-

farms were selected randomly for the production and marketing analysis. Thus a total of 50 farms were selected through the multistage random sampling procedure. In each farm, two cross bred cows in lactation were selected randomly for further analysis. Data were collected by personal interview with the farmers and relate to the year 1992-93. Feed-milk data were collected both in the morning and evening by actual weighing of 100 crossbred cows throughout their lactation at a regular interval of one week.

The principal justification for the use of milk production function was that the variables assumed to influence milk production were those which the farmer could readily observe and control to attain efficient yield. Formalising this concept, milk production per cow could be written as a function of concentrate consumed per day and roughages (green fodders) taken per day. Examination of the scatter diagram showed strong non-linear relationship between dependent and independent variables. Translog production function was preferred over Cobb-Doughlas type since the former is flexible, simple for applying shepherds daulity theory and for deriving translog cost function, is capable of several possible interpretations and helps to study the interaction effects of the independent variables. The function developed by Christensen, Jorgenson and Lau in 1972 was modified and used in the present study. The estimable form of the production function for the present analysis with two independent variables is given as:

$$\ln Y = \ln \alpha_0 + \alpha_1 \ln X_1 + \alpha_2 \ln X_2 + \gamma_{11} \ln X_1^2 + \gamma_{22} \ln X_2^2 + \beta_{12} \ln X_1 \ln X_2 + U_i$$

Where,

Y = Milk yield in kgs per annimal per day of lactation

X_1 = Concentrate consumed per day per cow in kgs.

X_2 = Roughage consumed per day per cow in kgs.

U_i = Random error term

γ_{11} = $1/2\ \beta_{11}$

γ_{22} = $1/2\ \beta_{22}$

α_0, α_1, α_2, γ_{11}, γ_{22}, β_{12} are the parameters to be estimated.

The marginal product is estimated with respect to i^{th} input as follows:

$$MP_i = \left[\alpha_i + \frac{1}{2} \sum_{j=1}^{n} \beta_{ij} \ln X_j\right] \left[\frac{Y}{X_1}\right]$$

The marginal value product (MVP) is calculated by multiplying marginal product with output price.

The elasticity of production with respect to i^{th} input is estimated as:

$$EP_i = \left[\alpha_1 + \frac{1}{2} \sum_{j=1}^{n} \beta_{ij} \ln X_j\right]$$

It is obvious that elasticity of production varies with the levels of input.

The Logit model was used to investigate the milk selling behaviour of the selected fifty farmers. The logit model postulates that P_i, the probability that farmer i sells the milk through the organised sector is a function of an index variable Z_i summarising a set of individual attributes.

$$P_i = F(\beta' X_i) = \frac{1}{(1 + e^{-(\beta' X_i)}}$$

Where,

β is a $(K \times 1)$ vector of coefficients.

X_i is a $(K \times 1)$ vector of farmer's attributes.

and e is the base of natural logirthm.

The index variable Z_i is a dichotomeus variable, that is, it takes the value of one if a farmer sells milk through the organised sector and it takes the value zero, otherwise (when the markets through the unorganised sector).

Z_i has been shown to be the logirthm of the odds ratio.

$$Z_i = \log (P_i/1 - P_i) = \beta' X_i$$

It is estimated through maximum likelihood estimation procedure. Within the logit framework described above, it is postulated that the probability of a farmer selling milk through the organised sector depends upon attributes like family size, number of dairy animals, average price received per kg of milk in the organised sector, distance to the co-oeprative society and farm income. The function can be written as:

Z_i = Intercept + β_1 (family size) + β_2 (number of animals) + β_3 (price) + β_4 (distance) + β_5 (farm income)

The probability of a farmer selling milk through the organised sector depends upon attributes like family size, number of dairy animals, average price received per kg of milk in the organised sector, distance to the co-oeprative society and farm income.

Production

The average milk yield per cow per day was 8,2 kgs. The average concentates and roughages (green fodders) consumed per day were 1.9 kgs and 20.4 kgs respectively. The average price received Rs. 5.60 per kg and it was given by the co-operative societies based on the fat content. The estimated co-efficients of translog milk production function are presented in table 1. The equation has reasonable R^2 of 0.64 confirming the appropriateness of the production function selected fror the study. As expected, the square terms of both concentrates and roughages were negative indicating diminishing returns at higher input application as evidenced from the sign of both the square terms. The interaction term was positive and significant at one per cent level and it was in accordance with the expectation. The estimated co-efficients for the concentrate and roughage consumed per day had the *a priori* expected signs and were statistically significant confirming the operation of rational stage of the production function. Form the estimated results, marginal physical product (MPP), marginal value product (MVP) and elasticity of production (EP) were derived and are presented in table 2.

Table 1 : Translog Production Function for Milk

Particulars	Variables	Regression co-efficient	Standard error	t value
Intercept	—	1.782	0.904	1.971*
Concentrate consumed per day (kgs)	X_1	0.461	0.117	3.936**
Roughage consumed per day (kgs)	X_2	0.392	0.092	4.261**
Square term of Concentrate	X_1^2	– 0.183	0.076	– 2.408*
Square term of Roughage	X_2^2	– 0.276	0.143	– 1.930*
Interaction term as Concentrate multiplied by Roughage	X_1X_2	0.549	0.186	2.951**

R^2 = 0.641
N = 100
* Significant at five per cent
** Significant at one per cent

Table 2: Marginal Physical Proudct, Marginal Value Product and Elasticity of Production

Particulars	Concentrate	Roughage
MPP	4.74	– 0.09
MVP	26.54	– 0.50
EP	1.12	– 0.23

The milk production would increase by 1.12 per cent for one per cent increase in concentrates keeping the roughages at their mean level. The positive sign for the elasticity of production of concentrates indicates that this input had been under-used in this locality. This might be due to higher cost of the concentrates supplied by the co-operative societies. The negative sign for the elasticity of production of roughages indicates that this input had been over-used in the study region. It might be due to the abundant supply of paddy straw in the study area and the fact that the green fodders were produced at the farm itself with low cost of production. The result reveals that milk production could be increased by resource reallocation in favour of concentrates. The MPP for concentrates also implies that milk production would increase by 4.74 kgs if the concentrates consumption is raised by one kg, keeping the roughages at their mean level.

The milk production would increase by 1.12 per cent for one per cent increase in concentrates keeping the roughages at their mean level.

Marketing

To analyse the selling behavour of milk producers in the organised sector, the logit model was estimated using the method of maximum likelihood. The MLE of the co-efficients of the logit model are presented in table 3. The specified logit model fits very well the data as indicated by the λ test which was significant at one per cent. The high level of McFodden ρ^2 obtained for the logit model attested the predictive ability of the model. All the estimated slope co-efficients were statistically significant and were in accordance with *a priori* expectations. The independent variables such as family size, distance from

Table 3 : MLE Co-efficients of the Logit Model

Particulars	Co-efficients	Asymptotic error	t value
Intercept	0.861	0.459	1.876*
Family size	– 0.037	0.016	– 2.312*
Number of milch animals	0.214	0.127	1.739*
Price received	0.186	0.084	2.214*
Distance	– 0.009	0.004	– 2.250*
Farm income	– 0.012	0.005	– 2.410**
λ test	531.24**		
McFodden ρ^2	0.76		
Sample size	50		

*Significant at five per cent level
**Significant at one per cent level

the society and farm income had negative signs but were significant. It suggested that longer the distance between the farm and the society, the lower the odds of a milk producer being a seller through the co-operative society. It might be due to lack of conveyance and infrastructure facilities and transport cost incurred by the producers while selling. Farms with higher income revealed less selling of milk in the organised sector because of upward shift in the home consumption, milk being an income elastic commdity. Larger the family size, the lower the odds of a producer's milk sold through the organised sector. It might be due to the greater household requirement. The average price received and the number of milch animals per farm were positive and significant variables. The higher the price, the greater the odds of milk being sold through the organised sector. It showed that the price is the most important variable in inducing milk supply to the organised sector. The larger the number of milch animals the greater odds of a producer being a seller of milk in the co-operative society. It might be due to certain advantages such as easy marketability, credit access, immediate cash payment, input supply and veterinary services rendered by the organised sector.

The price is the most important variable in inducing milk supply to the organised sector.

Summary

The production function analysis established that the concentrate is the crucial input in determing milk yield. The elasticity of production for the concentrate implied that the milk production would increase by 1.12 per cent for one per cent increase in concentrate, keeping the roughage at its mean level. The average concentrate consumed is 1.9 kg per day per animal. At present, it is under-used due to higher cost of concentrates supplied by the organised sector. The farmers could be encouraged to have their own feed mixing unit with cheap ingredients. This might reduce the cost of feed and thereby induce higher usage of feed for the milk production. The logit analysis sugested that the farmers may be encouraged to have more number of milch animals by raising the credit limit and animal husbandry facilities. This would increase the marketable surplus of milk in the organised sector. Though the price would influence milk supply as evidenced from the study, consumer welfare has to be considered in fixing the milk price. Infra-structural facilities should be develped in the remote areas for easy accessability and quick transportation of milk. □

The farmers may be encouraged to have more number of milch animals by raising the credit limit and animal husbandry facilities. This would increase the marketable surplus of milk in the organised sector. Infra-structural facilities should be develped in the remote areas for easy accessability and quick transportation of milk.

State of Indian Environment

Table 1: State of Ambient Air Quality in 15 Major Cities of India in 1989. Information on National Ambient Air Quality Monitoring Stations (All values are based on 24-hourly averages only)

	All values in Micrograms per cubicmetre								
	Sulphur Dioxide			Nitrogen Dioxide			S.P.M.		
	Avg.	Min.	Max.	Avg.	Min.	Max.	Avg.	Min.	Max.
** City: AGRA									
* Location: Taj Mahal	19.7	3.3	64.0	10.3	3.2	21.0	438	170	2016
* Location: Jaipur House	10.2	3.0	30.8	5.8	3.0	18.0	355	145	725
* Location: Agra University	10.4	3.0	30.5	5.2	3.0	13.3	360	135	662
* Location: E.S.I. Hospital	9.8	3.0	26.7	5.1	3.0	11.0	330	83	614
** City: ANAPARA									
* Location: Anapara Colony	45.3	5.7	161.4	34.1	6.1	60.1	236	81	607
* Location: Renusugar Colony	50.7	8.8	96.1	36.5	7.9	63.4	345	101	1331
** City: BARODA									
* Location: Nyaya Mandir	17.8	4.5	142.5	16.4	1.9	145.8	424	50	1780
* Location: Bapod	14.9	2.3	109.8	11.6	1.9	59.6	350	46	1363
* Location: Makarpura	22.3	3.5	207.2	15.0	3.3	82.4	300	31	902
* Location: Gujarat Pollution Control Board Office	16.9	1.3	138.1	11.6	1.8	90.1	299	26	74
** City:COCHIN									
* Location: Kalamassery	3.2	0.5	39.8	17.0	1.4	131.1	105	27	433
* Location: Tripunithura	3.8	0.5	16.7	17.9	1.2	137.3	110	31	360
* Location: Kadavanthra	5.5	0.2	27.8	27.8	4.5	136.3	136	62	281
* Location: Error	10.5	0.5	57.5	25.9	1.5	110.6	125	30	317
* Location: Irrupannam	3.6	0.5	28.1	18.5	0.5	225.0	112	31	305
** City: HALDIA									
* Location: WBIDC	4.7	0.0	46.4	17.5	0.5	64.8	151	50	280
* Location: Super Market	12.4	0.5	105.6	23.2	0.5	110.2	406	80	1091
** City: HOWRAH									
* Location: Municipal Corporation	87.5	4.7	229.8	108.2	33.1	362.7	552	41	1093
* Location Bandhaghat	29.4	4.1	147.2	95.3	23.0	310.7	275	71	628
* Location: Naskarpara Pump House	74.9	3.5	350.5	91.8	12.0	185.1	349	130	619
* Location: Bator Power House	22.9	2.2	97.0	73.1	17.3	259.5	256	80	615
** City: JHARIA & DHANBAD									
* Location: R.O. Dhanbad	22.6	9.6	37.8	24.4	5.6	41.3	268	53	694
* Location: R.S.P. College Jharia	27.2	12.2	53.7	31.1	16.7	50.8	387	262	510
** City: KOTA									
* Location: Akelgarh (R.O.)	26.9	3.6	65.5	75.2	24.8	358.1	269	128	598
* Location: Anantapura	27.6	4.5	71.2	99.1	21.3	292.3	208	80	471
* Location: Borkhera	15.8	4.6	48.1	60.8	20.3	165.6	137	50	309
* Location: Raipura	26.5	3.3	114.3	116.8	18.3	460.3	262	75	607

	All values in Micrograms per cubicmetre								
	Sulphur Dioxide			Nitrogen Dioxide			S.P.M.		
	Avg.	Min.	Max.	Avg.	Min.	Max.	Avg.	Min.	Max.
* Location: Veterinary Hospital	24.1	3.6	64.0	91.7	32.8	265.9	227	108	580
** City: MADRAS									
* Location: Kathivakam	26.3	0.5	160.6	22.2	2.0	81.1	180	55	384
** City: MYSORE									
* Location: Institute of Education, Saraswathipuram	11.9	1.4	29.2	5.9	0.0	23.5	66	8	193
* Location: K.R. Circle									
Visweseraiya Bldg.	13.6	2.0	43.2	8.8	0.0	45.8	136	19	532
* Location: KAID Buidling Metaguli	11.2	1.9	45.9	17.8	1.3	101.7	66	10	238
** City: SHIMLA	3.7	0.4	28.4	15.4	1.2	48.1	180	11	563
* Location: Tekka Bench, Ridge									
* Location: Bus Stand	3.1	0.5	16.3	18.6	2.9	44.5	348	45	934
** City: SINDRI									
* Location: FCI Main Hospital	29.4	12.8	51.1	30.4	15.0	68.3	287	56	1052
** City: SURAT									
* Location: SVR Engg. College	11.5	4.3	62.2	41.9	9.8	166.65	120	6	406
* Location: BRC Udhana	28.4	4.0	88.2	38.9	8.7	148.5	161	43	526
* Location: A.I.R. Building	18.9	4.0	100.7	33.4	8.8	89.0	378	68	792
** City: VASCO									
* Location: Vasco	4.4	1.0	10.3	12.8	4.0	29.5	144	12	408
** City: FARIDABAD									
* Location: R.C. Lothi No. 63 Sector 9	31.3	16.7	39.5	12.6	6.8	20.0	275	139	425
* Location: Escort Medical Centre	30.8	17.2	39.3	12.4	4.7	26.8	281	157	415

Source: Ministry of Environmental & Forests Environment Action Programme: India, 1993

Table 2: Statewise Position of Water Supply Wastewater Generation, Collection and Treatment in Class II Towns (1989)

Sl.No.	State/Union Territory	Total No. of towns	Population 1981 Census	Total Water Supply (MLD)	Per Capita Water Supply (LPT)	Wastewater (MLD)		Wastewater treatment capacity (MLD)	
						Generated	Collected	Primary Only	Primary and Secondary
1.	Andhra Pradesh	26	1713475	111.03	49	88.46	1.00	0.00	0.00
2.	Bihar	10	648643	43.11	49	34.46	0.00	0.00	0.00
3.	Gujarat	23	1542683	151.56	79	121.23	8.65	4.50	20.25
4.	Goa	2	122760	13.00	82	10.60	1.00	0.00	0.00
5.	Himachal Pradesh	1	70604	23.61	282	18.88	0.00	0.00	
6.	Haryana	6	395243	39.74	77	31.78	9.37	0.00	0.00
7.	Karnataka	12	808375	64.37	62	51.49	0.00	0.00	0.00
8.	Kerala	7	456275	88.74	182	70.98	0.00	0.00	0.00
9.	Maharashtra	22	1491042	191.82	101	153.46	10.00	—	1.40
10.	Madhya Pradesh	23	1553516	162.84	82	130.27	5.82	0.00	0.00
11.	Mizoram	1	74493	2.17	16	1.74	0.00	0.00	0.00
12.	Orissa	5	320383	35.09	73	28.07	0.00	0.00	0.00
13.	Punjab	10	665318	112.49	129	90.01	16.33	0.00	0.00
14.	Rajasthan	10	660790	44.80	51	35.87	0.00	0.00	0.00
15.	Tamil Nadu	39	2611397	200.91	64	160.74	3.20	—	0.00
16.	Uttar Pradesh	27	1891631	239.73	99	191.75	6.60	0.00	0.00
17.	West Bengal	17	1306780	97.14	64	77.73	0.00	0.00	0.00
	Total	241	16333408	1622.15	(78)	1297.52	61.97	4.50	21.65

Figures in parenthesis shall not be read as total.

Source: Ministry of Environment & Forests, Environment Action Programme; India, 1993

Waste Minimisation Audit in Small Pulp & Paper Mills

NPC Pollution Control Division

As on 1992, there were 311 small scale pulp and paper pulp in India. The total installed capacity of these mills is 2.0 million tones per year, i.e. about 57% of the total installed capacity of Indian Paper industry. The average installed capacity of a small paper mill has been found to vary from 25 tonnes to 50 tonnes per day. The raw materials used by these mills comprise rice and wheat straw, different kinds of grasses, bagasse, jute, cotton rags & linters, waste paper and purchased pulp. While about 60% of the total installed capacity used a

Table 1: Waste Minimisation Options

LONG TERM OPTIONS	MEDIUM TERM OPTIONS	SHORT TERM OPTIONS
1. Wet cleaning of Raw material	1. Installation of consistency indicator	1. Reduction in Alum consumption
2. Installation of multi stage vacuum washer	2. Installation of double felt after couch roll	2. Refining of pulp in hot alkaline condition
3. Installation of Broke pulper	3. Installation of Disk Mill	3. Separate tank and pump for the edge cutting nozzle
4. Solar Evaporation pond for black liquor disposal	4. Couch pit modification	4. Installation of fibre savers
5. Handling and disposal of Black liquor in anaerobic digestors	5. Installation of multiplex filter	5. Adjustment of edge cutter
6. Chemical Recovery from Black Liquor	6. Screw press for pulp dewatering	6 Appropriate collection of screen rejects
7. Bailing of Straw	7. Bleaching with NaOCl	7. Covering of conveyor from cutter to digestor
8. Removal of leaves from elephant grass	8. Bleaching with H_2O_2	8. Modification of Digestor loading Chute
9. Recovery of Lignosulphates from BL	9. Lignin removal process	9. Covering of all Vibratory screen and chemical dosing tanks
10. Installation of Twin-wire belt press for pulp dewatering	10. Pulp Consistency regulator	10. Dyke arrangement from cutter to paddle mixer
11. Installation of High velocity hood	11. Installation of rifflers for Centricleaner wastewater	11. Dyke arrangement from paddle mixer to digester
	12. Modification of Rag Pulp dumping area	12. Modification of Raw material dedusting screen
	13. Substitution of cooking chemicals	13. Initial thickening of pulp without water addition in potcher
		14. Fresh water substitution by back water in Johnson Screen, Transfer Pumps & pulp washing
		15. Handling of Lime sludge from
		16. Decker filtrate recirculation in unbleach potcher
		17. Recovery of fibre from fan pump pit overflow
		18. Installation of spring actuated self closing valves for all pressurised hosepipes
		19. Raw material dust handling

combination of all these raw materials, only 30% and 10% utilised exclusively agricultural residue and waste paper respectively.

Waste Minimisation Measures

With the present installed capacity level, chemical recovery system are not found techno-economically viable. Detailed pollution audit studies carried out by the NPC during 1992-93 in 3 different Agro based mills using bagasse, rice/wheat straw, waste paper and imported pulp indicate that it is feasible to reduce the pollution load, thereby by capital and recurring expenditure on wastewater treatment systems. The objective of NPC studies is to identify the possible waste minimisation measures like, water conservation, fibre recovery, segregation of black liquor, improvements in pulp washing efficiency etc. A summary of the measures is given in Table-1. The fibre loss from the paper machine approach system alone has been found to vary from 2% to 10% of the production capacity, Recovery of fibre has been found to be feasible within the paper machine approach system by effective recirculation of whitewater. For further recovery of fibre from the wastewater overflow and subsequent recirculation of whitewater to pulp washing activities, an equilisation tank-cum-external fibre recovery system (such as save all, sedimentation tank, Flotation system etc) is required.

Of the total BOD/COD load, more than 70% is contributed by pulp washing activities, Segregation of black liquor (initial spent cooking liquor pulp washing discharge) from pulp washing stage and it's evaporation in an appropriate solar evaporation pond has been found possible for units having production capacity less than 40 tonnes per day. The range of combined waste water characteristics and specific pollution load before and after waste minimisation is presented in Table-2. Economic evaluation of implemented options is presented in Table-3.

Table 2: Comparative Analysis of Data Before & After Waste Minimisation

Parameters	BEFORE	AFTER
Flowrate (m^3/t)	170-133	140-100
BOD mg/lit	1504-929	1220-715
BOD kg/t	200-140	130-100
COD mg/lit	7629-4575	6700-4052
COD kg/t	1010-700	730-600
TSS mg/lit	2550-1020	1605-923
TSS kg/t	340-160	225-130
TS mg/lit	8402-6319	6030-4805
TS kg/t	1210-980	800-640
OPERATING COST OF ETP Rs./ton	1200-840	1010-700

Table 3: Economic Evaluation of Implemented Waste Minimisation Options

ITEM	VALUES
1. Total capital investment	Rs. 1.95 — 3.12 Million
2. Annualised operating cost	Rs. 1.40 — 2.40 Million
3. Savings in effluent treatment cost	Rs. 1.50 — 1.60 Million
4. Total savings	Rs. 4.60 — 11.3 Million
5. Overall Payback period	4.40 — 11.0 Months

Compiled by
Shisher Kumar
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News & Notes

Managing Water Resources in Megacities

Representatives of the cities of Bangkok, Beijing, Delhi, Jakarta, Karachi, London, Manila, Seoul, Singapore and Tokyo met in Manila, 24-27 August, to discuss strategies for managing water resources to ensure the sustained supply of affordable, safe water for the largest cities of Asia. Also participating in the meeting were representatives of external support agencies and the Asian Development Bank staff. Beyond the basic agreement that there is considerable scope for mutual assistance among Asia's largest cities, several other conclusions were reached.

One conclusion was that "if you cannot measure it, you cannot manage it". It was agreed that the basis for good management of water resources of adequate monitoring of quantity and quality of water. Responsibility and funding for this activity must be assured on a long-term basis, and the roles and means of coordination of all agencies in the water resources sector must be clearly defined. A water resources master plan should be developed based on river basin management, and legislation affecting water resource management must have high priority. Urban planning should integrate water planning with land use, housing and environmental protection. Before developing new water sources, demand should be met through demand management.

With regard to economics and demand, it was agreed that increased efforts must be made to estimate demand and understand its determinants in an economic sense. Revenue estimation should be based on demand information and long-run marginal cost rather than financial cost. Demand management through penalty pricing of heavy consumption is generally accepted as necessary. Both economic and financial costs should be estimated, with the economic costs, including external environmental costs and opportunity costs, and water should be managed as an economic good as well as a social good. Subsidies, when used, should be transparent and directed primarily to benefit the urban poor.

It was agreed that utilities should develop strategy statements or corporate plans as the basis for planning and management, and that governments should make clear policy statements on tariffs and then allow utilities to administer those policies. Recognizing that attempts to reduce unaccounted-for water generally have been less than successful, it was suggested that basics such as leak repair, adequate metering, and user registration and mapping be addressed before employing leak detection equipment. Adequate maintenance must be undertaken. It was agreed that a flexible approach to the urban poor is necessary.

The meeting concluded that the outlook for Asia's megacities in the management of water resources is positive, and that there are a number of reasonable interventions that can be undertaken to improve current situations.

Source: Asian Development Bank, Research Bulletin, May-Aug 1993.

Integrating TQP, QC Circle and ISO 9000

Total Approach to Quality, popular management concept today, is an essential strategy that companies adopt to stay competitive. 'Total' because the implementation has to be systematic and integrated with all functions and levels in a company.

Various approaches are important in achieving Total Quality. One is the implementation of Total Quality Process (TQP). TQP paves the way towards Total Quality through inculcating a positive attitude among employees, giving them an understanding of the key quality principles, and involving them in quality improvement. It encourages total participation from everyone in a company, starting with the chief executive, whose commitment is a prerequisite for success.

The first phase of TQP implementation starts with a company-wide training programme aimed at winning the commitment of every employee to quality improvement. The objective is to build a quality culture of doing work right the first time within the company. This culture is reinforced by the five quality principles, which provides all employees a common language and understanding of quality.

TQP also serves as an excellent foundation for small group activities, giving an opportunity for rank-and-file workers to participate and contribute towards improving quality in their work. Upon completion of the TQP training, teams can be formed to manage and improve quality:

- Senior managers form a Quality Management Team (QMT) that manages quality by using the Plan-Do-Check-Action (PDCA) process of problem-solving. The PDCA cycle serves as a guide for managers in mapping out detailed programmes to create quality awareness and conduct education related to quality management and improvement.
- Rank-and-file employees form cross-functional teams called Quality Action Teams (QATs) and departmental teams called QC Circles to solve problem through a systematic and organised approach.

These group problem-solving activities can generate many benefits. For example, after tracking a company's cots of non-conformance (CONC) or the costs of not doing things right, the findings can be broken down into smaller specific problem themes that can be tackled by QATs, and/or QC Circles. The team members can make use of the various problem-solving tools to scrutinise work processes, cut down redundancies, and improve the present operations.

Through taking part in these activities, group members can expect to experience personal growth, and being able to give people more of what they want. Specially, those who have implemented these activities say they have experienced intangible benefits such as:

- having a say in the decision-making process;
- better control over their work and work environment;
- better relationships with superiors and peers; and
- a work atmosphere that is conducive to innovation and creativity.

All these eventually translate into greater customer satisfaction — which should be the ultimate aim of any improvement effort.

Another important aspect of TQP is that it can facilitate ISO 9000 certification. The ISO 9000 Quality System of documenting step-by-step effort in meeting customer requirements, becomes easier when every employee is trained in TQP. TQP training also ties in well with the ISO 9000.

Source: Productivity Digest, March 1994.

Blurred Lines Between Home and Work Place

Millions of women are fitting jobs into a complex daily schedule. Fathers work flexi-time so they can share responsibility in the home. Enterprises provide day-care for employees' children. The dividing line between home and work is becoming ever more blurred, says the 1994 *World Labour Report* from the International Labour Organization.

One of the main reasons for this has been the 'feminization' of the workplace. Women have become a higher proportion of the labour force in almost every region of the world, says the Report. In the OECD countries, for example, the proportion of women aged 15-64 years who are in the labour force increased from 53 to 60 per cent between 1980 and 1990. And in the world as whole, over 40 per cent of women aged 15 and above, are now economically active.

For many women this is a deliberate decision: they want to work outside the home. Many women are now better educated and have higher aspirations — they expect a career as well as a family. But women are also being forced to work: families which are struggling to survive often need both partners to bring in a wage. And when the woman is a single parent she may have little choice but to find a job to feed her children.

This increased 'supply' of women workers has been reinforced by an increased demand. Employers in an ever more competitive global economy have been searching for ways to cut costs by using a flexible low-wage labour force. In general that means women. "Everywhere, " says the Report, "women comprise the majority of the 'contingency' workforce, that is, temporary or part-time workers, and workers in various forms of precarious contract".

When both parents go out to work this can bring strain as they juggle the demands from home and work. Primarily this means meeting the needs of children — both routine child-rearing and coping with emergencies such as illnesses. But there can also be elderly parents to consider, and again the carers are likely to be women:

in the past they may have looked after their parents after bringing up their own children, but now that they are bearing children later in life, the two resistibilities are likely to come closer together — and even overlap. Today's mothers can find themselves part of the 'sandwich generation' — squeezed between their parents and their children.

A trend for men to take on more caring responsibilities — although still discreet — can be discerned, resulting in greater strain for them. A study in New York, for example, found that between 1977 and 1989 the proportion of men reporting a significant conflict between work and family obligations had increased from 12 to 72 per cent.

These conflicts also create problems for employers — particularly through absenteeism. One survey in Canada found that in the previous 6 months almost half of the respondents had to miss at least one day's work for family reasons. And in the United States, according to the US Department of Labour, absences cost industry around $3 billion per year.

Despite the widespread nature of the problem, the Report says that few countries have explicit policies of offering adequate support to workers with family responsibilities. The most important issues it identifies are care facilities for children and the elderly, maternity/paternity leave and adequate allowances for such leave, and working arrangements sufficiently flexible to be able to respond to family needs.

Child-care is one of the most pressing issues. In a number of countries, governments leave this primarily to parents, believing that arranging child care should be just another aspect of family life. Other countries take a different approach — seeing child care more as a public responsibility. In Sweden and Denmark, for example, local authorities, operating under central government guidelines, offer day-care facilities for young children. In many other countries, despite a tremendous growth in the provision of private and public institutional arrangements, an informal child-care industry has emerged — usually women who take care of a small group of children while parents are out at work. In France, for example, they are called 'mothers' helps'; in Germany, 'day-mothers'; in Venezuela, 'guardian-mothers'. Governments seek to regulate such careers to ensure they achieve minimum standards. In practice, however, many of these careers remain beyond regulation; in the United States, where there are up to one million 'family day-carers', it is thought that between 60 and 90 per cent of these are unregistered.

Regardless of who provides the care, the number of facilities generally falls far short of demand — particularly for children under 3 years old; in Germany, Greece, and Spain, for example, only 2 to 3 per cent of babies find a place in a creche. And parents in developing countries are even less likely to find a formal system of day care. Bolivia, for example, has only 95 centres, catering for some 4,800 children.

In the absence of suitable or affordable facilities, more employers are developing child care programmes, either to provide facilities on site, or to subsidize totally or partially places at other institutions for the children of their employees.

An important development in the search for harmony between work and family has been the adoption by an increasing number of countries, during the last decade, of a period of leave to care for a young child, which can be taken by either parent immediately after maternity leave. However, there is evidence that parental leave, as it is commonly called, has not yet been widely used by fathers, who it would seem are fearful of detrimental effects on their careers. To help fathers take advantage of such leave, it has been suggested in Norway, for example, that four weeks of the statutory paid parental leave be reserved exclusively for the father.

The Report also identifies a number of other key issues for working parents, such as the right to take leave to look after sick family members — whether children or other dependent relatives. And it argues that more and more companies will have to introduce more flexible working arrangements — including job sharing, flexitime and others — not just to cut costs but also to accommodate the family commitments of their workers.

In the 1990s, it seems that the enterprises who want to attract and keep the most valuable workers - men and women - are going to have to make themselves more 'family friendly'.

Restructuring in Japan

More than 70% of Japanese companies are reducing expenditures for overtime, advertising, transportation and business entertainment to cope with the prolonged business slump, according to a survey conducted by the Social and Economic Congress of Japan.

The Business Behavior Study Committee of the SECJ conducted a questionnaire survey on business

behavior in August 1993. A questionnaire was sent to executives in 324 companies nationwide and, for comparison, a similar questionnaire was sent to leaders of 144 labor unions.

The survey revealed that more than 60% of the corporate managers had no intention of resorting to wage curtailment or early retirement in the near future. Such replies were in striking contrast with the opinions of union leaders, of whom about 90% believed their companies would introduce wage cuts or early retirement schemes.

Asked about their primary tasks as executives, 71% said achieving profit goals, another 42% gave top priority to restructuring through rationalization and cost reductions, and 30% mentioned renovation and reactivation of corporate organizations.

As to the most important tasks of individual companies, maintaining profits was picked by 54% of the executives, followed by reinforcing R & D (35%), and maintaining and nurturing work forces (31%).

Turning to the priorities of the Japanese business community as a whole, tops on the executives' list was coping with environmental problems (37%), followed by easing trade friction (34%) and promoting internalization (31%). Noteworthy is the marked difference in the respondents' views on tasks for individual companies and the overall business community.

Managers were most concerned by inadequate managerial capabilities (55%), followed by inabilities to clearly read market and customer trends (52%).

Based on the study, the SECJ made three proposals for Japanese executives. First, said the SECJ, they should talk frankly and directly to employees at all levels to brief them on the company's policies and decisions during the recession.

Next, executives should establish rules for building environmentally oriented corporate structures to gain consumer understanding about environmental cost and to do away with conventional practices that ignore real benefits to consumers.

Finally, the SECJ recommended that executives encourage marketing staffs to go out into the market to discover the real needs of consumers and to view marketing as a function for realizing customer satisfaction rather than simply selling goods.

Source: JPC News Winter 1994.

Refrigerator Mania in India

Refrigerator industry officials and researchers met at Oak Ridge National Laboratory (ORNL) this April to examine results from an analysis of the efficiency of the top-selling Indian refrigerators. Based on the researchers' finding that significant potential for efficiency exists, participants reached several important conclusions regarding India's booming refrigerator industry. One key conclusion: energy-efficient refrigerators could provide an important utility for the power-starved nation.

The meeting was the latest step in a project begun by IIEC and India's Tata Energy Research Institute (TERI). Beginning in 1991, the two organizations analyzed India's growing refrigerator industry, which had been targeted for CFC reductions according to the Montreal Protocol. The goal: to increase refrigerator efficiency while simultaneously eliminating CFC use. Recognizing the economic and environmental value of this vision, the refrigerator industry has led the way in pursuing development of an efficient, CFC-free refrigerator for the Indian market.

Why Focus on Refrigerators for Energy Efficiency?

Consumers in India's growing middle class are elevating the refrigerator from a luxury item to standard home equipment. The annual growth rate for refrigerator sales in India is an unusually high 15 per cent — meaning nine million new units in place by 1999 and 110 million by 2010. Because India-made refrigerators tend to be highly inefficient, the proliferation of these appliances is pressuring the country's already stressed power sector. Efficient refrigerators would use less electricity, allowing the highly constrained power system to meet a larger amount of industrial and electricity requirements.

Preliminary tests at ORNL conducted on India-built refrigerators demonstrated significant potential for improving the units' efficiency. Although the units varied widely in their efficiency, all were constructed with oversized compressors to compensate for large fluctuations in power voltage in the Indian electrical system. The tests showed that oversized motors drain several times more electricity than what is actually required to power the refrigerators. Technological innovations will result in a refrigerator that can operate under Indian conditions without squandering valuable electricity.

The Leading Role of Industry

In late 1991, five Indian and three U.S. refrigerator manufacturers as well as Indian government officials first met to explore the possibility of this new technology. TERI and IIEC assisted the effort with sponsorship from

the U.S. Agency for International Development (U.S. AID) and the Rockefeller Foundation. The U.S. Department of Energy is funding the project's current phase through their ADEPT (Assisting Deployment of Energy Practices and Technologies) program, as is U.S. AID through the U.S. Asia Environmental Partnership (AEP).

India's manufacturers maintain that higher efficiency refrigerators could be available to consumers within two years. Four of India's five major manufacturers have formed joint ventures with several multinational companies, including General Electric, Electrolux, Sanyo, and Matsushita, who will provide technological capability necessary to produce efficient units. The fifth company is reportedly talking with potential partners.

In an unprecedented alliance, India's refrigerator manufacturers are working with ORNL to identify technical opportunities for a more efficient, CFC-free refrigerator for the Indian market. IIEC is assisting the industry in developing an action plan to commercialize this advanced technology. The plan includes an initiative to work with the Bureau of Indian Standards to set performance standards for refrigerators in India. It charts a course to develop labeling practices to educate consumers about the energy costs of this appliance. The plan also explores innovative means of spurring the market for advanced technology, such as concessionary excise duties linked to the standards.

Indian industry leaders will also work with India's utilities to identify opportunities for cooperative efforts. And finally, as the manufacturers retool their facilities to meet CFC phase-out requirements, they have decided to upgrade efficiency design at the same time. In addition to advancing the appliance market toward a more efficient technology, the manufacturers are defining a new role for themselves in the evolution of their technology and their market.

Source: IIEC Quarterly News Letter, April-June 1994

A Three-dimensional Economic Crisis

A new Government is in position and there are many problems waiting to be tackled. To be sure, there are many things still going right with the economy: We have had three reasonably good crops in succession, the foodgrain stocks are normal, the growth rate still remains about 4.5 per cent and industrial production is not languishing. As against this, the things that are going wrong are so many and so disturbing that the term "economic crisis" is very much in order.

Actually, there is not one but three separate crises, — all interrelated and reinforcing one another. First, there is the crisis of resources manifesting itself in the huge budgetary deficits of the Central and State Governments. These are substantially met by net credit from the Reserve Bank — that is, deficit financing — which has its own deleterious effects: double-digit inflation, below-par performance by the infrastructure sector and diversion of exports into the inflationary home market.

Next, there is the balance of payments crisis. This partly arises from the inflationary environment generated by the first crisis, in the process, augmenting imports and depressing exports. But, it is also due to the technologies absolescene and non-competitiveness of Indian goods and services, a high import tariff — about 125 per cent, on an average — which makes inputs for exports and boosts import.

The third crisis, which is all pervasive, emanates from the command economy, with a growing plethora of regulations, price, wage and foreign exchange controls, and an oppressive licensing system — all of which flourish on bribery and corruption. These restrain production, trade and exports and raise the cost of operation, making it non-competitive. Our command economy has essentially become inimical to production. It is time that politicians, policy-makers and the executive realised that the concern of the people is not so much with the loans, remission and other populist concessions as with the innumerable obstructions in their daily economic operations which they find difficult to tackle — so tight is the grip of numerous petty dictators who sit at various control points and demand their cuts. As a result of this overregulated and fairly high-taxed economy, the country has become a haven for black money operators and the quality of development has been compromised.

As the economic crisis has a national character — budget deficit, resource shortage, inflation, obstructionism — as well as an international slant — foreign exchange crunch, downgrading in the global capital market and withholding of loans by aid consortia and international institutions — a mere tinkering will not resolve it. Rather, tough structural adjustments are required. It has been clear for sometime that if four primary conditions are met, the economy will survive in the short-to-medium term. The four factors are: (i) a stable Government, (ii) a non-inflationary, deficit-reduced, macro-economically consistent Budget, and (iii) some crucial policy announcements for structural adjustments in the realm of deregulation, delicensing, cut in subsidies and

(iv) a phased downward adjustment in the external value of the rupee.

Once this is ensured, the domestic capital market will shed its sluggishness and become buoyant and the right signals will be sent to the international financial institutions so that our credit rating improves and we are able to secure the much needed loan of $ 2 billion this year and posssibly $ 7 billion over three years.

It is gratifying that the new Finance Minister, in his initial pronouncements, has promised to tackle the problems of the macro-economic imbalance, the large deficit, the foreign exchange crisis and excessive controls and has promised to introduce structural reforms to eliminate all the cobwebs. All this augurs well for the future.

We had hoped that the first few policy statements of the new Prime Minister will set the base for the politicians, bureaucrats, industrialists, agriculturists, traders and consumers, and even for our foreign partners and world institutions. These early pronouncements should not be given the go-by but must be incorporated into policies. The new Government must not shy away from bold decisions. It should tell the people that the days of populist concessions are over and that through toil and trouble and sweat and blood alone can this nation get somewhere.

It is encouraging that the Prime Minister as well as the Finance Minister have avoided taking a populist line. The appointment of Dr. Manmohan Singh as Finance Minister is itself a healthy signal as his standing in global institutions and his faith in unorthodox and liberal policies is well-known. Moreover, the initial signals through his policy position ought to satisfy the country as well as our international partners. Dr. Singh has refused to accept unrealistic goals — even if these are embodied in the Congress manifesto — about rolling back prices of some essential commodities to the July 1990 level. He has favoured acceptance of those IMF conditionalities which are in India's interest as part of an "honourable agreement" and has set a realistic three-year time-frame to achieve a "modern, dynamic and vibrant economy".

The proposed trimming of the Budget deficit and removal of macro-economic imbalances cannot be brought about by major changes on the side of taxes and other revenues but have to be achieved by slicing expenditure. When we talk of an important policy turnaround such as a cut in subsidies, a reduction in import duties and a downward adjustment in the external value of the rupee, it is not possible to do so all at once. Subsidies cannot be reduced to zero; import duties, on an average, cannot be rolled back from 125 per cent to, say, 40 per cent; and the rupee cannot be devalued from Rs. 20 to say Rs. 30 per dollar at one go. But in all these matters, phased reform is entirely feasible and should be undertaken. For instance it can be announced this month that food and fertiliser subsidies will be gradually done away with so as to become minimal by 1994 and will be focussed only on deserving beneficiaries. The populace will then accept this without too much demur. Further, it can be planned and implemented — though not formally announced — that the value of the rupee will be brought down from Rs. 20 to a dollar to Rs. 30 within a year or so and that a reduction in average import duties — from 125 per cent to 40 per cent — will be worked out over three-to-four years — and this should be good enough.

The process of deregulation, delicensing and decontrol can be undertaken more speedily. All in all, the restructuring of economic policy seems to be in good hands. it has started well and promises to move steadily to make for a resilient economy.

Source: A M Khusro: Unfinished Agenda — India and the World Economy. New Delhi, Wiley Eastern, 1994. □

Book Review

Black Income in India, Suraj B Gupta, Sage Publications, New Delhi, 1992, pp. 187, Rs. 215.

Economics, definitely conventional economics even today does not have the theoretical framework, conceptual clarity and methodological device to deal with large areas of social phenomena. The worst part of it is that the tribe of economists who subscribe to main stream thought includes a good many nobel laureates as well. Economists seem to proceed as if black money, black income, black wealth or any economic activities that lie outside the market pricing process are to be treated as "the happy hunting ground of the Charlatan and the Knave" (to borrow the famous observation of Lionell Robbins, one of the founders of neoclassical economics) and not the legitimate field of enquiry of economists. Professor Suraj Gupta may be congratulated for taking up the study on black income using a political economy framework. Though a few authors before him have pioneered such investigations, Gupta has done his study with remarkable ease, clarity and objectivity.

Professor Gupta on the basis of authentic evidence and reasonably convincing analysis, hypothesises that political corruption defined broadly to include administered corruption is indispensable to the growth and reproduction of black economy in a country like India. The quality of the work would have been considerably enhanced if the author had built up a theoretical frame to hang the analytical content. The review of Ann Kruegers' dated piece is no substitute for that. Rent seeking is as much true in a liberalised regime as under the control raj.

Professor Gupta also provides detailed estimates of black income for three selected years. These estimates are probably the most reliable "guesstimate" on black income in India. In the latest year of his estimate viz 1987-88, black income works out to over 50 percent of the GDP and given his finding that black income increases faster than GDP growth, the percentage today will be much higher and could be over 60 percent. Where are we heading to as a Nation?

The chapter on the review of polices is rather sketchy. The policies themselves are formulated to periodically whitewash the black income the ruling elites themselves help to generate. A critical review of the remedies suggested by various scholars followed by the author's own prescriptions would have enhanced the usefulness of this extremely timely work.

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Managerial Unionism: Issues in Perspective, by Baldev R. Sharma, Shri Ram Centre for Industrial Relations & Human Resources, New Delhi, pp, xvi + 291, Rs. 275.

The expression "Managerial Unionism" gained currency during the first quarter of 1980's to refer to a growing tendency of collective and organised action among officer/executive cadres of the Indian Public Sector. Trade unionism was traditionally associated with the lower level employees commonly known as blue collar workers/award staff. Although in the West unionisations had spread vertically among higher levels of organisations much earlier, the same phenomenon began to appear in India only during the late 1960's, and picked up real momentum only in the 1970's.

The vertical growth of unionism followed the normal path of clerical — supervisory — managerial employees, in that order. This new variety of unionism, initially confined to banking and financial sectors slowly made inroads into professional groups such as doctors, lawyers, university teachers, and finally corporate managers of the public sector. As the managers began to embrace trade unions, which they had so far shunned like a plague among their own subordinates, it caught the attention of scholars and researchers.

Some of the questions addressed by Dr, Sharma, such as the evolution and activities of managerial unions, the nature of its leadership and membership, had been examined by other scholars. However, Dr. Sharma's

book under review is different from the earlier studies primarily for its coverage at a national level cutting across a wide variety of organisations, in terms of size, geographical location and type of industry. The study which began with a mailed questionnaire sent to 1500 Indian companies finally concentrated on a sample of 40 public sector organisations. The author has used a combination of different sources and methods of data collection including literature survey, company records, and interviewing of top management, leaders and rank-and-file of managerial unions, and trade union leaders to arrive at an understanding of the structure and strategies of managerial unionism in India.

The book which begins with an attempt to trace out the history of managerial unions in the global context as well as in India, devotes the subsequent chapters to examine a number of issues such as the causes, the activities and methods of managerial unions, the nature of their leadership and membership involvement, the response of top management, the government and the worker unions towards managerial unions. Although managerial unionism is a universal phenomenon, its nature and rate of growth vary from country to country. Wherever it has gained momentum and density as it has in some of the European countries, the author argues that the labour laws have played a directly contributing role to its development. However, even in the absence of any encouraging legal environment managerial unionism has made substantial progress in the Indian context, though confined exclusively to the public sector only.

While the study attempts to understand the formation of managerial unions, it unfortunately confines itself to a process of verification of possible reasons which are already known through earlier studies and literature existing elsewhere. This is a limitation of the survey methodology used in the study, instead of an in-depth case methodology. However, the study brings out an important difference of the Indian experience in comparison to experiences elsewhere in the world. While in other parts of the world, the rise of managerial unionism has been attributed, among other reasons, to job insecurity caused by redundancy and unemployment, the covert job security appears to have contributed to its formation and development in the Indian public sector. But, then, a reader would have been better convinced if the study had also examined what really inhibited the growth of unionism among the managers of the private sector. Because as the study asserts that the main thrust of OA activities is on protection, preservation, and improvement of the occupational interests of managerial employees (members), it needs to be explained if such concerns are absent among the managers of the private sector. Is the "crisis of identity" confined only to managers of the public sector alone, and if so, why?

The study notes that the leadership of managerial unions is almost entirely in the hands of junior and middle level managers. This is not surprising as the majority of membership belongs to the junior and middle levels of the managerial cadre, which incidentally reflects the make-up of the corporate organisation. As a corollary to this reality is the fact that these junior/middle level managerial employees do suffer from a sense of deprivation, especially as they are removed from decision making centres of the top management, and a gradual fall in their socio-economic status.

The attitude of top management in the public sector towards managerial unionism, though, initially one of antagonism and hostility has, over the years, become tolerant (in science). The author suggests that in the absence of appropriate legal support, managerial unionism is unlikely to succeed in achieving a position of bargaining strength. A reader who is familiar with the growth and development of worker unionism is no wiser by this argument. It would have been interesting if the author had probed as to why is it that, despite mobilisation of a large percentage of the public sector managers, managerial unions have not succeeded in obtaining formal bargaining powers. One is even tempted to ask whether legislative support leads to bargaining powers, or bargaining power necessitates legislation?

The conclusion of the book is disappointing as it merely recapitulates the main points already discussed in the previous chapters. A reader would have benefited if the data gathered were extrapolated to draw some general conclusions and their implications on the ensuing industrial relations in the country, in general, and the public sector, in particular. The observation that the new economic policy is likely to bring the worker unions and managerial unions closer is unconvincing in the absence of sufficiently supportive empirical evidence. A study of the nature and magnitude as the present one could have, perhaps, gone beyond statistical tables and provided much more qualitative insights into the phenomenon of managerial unionism. However, Dr. Sharma's work has filled an important vacuum and has provided fresh knowledge on this rather recent development among the Indian public sector managers.

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"Getting More at Less Cost — the Value Engineering Way" by G. Jagannathan, 1992, Tata McGraw Hill Publishing Co. Ltd. Rs. 150.-

Although there are many books on cost accounting and cost analysis particularly emphasing the theoretical concepts, the book under review has been presented by the author with an entirely different focus highlighting more on the methods and approaches through which an organisation can get more at less cost. The author and the publisher both deserve appreciation for this timely publication particularly in view of the global competition the Indian industries are facing. To meet the challenges of the liberal economy, Indian industries have to identify and remove unnecessary costs without sacrificing reliability for quality to meet the consumer's need at affordable price. The task of achieving this with an integrated use of science, accounting and engineering is by the value engineering method. The present book is a useful contribution by the author in this context.

The author is a pioneer in the field with experience of two decades including in the field of value engineering. He presents his ideas in a systematic and logical manner making readers comfortable and interested in the book. The book focuses on the concept, need and approach of VE and its phased implementation with cases based on practical experiences. The concept of VE is covered in context to unnecessary costs in the products and its potential reasons such as lack of information, honest wrong belief, circumstances, habits and attitudes, lack of ideas etc. The outstanding feature of the book is that each potential reason has been substantiated with the practical example the author has observed during his varied and long work life. This has added 'value' to the book in the sense that a non professional can also understand the concept, its need and scope to implement in real business situations.

The book unfolds the need for value orientation with an analogy of the theory of magnetism and its impact with the help of a case study. Then follows a detailed presentation of the process of execution of Value Engineering in a real business situation. The first phase highlights the three aspects of training project and team building. The second phase explains the importance of collection of accurate and relevant information which is an essential requirement for the success of VE project. This has been elaborated with the help of a case study. The third phase of functions recognises the types and levels of functions and the functional utility of products/services. The technique of functional analysis system (FAST) has also been enumerated with the help of figures and diagrams.

The author has also made a successful attempt in the creation phase narrating various approaches of brainstorming activities required to find out alternatives. The study of split-brain theory, Gordon technique, Morphological analysis and Jog's approach would help the members of the VE team to accelerate the thinking process needed for it. Then follows the evaluation' of ideas and the recommendation for trial. After the trial test is undertaken, the need for systematic 'implementation' has been worked out. Each step of implementation has been discussed alongwith possible problems and the strategy to deal with. The last phase of the audit is to ensure whether the company has introduced the changes as per VE Plan and what has been the effect of these changes. A checklist covering technical and cost audit has been given to facilitate audits be to undertaken.

Another outstanding feature of the book is its richness in terms of more than 50 different types of cases discussed. The first case has been elaborated in greater detail synchronising with the presentation plan of the book and nine others have been discussed to highlight the steps that led to team success. The others have been briefly explained with reference to special points. At the end, the author has given the various packages of training modules a bibliography of reading material which are likely to prove very useful.

The author seems to have practised self restraint in specifying the names of the Indian companies which have adopted this techniques with success and possess a dedicated group for undertaking VE activities. A little more information about this would have been useful to readers particularly to researchers. However, this is not a limiting factor for the quality of literature the author has produced.

Apart from the useful information on this developing subject, the pricing of the book is moderate and affordable (Rs. 150). It is recommended for engineers, training managers, finance and cost controllers and others interested in management subjects.

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Work & Productivity, by Kawaal L. Hira, Oxford & IBH Publishing Co. Pvt. Ltd., 1993, Delhi.

Measurement and quantification have fascinated students in a variety of disciplines to the point where it is believed that, that which cannot be measured cannot be

managed. This has given rise to a body of literature of measurement in several disciplines including Industrial Engineering. The present work focuses on the measurement of human effort and begins with a very interesting Chapter on "Units of Measurement".

While Industrial Engineering Handbooks and Manuals give various types of classified data regarding standard allowance in relation to work measurement, this book is somewhat different in that it is based on the author's personal experience of industrial productivity improvement. In this context, the reference to managers productivity and its measurement will be found particularly interesting.

The book by Mr. Hira who has had a long experience in a whole range of management functions gives information starting right from the Fundamentals of Work Measurement. It should help in developing a conceptual understanding of human effort measurement in standard-man-hour units. The assorted data about various allowances for different types of work is likely to be of particular interest to those who are directly engaged in work measurement in Industrial Engineering Divisions, in organisations or in Consultancy.

The book also presents detailed information on the preparatory work required for setting standards on the relevant documentation. Of particular interest to the reader are the practical aspects of how various records are created, analysed and maintained for setting one-time standards. The treatment of Group Measurement and Standard Setting would in fact be of interest even to Trade Union leaders.

The discussion of work-measurement and productivity-improvement techniques by production types provides useful insights to those who are interested in developing as work study professionals. What sets this book apart from the others in the area is the inclusion of information derived from the author's personal work in the field, an example of this can be found in the author's comments on systems setting for batch type production.

The SHM balance sheet is a novel idea which will be interesting to pursue.

While the personal experience base of the author is an advantage in some ways, it also detracts at places from the rigour expected of a standard work on the subject.

With its minor limitations on account of subjectivity of treatment, the book is indeed a valuable addition to the literature on work setting and deserves to be perused by Industrial Engineering professionals engaged in productivity standard settings and productivity improvement. Mr. Hira deserves to be complimented for sharing his insights with the reader and stimulating their thinking into newer avenues.

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'Worker Takeover in Industry' by B. Srinivas, Sage Publications India Pvt. Ltd., New Delhi, 1993, Rs. 225/ (Cloth Bound) Rs. 125/ (Paper)

"Worker takeover in Industry" is the result of Doctoral research completed in August 1990 in the Department of Sociology in Central University of Hyderabad. The book begins with an explanation of the theoretical background referring to many concepts viz. workers cooperatives, democracy of small capitalists versus solidary collectivity of workers, worker but out, labour managed firms etc. Examples are quoted from American industry. However, detailed information about these takeovers is not furnished. Then starts the narration of events that took place in the Kamani Tubes Ltd. (KTL) from the year 1959. The author has panistakingly given the relevant information in a sequential manner. During the course of the description he explains important issues e.g. the complaints of Kamani Employees Union (KEU) overlooked by the Government, role of mediator, role of BIFR and the role played by other Governmental Agencies. Further while describing the struggle and strategy for survival, he gives due importance to sacrifice demanded from workers, how the workers solved problems regarding payment of capital, reduction in salaries, dealing with members and non members of KEU, dealing with recalcitrant workers, recruitment at managerial and other levels. At relevant places the author highlights the impact of delay in decision making by various governmental agencies.

Then follows the description of the actual takeover and the conditions thereafter in great detail. These details include all the compensation package, service conditions etc. Further, problems faced by KTL viz. relating to marketing, production and finance are also indicated.

The case study of KEU brings out trade Union Dynamics and its impact on process of takeover.

The concluding chapter raises some issues relating to worker takeover, the major one being management of

executive staff by a workers cooperative. The attitude of managerial staff to worker takeover is well analyzed. Further the author also highlights the problem caused by undercutting, competition and support required from government agencies. The built in conflict in business management and democratic philosophy is also well brought out. However, as this is a research based publication, detailed information regarding hypothesis, methodology, scope and limitations etc. would have enhanced the value of the work. Similarly, at the end of each chapter, its summary would have helped the reader in understanding.

During the last decade some positive changes in work environment have been noticed which have resulted in successful introduction of quality circles by many organisations. A slight shift from total trust in trade union leadership is also discernable. In this changed situation, this experiment of worker's takeover has assumed significance. Further study with greater analytical approach is likely to be undertaken and will be welcomed by all.

To conclude, this indepth study of the first take over experiment will serve as a guide to similar cases which are likely to take place in time to come.

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Paying for India's Health Care, edited by Peter Berman & Me Khan, Sage Publications India Pvt. Ltd., New Delhi 1993, 325p Rs. 295/-

The book contains thirteen essays by Health Research executives/academics, Directors of Health Services, sociologists, economists, population control advisers, heads of consultancy research organisations, etc. The topic range from India's health care system, health finance research/measures, family welfare programmes, problems of nutrition, health insurance and case studies of the states of Maharashtra and Madhya Pradesh. The information contained in these studies is wide-ranging, available hitherto only to government departments or international agencies who have access to such specialist reports. The studies are contemporary and present a balanced view, which should interest both generalists and specialists who wish to understand the multifarious problems confronted in the health care of a country of continental dimensions, seething poverty, inadequate medical care, population explosion, etc. As in many other countries, including the advanced, the Damocles Sword of budgetary costs is a nightmare. Added to all these is the spectrum of spiralling costs of medicines, medical equipment and infrasture and enormous cost escalation of specialist treatments.

Most of the articles are well researched and contain comparative studies — India vis-a-vis other Asian countries; growth of health infrastructure and investments; trends in medical care; allocating during plan period; population projections; hospital details and bed strengths; performance indicators, etc.

The bibliography at the end of each article is comprehensive and varied which will naturally stimulate those who are interested in health policy, planning and financing, and wish to understand the inter-relationship between health care systems and the overall economic and social progress of the country.

It is paradoxical that the promises of the National Health Policy approved by Parliament in 1983 as "Health for All" by the year 2000 are fading out presenting rather a gloomy picture, which forces one to think that even by the year 2011, the situation may not be any better.

The key elements of primary health care are malnutrition, immunisation; first aid; maternal assistance; child health and family planning; sanitation and water supply; supply of essential drugs; control of endemic diseases, and health education. These are inter-related, and results can be achieved only through inter-sectrol action, full community participation, and a sense of dedication and commitment on the part of all concerned. For example, despite the reasonable economic growth over the last ten years, poor housing, lack of sanitation and safe water supply, inadequate dietary intake etc. persist. This explains the continuing high incidence of infectious diseases and the elevated infant and maternal mortality rates. Two fifths of the population lack regular access to health services, which are either inadequate or maldistributed socially or regionally. It is well known that unlike China (which has the largest population in the world), where the allocation to health is almost four times that of India, there is a tremendous commitment and excellent results have been achieved in controlling health care systems etc. India has not broken this Gordian knot due to a variety of factors, and woefully lags behind. It would seem that the health care system itself is under tremendous strain and has almost reached a breaking point. On the other hand, within the country itself, states like Kerala, Maharashtra etc have achieved much better results, and this situation is due to better standards of education and female literacy, comparatively greater al-

lotment of funds to health services during the past many decades, a consciousness of the population in general to lead a healthy and hygenic life etc.

In this context, it is axiomatic that India has reached a stage where health techniques alone can contribute little towards finding solutions to the crucial questions that are unresolved. The facts must be recognised at the highest level, and all segments of society must put their shoulder to the wheel of health care rather than depending upon governmental fiats and organisations to tackle the ever-increasing malaise.

Recent suggestions of the World Development Report (WDR) like decentralisation or increased autonomy in financial decision making, quick appraisals, etc. are worthwhile. With the winds of structural adjustment blowing through the land, it is imperative that the positive aspects of public health structure, whether primary or tertiary are not thrown out in the interest of economic criterion like, efficiency and cost recovery. Health care is verily a long-term increment which could eventually contribute towards poverty reduction.

The World Bank has criticised the Government of India, and in particular the Union Finance Ministry for its neglect of health care sector, and for not providing adequate funds for health and family welfare. It has also suggested that the means available to achieve goals are targeting communicable diseases with public spending; re-invigorating other primary care activities; encouraging effective private health sector service delivery; enhancing the quality of hospital care; improving returns to private spending by benign regulation and selective encouragement of the private sector; also the setting up of a Health Economic Unit in the Ministry of Health and Family Welfare.

Many of the inherent constraints preclude any movement towards a generalized and uniform health care structure for the community as a whole. Many of the deficiencies in the present structure can be overcome by improving the management of administration of health care system; strengthening both the public and social security systems; insisting on greater solidarity and cooperation between all the agencies; establishing an independent planning and supervisory body at the national level charged with ensuring the coordination, regulation and supervision of the different actors, both financing agencies and health care provides.

Finally, it is relevant to appreciate what "THE ECONOMIST" (London) wrote in its supplement on Health Care System" (July 1991):

> "Health care systems have come a long way since HAMMURABI they have changed a lot since the proverbial Beveridge Plan. In many ways, it has changed too much. However, it is time to return to the priorities of value in health care, namely money measuring of results, and using available incentives to improve performances. It is an on going process".

An exceedingly well brought-out book, containing very useful and informative articles. The book can be highly recommended to a wide cross-section of the people health policy makers planners hospital staff, hospital administrators health financing agencies, public health executives, etc.

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