

Emerging dilemmas in the management of science and technology

Rajendra K. Bera

The impact of scientific discoveries and technological innovations has always been impossible to predict. It is more so in today's climate of fundamental shifts. Many of these shifts are related to science and technology. For example:

- Pursuit of science has become expensive. It needs government and hence political support for funds. Scientists are perforce turning into lobbyists.
- Modern society's dependence on science and technology is such that the competitive edge of industries today lies not just in new but increasingly in innovative technology whose basis is science. Naturally, industries have begun to play godfather to science and their funds carry considerable clout.
- Technology and, indeed, any form of application-oriented knowledge, has become an important marketable commodity. It has become an important component of international trade.
- Science is no longer pursued by gentlemen-of-leisure. It has become a profession. Scientists now rarely operate as individuals or in small groups. The functioning entity is now a large group requiring 'professional management', which means that it focuses on projects rather than on knowledge.
- The new keyword for survival in the marketplace is innovation. Frequently it means sloughing off yesterday's technology, yesterday's skills, and those of yesterday's work-forces that are unable to adapt with speed. As employment security becomes a thing of the past, how do we make people see this change as an opportunity and not as a threat? Unfortunately, innovative work cannot be organized and done within existing standard management components. It needs to be organized separately, with different structural principles, and in different structural components.
- Any technological innovation, when it comes to the marketplace, is a gamble. One cannot do market research for something genuinely new or for something that is not yet in the market. Its success depends on advertising, user preference, cultural biases, adaptation, perceived prestige, etc. It frequently

requires a supporting cast. For example, TV has little meaning outside the context of TV programmes; cars outside the context of good roads, refineries and petrol stations; electric bulbs outside the context of power stations and power distribution networks; and so on. When such context-sensitive support requires large resources, governments necessarily step in. Innovation must then pay its obeisance to politics.

- New technologies are likely to involve big money, big consequences and big controversies. There will also be ethical concerns (such as those arising from genetic engineering) which may have a paralysing effect on technology development. For example, how do we bring new, beneficial, very expensive, but life-saving technologies to the aid of the poor? If some must be denied then what is the socially acceptable value system on which such denial is to be based? This is an area where basic science and technology must make 'common cause' with social sciences, humanism and religion.

- Recent technological strides have made people's expectations soar. They cannot be met without large-scale, impersonal automation in industry, home and services (specially, in information and diagnostic services).

Few, if any, would contest these observations. Indeed, a major shift in the technological foundations of the economy in several countries is already under way. It will surely present tremendous economic, social and political problems and produce many consequential dilemmas. Yet economists and social scientists barely acknowledge this fact, let alone account for it in their theories and comments. So it is highly unlikely that they will foretell the future.

On the other hand, since science is no longer a marginal activity in nation-building, scientists, to a large extent, will be expected to be accountable. Science is unlikely to be measurable even though its primary function is quantification. But science may, and should, be able to tell us what to expect, what to anticipate, and how to judge. This is

important since, in the framing of government policies, science and technology are no longer afterthoughts; they are among its essential elements.

Science, however, has its limitations. It alone cannot solve all problems. Unless wisdom and sensitivity are brought to bear, scientific solutions may escalate into ominous political and social confrontations. In this light the growing nexus between politicians and scientists must be viewed with concern. There is already a tendency among certain scientists to bypass their scientific peers and go directly to people who have important political access. The scientific community must enforce strict self-discipline to curb such tendencies before the credibility of science as an institution is eroded beyond repair.

There is a keenly felt need for new ways of managing growth of science-based technologies. The new views must bear in mind at least the following: (i) the dramatic shift to knowledge-based industries requiring knowledge workers rather than blue-collar workers, (ii) the rapidity of the shift, and (iii) the consequent ecological changes.

Any new management perspective must recognize that societies function around organizations and institutions, and that technologies must nurture the country's developmental priorities. Therefore, technological innovations must match steps with social innovations. Technologies can be imported for a price but the institutions that must support them need cultural roots to grow and prosper. This is what makes technology transfer to an alien society so unreliable.

A few technology-generated social changes are already in evidence. For example, social groups are increasingly being identified not by their socio-economic status but by their lifestyles; professionals are looking less for employment security and more for employability security; national power and pride is no longer measured in military terms but in shares of world markets and in technological prowess.

An important aspect of technology is to do something better; its most impor-

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tant aspect is to do something new. Thus innovation is the key—the search for and the exploitation of new opportunities for satisfying human wants and human needs. Rapid spread of technology will affect social values, perceptions, attitudes and demographics (migration, education levels, sources of employment, etc.). Already, in affluent societies, populations have become unstable and are subject to sudden sharp changes in location and lifestyle. Today the world must also contend with an ageing population in the developed countries alongside a tidal wave of young adults in the Third World. With dramatic increases in international co-operation, travel and trade, the impact will be global and confusing. The tragedy of modern technology is that, while it produces material prosperity, it also uproots people from their cultures, their families and their tribes, and creates in them disabling emotional vacuums.

Science has won for itself certain social concessions—freedom from politics, religion, hierarchy, even national boundaries. In technology-dominated systems these freedoms percolate and traditional hierarchical management is unable to resist the percolation. Thus, in a growing number of institutions, horizontal ties between peers are replacing vertical ties as channels of activity and communication. Superiors and subordinates as concepts are in many instances being shoved aside. Career paths are no longer straightforward or predictable but idiosyncratic and confusing. Authority and power associated with a hierarchical position can no longer be taken for granted since the key to competitive success is now centred on the knowledge workers. This creates problems of how to mobilize and motivate staff since everything now seems negotiable by everyone.

Today managers find that they have no book to follow, that they cannot take a hierarchy-based flow of power and authority for granted, that they have only themselves to count on for success, that subordinates are encouraged to think for themselves, that success depends increasingly, indeed crucially, on tapping into sources of good ideas and good collaborators. There is no past history for guidance. Industries are becoming leaner and flatter. Knowledge indeed now translates to raw power. Defection of one or a few key knowledge workers can bring ruin to a company or spawn a powerful competitor. Business must continuously

innovate to stay competitive.

Any kind of progress requires gradients. Generally, the more rapid the progress, steeper the gradient. Thus preconditions of social and economic progress are disparities in salaries, status, recognition, etc. Progress generates its own dynamics. For progress to be sustainable it must assure that gradients do not become too steep, so that there is enough time for the fruits of progress to percolate down to a reasonable degree. However, too rapid or too uniform a percolation would even out the gradients and progress would come to a standstill. To people sameness appals and boredom, like tyranny, is the precursor to social unrest.

Rapid growth is bound to create islands of prosperity. This can create problems of conscience, which can easily lead to misplaced altruistic concepts of a welfare state. Since the price of such concepts is payable in the future, the present will be tempted to adopt a cavalier attitude. Welfare is best met by adequate surplus productivity. Otherwise one may easily walk into the trap of an uncontrolled, and perhaps uncontrollable, inflationary deficit.

Rapid changes make their management impossible because there is no time for ethical reflections, to collect data, and to evaluate their impact. On sociological time-scales, rapid changes are not even quasistationary and there is no past experience for guidance except that they generally produce chaos and collapse. A good deal of management practices in the past has evolved through time-tested wisdom embedded within a culture. That wisdom holds even today but people are in too much of a hurry to exercise it. Adapting oneself to the hectic present has already become an exhausting task, so the future is often blindly mortgaged. Today's economists and social scientists do not even understand the nature of the technological forces at work or the mental make-up of the knowledge worker. So they cannot provide timely warnings and advice on what to avoid or what to pursue.

Control of inadvertent ecological damages created by technological growth will require massive data collection and analysis, in itself a major financial burden. It furthermore requires a global watch system dependent upon co-operation among nations. Mankind may yet be decimated, not because of World War III but because of technological growth careering out of control. Even

though predicting the impact of technology is inherently impossible, its monitoring is not. Technology monitoring, often enough, allows us to gain experience in the complex way it interacts with society and the environment and hence of its likely future impact in the short term. This, in turn, permits, in many instances, containment of its adverse effects, or at least provides an early warning of such effects.

Conventional means of estimating gross national product and other standard measures of progress have already become inadequate. They merely look at increases in output and neglect to account for the irreplaceable loss of natural resources, pollution costs, and other environmental damages (depletion of the ozone layer, contamination of rivers, oceans and subsoil water, smog, acid rain, the greenhouse effect, etc.) they cause. It is estimated that paper, glass, metal and plastic packaging constitute 50% of US garbage by volume and 30% by weight, a frightful indicator of where the Third World might be heading as it industrializes. Immediate global steps are needed to preserve rain forests, freshwater sources, topsoil and a clean atmosphere. Technology must develop recyclable products, specially in packaging. The motto should be 'waste not, want not' and 'recycle, reuse, repair'. While nature may be resilient enough to survive the ecocatastrophies that we burden it with, it might well do so by first wiping out the human race!

The future, however, need not go completely out of hand, or the human race into oblivion, if considered political actions are initiated right away. Presently there is no political mechanism to slough off the old, the outworn, the no longer productive, specially in government. We need some 'sunset laws', not just 'sunrise laws', an organized process of abandonment and replacement of laws and institutions that have become dysfunctional. We need to encourage habits of flexibility, of continuous learning, and of acceptance of change as normal, indeed as opportunities. And what better incentives than tax laws which encourage moving capital from yesterday into tomorrow.

Rajendra K. Bera is in the Computational and Theoretical Fluid Dynamics Division, National Aeronautical Laboratory, Bangalore 560 017.