Change of Paradigm in Science & Technology Policy

by CARLOTA PEREZ

The world-wide technological revolution has changed not only the rules for scientific and economic behavior, but also the game itself. Therefore, the way developing countries deal with science and technology needs more than reassessing — it needs fundamental rethinking. Carlotta Perez, an international consultant, discusses concepts and attitudes that need to change in order to take full advantage of the new conditions.

WE ALL KNOW we are in the midst of a change of paradigm, in the midst of a change in the rules and principles for effective techno-economic behaviour. We have been living through a deep modification of the "common sense" for achieving best practice. This change affects every organization, from business to government, and every level, from international organizations to the smallest local NGO.

We know this has been brought about by the information technology revolution. Yet the transformation goes far beyond the power of computers and Internet; it entails the adoption of organizational models that are adequate for taking advantage of that potential; it involves the modernization of both the structures and the forms of operation of every organization in any field of activity. It implies moving:

- From rigid mass production to flexible networks
- From centralized pyramids to decentralized adaptable structures
- From people as human resources to people as human capital

And, in the developing world:

- From protected subsidized industrialization to competitive production in a globalized world

We all know that and we also understand both the difficulties of such a

transformation and the opportunities it opens, both the uncertainty involved and the inexorable nature of those trends. They are precisely the direct consequence of the technological revolution that emerged in the 1970s and is fully taking root as the main productive potential into the 21st Century.

The questions we need to ask are:

- What does this transformation mean when we look at science and technology in the developing world?
- What does it mean when we examine South-South cooperation in S&T and want to achieve concrete and meaningful results?

It simply means that, just as managers of firms have had to do, painful as it may have been, the science and technology community needs to revise, redefine, reassess and rethink every single thing we thought about S&T in the 1960s and 1970s. We must recognize that the body of knowledge and experience about S&T that we now have was shaped by the conditions of mass production technologies, as well as by the import substitution model of industrialization.

In my view we are far behind in the necessary reassessment. This partly explains the meager results. Without that rethinking, our actions can miss the target. Without that, our chances for success are minimal.

One of our basic tasks is to redefine the field of activity by widening the scope of what we call technology. The changes are quite dramatic and fundamental (see table 1).

Further still, there is a difference between the old and the new paradigm that has far-reaching consequences for developing countries. Because mass production required very high volumes of identical products for maximum profitability, the whole world was pushed into homogeneous patterns of production and consumption. Cultural differences and identities were ironed out in the melting pot of the "American way of life." So transfer of technology was often seen as imposed from abroad and, even when welcome, was in practice judged inadequate.

This situation could change dramatically. The flexible technologies of the new paradigm are essentially adaptable and can cater to diversity. The world is far from reaping the full fruits of this characteristic because the habits of mass production are still too deeply ingrained. This has happened with each paradigm change. The first automobiles looked likes carriages without horses and we are still measuring engines in "horsepower." But, as we learn to use the new potential, we will discover that appropriate technology is possible, profitable and natural in this paradigm.

Those are only a few of the many fundamental changes in outlook that we need to make in order to guarantee that we can take proper advantage of the opportunities offered by this paradigm.

But the essential thing we must be

Table 1—SCIENCE AND TECHNOLOGY PARADIGMS

	Previous paradigm (1950s-70s)	Present paradigm (from 1980s)
Focus of technological efforts	Mainly manufacturing industry (to escape from raw materials dependency)	All wealth-producing activities, from raw materials to information and social services
Type of technology pursued	Tangible technology (embodied in equipment and products, while human know-how was about using them)	Tangible and intangible technologies (not only software and design, but also organizational know-how)
Aim of technological development	Radical innovations, patentable products which can be "sold" and/or processes that can be "packaged"	Radical and incremental innovations. Those that can be sold and those that imply constant modifications, adaptations and improvements (which make a difference in results, but cannot be sold as such).
Where and by whom is technology developed	In R&D departments inside firms or in university institutes by scientists, engineers and technologists	In firms, in institutes and between them, done by all members of the organization and by all members of society
What is innovation in society	Innovation is a "job" in a specialized organization	Innovativeness is the way of living and working in the Knowledge Society

clear about is the need to reexamine our ideas and our experience:

- What worked yesterday will probably not work today.
- What failed yesterday could work tomorrow.

Now I would like to advance some ideas about what, in my own view, are the ways forward, the concepts and attitudes we need to change in order to take full advantage of the new conditions:

1. Break the "marriage of convenience" between science and technology

In import-substitution times, technological activities had to take refuge inside the scientific laboratories. Mature tech-

nologies from the North were in no need of local innovation. So there was no real demand for technology, and it had to "marry" science and adopt its behavior. Now, technology is needed side by side with every production activity and with every social service. Now it must come out from the temples of science and fully join the action.

We need to bring technology in full contact with production. We need it to become technological development and engineering so we can really change the quality and productivity of our productive activities. What we don't need is to have technology working in isolation, with the methods, criteria and pace that characterize, rightfully, the production of scientific knowledge.

But we also need scientific and technological research (and it is unreasonable to pretend that scientific projects should respond to demands from industry in developing countries). Local science and local scientists are our dynamic link with the universal pool of knowledge.

2. Widen the scope of "technology" to include organizational, managerial and social capabilities and know-how

Scientific, technical and social disciplines need to be put to the task of problem-solving both in directly wealth-creating activities and in those that are geared to enhancing the quality of life of the population. If firms need to be world competitive, governments and social services need to modernize even more urgently, to deliver management and social well-being with maximum efficiency and effectiveness.

Unless we believe in the "trickle-down effect" (and are also willing to wait for it to slowly work its way through the system) there is no reason why publicly funded technological development efforts should concentrate on competitive activities only. The whole range needs to be covered, though probably by different people.

3. Expand the range of actors in producing innovation

In accordance with the new paradigm, continuous improvement needs to become the way of working for all, from the top managers and specialists to every single worker, and it needs to become a way of approaching activities, from the production world right into the community and the home.

Learning to analyze processes, to identify ways of improving them, reducing efforts and costs, adapting them to specific conditions and even changing them radically is necessary for all citizens. Educational reform should include the introduction of such habits as a key component, and so should job training programs. But the almost "cultural" change that this implies for all those that are now in industry or government is very deep and very necessary.

A huge social contribution could be made by the S&T community by becom-

ing the champions of generalized innovativeness in society.

4. Stop trying to build a "bridge" between university and industry, and instead take the dividing river away

We need to learn to live in constant interaction between technology users and producers. We need to open universities to all social actors and move researchers and engineers out into the field, out where their work is used. We are coming from long decades of mutual distrust. Researchers looked down on "business people who are only interested in money," and business people considered researchers "impractical dreamers who don't know the real world." These attitudes resulted in a lack of common language between the two worlds. We now need to build a platform of mutual trust and respect, which can only result from frequent collaboration, probably beginning with small simple things and growing from there.

5. Clearly distinguish four areas of action which are all equally crucial:

- Scientific and technological research understood as the creation of knowledge capital for today and tomorrow;
- Technological development for world competitiveness geared to modernizing the export sectors and their support network, involving incremental and radical innovations (with full consciousness of the international knowledge frontier);
- Technological development for improving the general wealth-creating capacity of the country, the regions, industries and firms (particularly small and medium enterprises). This includes educational reform, technical infrastructure, development of consultancy, financial and technical services (from information to maintenance), and so on;
- Technology for the people geared to enhancing the quality of life of each portion of the population on each portion of the territory. It would involve the development and implementation of appropriate technology, the enhancement of human capital with the specific needs of each particular locality, and stimulating general innovativeness to solve local problems.

We need to move strongly on all four fronts. Yet, each of those four distinct areas of action must be approached differently. Each requires:

- Different criteria of priority
- Different ways of funding and different sources
- Different actors and ways of organizing
- Different mechanisms for promotion and conditions for diffusion

(for instance, scientific research and technology for the people should be vastly disseminated, while technology for competitiveness should be patented and closely guarded)

- Different ways of measuring results

What works or fails in one front, does not necessarily work or fail in another. As with everything else in this paradigm, segmentation, diversity and adaptability are essential for effectiveness and for successful efforts.

So, let us segment and diversify our efforts in South-South cooperation for science and technology. Let us differentiate the goals in research, development, engineering and organizational modernization, and let us gear them carefully to the various objectives to pursue.

Let us also adapt them to the various realities of the developing world, between and within our countries. This was not easy to do in the mass production world. It is not easy either in the flexible networks world we are now building, but it is certainly feasible. Let us make sure we don't miss the opportunity. ■