

Table 10. Waste utilization opportunities in industry sector: (industrial complexing)

| Industrial waste | Physical form of waste | Source industry | Present disposal method | Potential for use |
|--------------------|------------------------|---|---|---|
| Fly-ash | Power | Thermal power station | i) Pumped in the form of slurry to nearby low lying areas in the wet system of disposal. ii) Fly-ash discharged from the precipitators is conveyed for disposal to the dumps in the dry method | i) In portland pozzolana cement. ii) In construction industry iii) (a) Dam construction, (b) land reclamation, (c) road construction. iv) Cellular concrete v) Lime fly-ash bricks vi) Sintered light weight aggregates. |
| Blast furnace slag | Solid lumps | Steel industry | Dumping in open area | i) As a component in blast furnace slag cement. ii) As a component in binding material i) Road aggregate ii) Slag wool |
| Lime sludge | Slurry/paste | Fertilizer, sugar, paper and acetylene industry | Stored in large outdoor settling ponds | i) As raw material in cement manufacture. ii) In limo pozzolana mixture. |
| Chemical gypsum | Slurry/paste | Fertilizer industry | Pumped in the form of slurry to the dumping ponds. | i) As a set controller in the manufacture of cement in place of mineral gypsum. ii) For making gypsum block board. |
| Red mud | Paste | Aluminium industry | Dumped in open area | i) As a component of raw mix in the cement industry. ii) In the manufacture of building bricks. iii) Light weight structural blocks. |

Source: National Environmental Engineering Research Institute, Nagpur.

many of these units are not in a position to comply with mandatory environmental requirements because of their limited resources. The government along with industry has to promote schemes for common or shared pollution control facilities which will help the industries in producing goods of international quality, environmentally friendly and at competitive prices. A beginning has been made in this direction by the World Bank and its Soft Loan Affiliate (IDA) in sanctioning a loan of US dollars 155 mio. for common water treatment facilities in industrial estates and in Gujarat, Maharashtra, Tamil Nadu and UP.

The government should seriously consider some sort of fiscal incentive to subsidize export of green products.

Industrial complexing has to be adopted as a policy to ensure cross-sectoral usage of waste and bi-products, thereby opening up newer and expanded market for the industry without environmental damages. An example of waste utilization opportunities through industrial complexing is given in Table 10.

We should maximize our efforts in accessing the latest technologies for improvement of our environment. As already pointed out, international collaboration will be a more cost-economic and market-friendly alternative.

Globalization — an entrepreneur's point of view

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As India sets sail towards export-led growth, liberalization and globalization, the forecast for business organizations is clear—of rough sailing and harsh expectations. We will be in the high seas of mega-

competition and world class competitors making inroads on our very own turf.

There are no sops or emotions involved in the new playing field. Those who will grow are the ones who

respond, change and adapt. Those who do not will fade away.

There will be no national, patriotic or composite product considerations. Growing geographical segmentation of the manufacturing process that aims to put a product together based on competitively sourced components, sub-assemblies or material/service inputs would be the order of the day. The Boeing or Airbus airplanes manufacture is one example.

As companies are progressively exposed to global competition, the focus would clearly be on their competitive advantage. The goal of competing globally will be increasingly dependent on Science and Technology, in the short term as well as in the long term. Volkswagen, the automobile giant, is justifiably proud of its ability to develop an automobile between teams across continents with assistance from research centres.

In the short term the emphasis has to be on:

- a) quality
- b) productivity
- c) costs
- d) response time
- e) innovation.

In the long term the emphasis has to be on:

- a) scale
- b) technology upgradation
- c) product design
- d) strategic partnerships
- e) attitudinal change
- f) patent laws and rights.

In all these areas science and technology has a lot to contribute. As companies strive to compete globally, they must set goals that are increasingly dependent on science and technology.

Short-term emphasis

Quality will be a key competitive determinant. Once limited to only technical inputs, it now encompasses all elements and people involved in the business matrix — from consumer/customer-oriented product/service designs, operations, communication process, distribution systems, pricing packages, after sales service, etc. One need not elucidate on this point given the industry's growing awareness especially in the context of ISO 9000.

Process improvement, process simplification and cycle time reduction using technology to meet customer expectations are areas in the realm of quality improvement where technology can contribute.

Inherent in these process improvements is the aspect of productivity. For Indian companies, the focus will have to be equally on labour productivity and automation. Technology has a lot to contribute in automation in engineering and service industries, material handling, packaging, per pass conversions and yields in process industries. Other areas in productivity improvement where technology can contribute are in maintenance, corrosion, value engineering and in better manufacturing practices.

Improved quality and productivity do lead to cost reduction. However, more efficient management of financial, labour and material resources, aggressive purchase policies, energy management, etc. are equally important areas. The contribution of technology in reducing energy cost is critical; as I have experienced in the case of IPCL.

Then comes response time. So far Indian business had a certain adjustment time for changes in the external environment. This will not be the case in the future. With increasing internationalization, we will be susceptible to shocks and changes in legislations, trade flows, pricing, etc. Recent experience has shown that there is hardly any time to absorb one shock before another one impinges. Being able to cope fast will be key to staying competitive, not just quality, price and service.

Coupled with fast response is innovation; essentially implying that ideas are quickly translated into the market place and locked in with customers.

The pharmaceutical industry in India is an excellent example to study. Squeezed by a restrictive policy the industry has done well to focus on costs, productivity, product mix, manufacturing process improvements and innovative inter-firm partnerships. This is probably the only industry in India that can be truly termed cost-conscious. The difference is that this industry has had a longer time period to adjust, but, other industries in a liberalized regime will not have such a time benefit.

Long-term emphasis

Scale of operations is important in the globalization context given the fact that domestic markets would not be a limiting factor. Technology has an important role to play here. The small-scale units need to be supported in this context.

Concurrently, technology upgradation is an imperative. India has this image of producing and exporting low technology products. This needs to be improved both in terms of upgrading existing technologies and bringing in new technologies and materials.

The construction industry world-wide has been the slowest to incorporate the advances in CAD/CAM and robotics. In India too this is lagging, not only in construction, but in most industries.

Industrial product design is an area neglected in our country. If our competitive advantage has to improve it will be necessary to benchmark and bring with speed new products and services with variations in features, style, technology and consumer appeal. In GE Plastics we have a live example of how critical product design is in advanced materials for automobiles, telecommunication, business machines, etc., which have large potential markets in India.

Strategic partnership promises to be an exciting area for businesses and science and technology. From our limited experience in R&D and JV's in IPCL we have this conviction that megacorporations would be keen not only to venture in businesses and markets, but also in components of applied research. Speciality catalysts and engineering plastics are two areas where we have had proposals for collaborative S&T work from megacorporations. GE has a good part of its research work being carried out outside USA.

The structural linkage between industry and research institutions needs to be overhauled and simultaneously JV's brought into this system of research linkages. There is a need to radically change attitudes to make sponsored research focused, aggressively time-bound and result-oriented.

While we have research institutions being represented on industry research programmes and advisory panels, the converse is not true. Research institutions have to open themselves for participation of industry in their steering positions.

There are a number of medium-sized manufacturing organizations whose research personnel are primarily involved in making improvements and introducing innovations in the manufacturing process. These persons need to be exposed to leading research and technology institutions to help improve their horizons and update themselves, just as it is important for personnel in research institutions to be exposed to industry practices.

Participation of scientists in technology evaluation, selection and use is another area of linkage with larger benefits. In IPCL this is being practiced and has helped in technology absorption and upgradation.

In the era of globalization, attitudinal change is a prerequisite. Science and technology in India suffers from a leisurely pace, diffused priorities, obscure responsibilities and an orientation to publications. Science and technology has to come into the mainstream.

In a globalized environment it is necessary for science and technology-driven products and services to recognize patent laws and rights and offer the buyer immunity from infringement of Indian and foreign patent rights. Our sensitivity to patents and propriety needs improvement.

Larger issues

There are some larger issues relevant for the future of science and technology in a globalized environment.

The first issue is in terms of creating constituencies for science and technology. In today's ethos political and economic solutions get priority. Scientific or technological solutions get the last priority except in the field of agriculture where its contribution has been remarkable. Policy planners and decision makers need to be sensitized to science and technology. A wider societal recognition of scientists and technologists is required.

In business management, the focus on science and technology appreciation and management is diluted. It has been said that the global manager has to be technically aware, socially sensitive, geographically cosmopolitan and have a competitive sense. Quite recently, we have had reports of Chinese students being encouraged to be technologically strong for business positions.

Then the question of priorities. Instead of diffusing efforts on all areas, it will be useful for science and technology to focus on few areas that pass the criteria of India being endowed with requisite resource or having competitive export advantage. This would mean that agriculture and allied fields (horticulture, sericulture, tissue culture, marine science, etc.), textiles, building and construction, computer software, etc. get priority in science and technology endeavours.

Technology licensing

Purchase of developed technologies in the context of globalization is going to be constrained and difficult. From our experience of over thirty technologies in IPCL in the last two decades certain trends are discernible. These are:

India will no longer be considered a bottomless pit of domestic demand. Technology buyers from India will also be seen as potential competitors in world markets and hence technology sales will be conditioned with marketing territory restrictions.

Technology is now being seen as part of a company's global strategy. The age of straightforward technology licence agreement is giving way to technology-cum-market, technology-cum-stakeholding, technology-cum-product swap or tolling agreements. Hence it will become available to an Indian buyer only if he fits into the supplier's global scheme. The fit would work well for joint ventures riding on market access, product swaps or competitive territorial advantage.

There is also a trend towards breaking up of a technology, which was once available as a package, into

smaller elements and pricing each element separately.

With forging of strategic alliances, mergers and acquisitions worldwide the post-technology sale improvements are taking a beating depending on the strategic importance placed by the new owner of the technology and patent rights. This has led to technology suppliers making technical services as part of separate agreements.

Conclusion

We are moving towards an era of the global village characterized by global presence, strong brand identification, cross-border manufacturing and marketing, strategic alliances and heavy investment in future oriented research and development. In such an era there will be no such thing as sustained long term success and growth in chosen fields.

Publicly funded R&D institutions in the post-liberalization era

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The changing scenario

In the new global order, there are vast changes in the political, social, economic and technological spheres. Marginalization from the global process will be on cards for the developing world, if it does not make some strategic moves. Indeed the developing world will find it difficult to get an access to the world market and also difficult to compete successfully, if R&D and technology are not used as powerful strategic tools to surge ahead. Publicly funded R&D institutions will have a major role in the scheme of things, if only a major transformation is planned and executed now.

Let us view the Indian scenario in the global context. The recent initiative of the government to integrate the Indian economy with the global system has posed new challenges for the publicly funded R&D institutions. The new environment is characterized by deregulations and abandonment of import substitution strategies. A new definition of the role of the state is emerging slowly but surely. Privatization of the previously state operated services is on the cards. Restructuring of the productive system has become as important as obtaining access to new technologies and promoting a deep process aimed at technological innovation. Publicly funded R&D institutions in India have to be viewed in this context today. Notwithstanding many contrasting views, the Indian R&D institutions, with appropriate government support, could play an increasingly important role in the process of global competition, restructuring of the industry and economy and in upgrading the local industry to gear it to face the

international competition successfully. This will only happen if an *enabling environment* is created with the support of the government and the industry in which these institutions will flower and flourish. This paper deals specifically with the question of creation of such an enabling environment.

Need for change

Publicly funded R&D institutions are under clear pressure all around the world today. Many old styled industrial research institutions had largely employed the *supply push* approach. They believed that just doing good science will automatically produce results for improving the economy and the society. This thinking has been shown to be wrong. In the past, there has been a lack of an organic linkage between these institutions on one hand and the productive sector on the other. This has proved counterproductive. There has been a harsh reassessment of the role of these institutions and an agenda for change has been already drawn out.

In many countries, different types of organizations and management structures for publicly-funded R&D institutions have been proposed. They have been also implemented boldly. For instance, in Australia, CSIRO was questioned in the early 80's as to whether it provided value for money in terms of its contribution to economy. In 1986, CSIRO organized itself into a number of institutes with clear missions and targets for cost-sharing with the private sector. DSIR in New