"There must be a close linkage between science and industry or between the producer and the user of technology."

Pivotal Technological Problems Confronting Third World Countries*

by

Serafin D. Talisayon**

ASSUMPTIONS

My first assumption, which many share, is that the basic root cause of the difference between developed and underdeveloped countries arises from *difference in productivity*. The difference lies in *how* new wealth is created in an economy.

Productivity, on the other hand, is a function mainly of technology *and culture.* This constitutes my second assumption. That technology is a strong determinant of productivity is also self-evident (Figure 1A). That productivity depends on culture requires explanation.

Immediately after World War II in Japan and Europe, one notes many factories and production networks destroyed except those used for providing basic needs. What remained were skilled people, production equipments and infrastructures, and technological formulas and blueprints. Besides, the following were obtaining in their societies: (1) a shared, concrete image of the system they would like to recover or restore, and (2) shared will towards recovery. These last two are cultural factors. Take modern Israel. A shared moral consensus and a strong political will, necessary for their national survival, are strong cultural factors which have made Israel and its economy what it is today. The associated agreement in goals and objectives, discipline and work ethic are important cultural determinants of Israeli development. A similar pattern can also be noted in Japan during the Meiji Restoration starting in the 1870s, when Japanese leaders were convinced of the necessity to modernize Japan using industrial know-how from outside.

Recent interest in the behavioral and cultural factors affecting productivity is evidenced by the popularity of books such as "Theory Z" and "In Search of Excellence". The latter book's popularity also stems from the idea, and the associated concern, on the part of American managers and entrepreneurs that a Japanese edge in productivity could very well be traceable to cultural differences between American and Japanese societies.

My third assumption is that the *utility of technology is a function of economic and cultural environments.*

---

*Edited transcript of talk before the Workshop on Invention Development and Innovation organized by the World Intellectual Property Organization (WIPO) in cooperation with the Philippine Invention Development Institute (PIDI-NSTA) with the assistance of the U.N. Development Programme (UNDP), Manila, November 25-December 6, 1985.

**Professor of Philippine Studies, Asian Center, University of the Philippines, Diliman, Quezon City, Philippines.

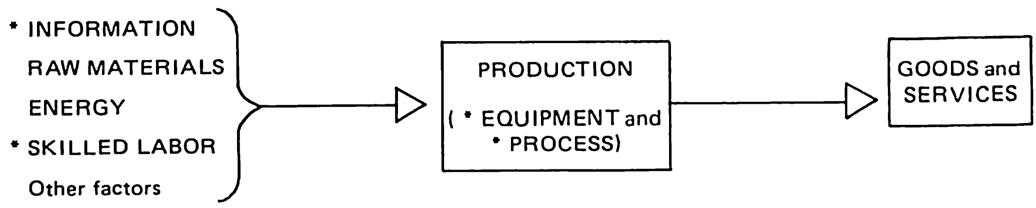
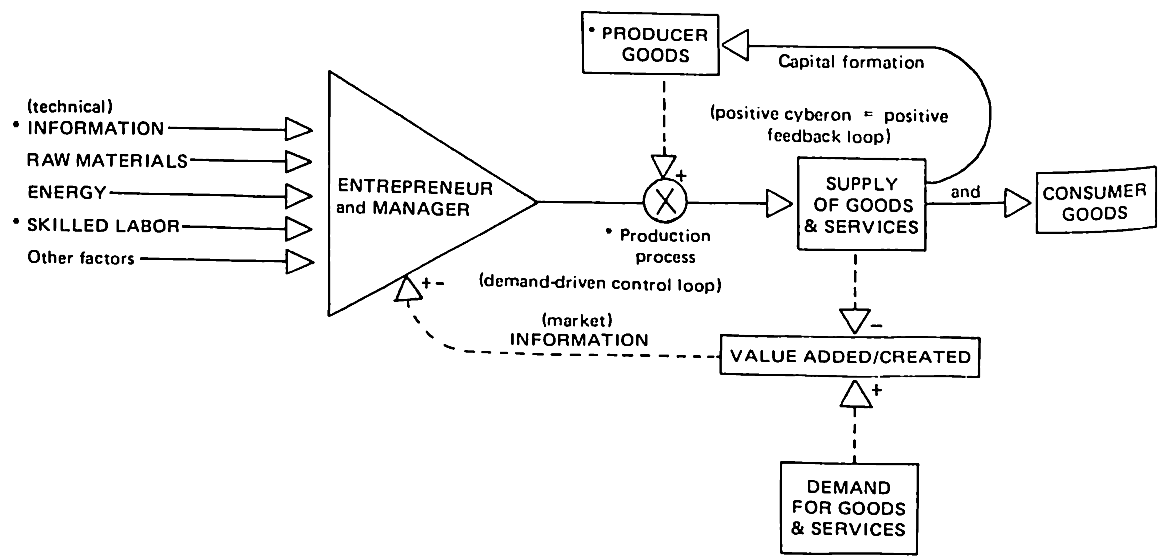


Figure 1A
Four Points (*) Wherein Technology Enters into the Production Process



LEGEND:

– – – –▷ control or information flow (dashed-line arrow)

———▷ material flow (solid-line arrow)

(X) control over process or flow

Rectangles: quantitative pools or compartments

Large triangle: integration of inputs

+ or – beside arrowhead: general direction of influence

* points wherein technology comes into the production process

Figure 1B
Feedback Pathways in the Production Process

Take the SEIKO digital wristwatch. It is very useful in an urban setting: in keeping track of time and appointments in a fast-paced, formal and highly organized urban environment. But the moment I visit my home province in the rural areas I find the same wristwatch quite useless. I remove it and set it aside because I do not have schedules to keep, except to find out when to turn the radio for the 7 o'clock news. Transported into a rural environment, the utility of this technology is drastically reduced.

I have a Commodore VIC20 microcomputer, a very cheap but useful home-use computer. When used in an urban setting like Metro Manila, its utility is not 100 percent compared to when it is used, say, in New York City. In Metro Manila I can use my VIC20 for accessing data banks such as COMPUSERVE in the U.S. With only one franchised supplier, there are less softwares and peripherals available locally than in New York City. In addition, Metro Manila VIC20 users are too few to warrant organization of users' clubs linked by telephone. I estimate that the utility of a VIC20, when used in Metro Manila, is only about 70-80 percent of its full utility in New York City.

Take an extreme case. If one gives a programmable calculator to a forest-dwelling upland ethnic group, zero technology transfer takes place. The calculator is not useful at all to this community; it is *not a technology* at all in this particular environment. All properties which make the programmable calculator a technical tool to, say, a university engineering professor disappear in this cultural setting. No member of the ethnic group can use, let alone repair, manufacture, assemble, or redesign the device. From this extreme example, one may restate the third assumption in stronger terms: *that technology is embedded within an economic and cultural milieu.* Technology can be viewed as consisting of two components:

(1) the visible part, which is the physical gadget, machine or device one can physically transfer or transport from place to place quite readily; and

(2) an invisible part, namely the sociocultural milieu which makes the technology what it essentially is: useful. This not-so-visible part is left behind when a device is physically transfered to another milieu.

SOURCING OF TECHNOLOGY

There are two sources of technology with respect to a nation: external (foreign) and internal (domestic). Third World countries, in a hurry to develop, increase productivity, and set up employment-generating enterprises, find it more expedient in the short term to simply import technology. Educated urban elites, from whose ranks many entrepreneurs and other technology-users originate, are often beholden to and more familiar with Western technologies and technological lifestyles and choices. It appears that this manner of sourcing technology will not abate in the near future; Third World countries, by and large, do not have sufficient indigenous capabilities to produce new technologies for all their needs. They have little choice, in the short term.

Two main problems attend DC-to-LDC (developed countries to less developed countries) technology transfer. The "transfer" of technology is not always complete, as pointed out above. Utility of the technology is not always 100 percent in a Third World setting compared to its source, and utility may be so low and control over its use and production so curtailed that no real technology tranfer may be argued to have even taken place. This brings up the second problem: control over the technology transfer process. Often Third World countries do not have this control and as a result, technology dependence remains over the long term. The problem may be compounded by lack of clear and coherent policy and corresponding government agency with central authority over technology transfer decisions.

A technology transfer scale, which sequences the types of technology transfer according to desirability, is suggested here as an operational way of clarifying the concepts and criteria involved in technology transfer. The sequencing criterion used here (see table below) is short and long term impact on a country's balance of payments. The approach can be applied quantitatively to specific technologies using the analytical framework of social benefit-cost analysis.

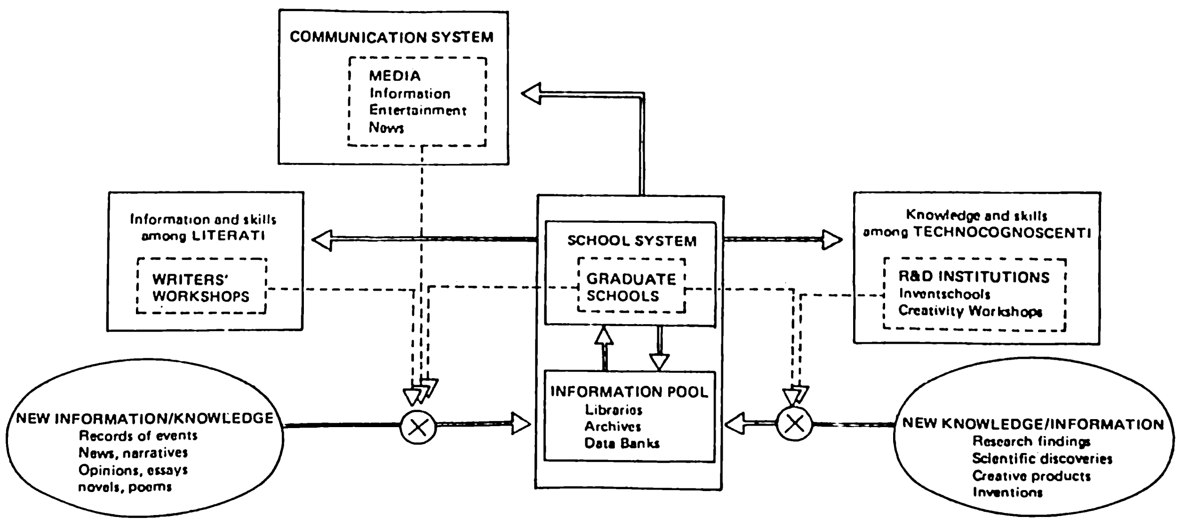
TECHNOLOGY TRANSFER SCALE

	Method	S Impact on Balance of Payments Short-term	Long-term
1.	Transfer of expertise or equipment to create or expand exports from Source(S) to Recipient (R) (example: Transport Training Center in the University of the Philippines at Diliman)	+	– – –
2.	Transfer of technology resulting in shift of S-R trade mix towards S's advantage (example: U.P.-Cornell Graduate Education Program)	+	– – –
3.	Import of spare parts and foreign expertise to run/repair equipment imported from S	– – –	– –
4.	Purchase of franchise, payment of royalty, or tied purchase of raw materials from S to R.	– –	– – –
5.	Import of equipment or expertise.	– – –	
6.	Import of equipment with training of local R personnel in operation and repair.	– – –	+
7.	Training from S of local experts from R in adapting/redesigning of equipment.	– –	+
8.	Local R experts/inventors design, test and produce goods or equipment from technical information bought from S.	–	+ +
9.	S assists R in setting up complete local capability to design, test, and manufacture equipment or goods produced from such equipment which R in turn can export.	–	+ + +

We take special note of the worst or most insidious form of technology transfer: this is the transfer of expertise, know-how and equipment in order *to pave the way* for later entry or expansion of exports by the technology donor country (Type 1), or in order *to shift the trade patterns* of a Third World country in such a direction as to favor the donor country (Type 2). An example is the Transport Training Center in U.P. Diliman set up and operated with Japanese technical assistance. The Center has been helping Filipinos and other Asians learn how to solve traffic problems and how to plan and manage transportation systems but in so doing, the Center creates conditions favorable to more Philippine importation of Japanese cars, car parts or associated automotive equipments. American technical assistance which poured into the U.P. Los Baños (agriculture and forestry-based) campus including the associated International Rice Research Institute has undoubtedly also been of great help to the country. However, the same assistance can be viewed as contributing towards distracting Philippine expertise, resources and attention away from equally or more important technological/engineering areas crucial in the long term such as small-scale computer technology, power engineering and biotechnology.

Types 7, 8 and 9 are the most desirable types; they all involve establishment or improvement of local capabilities to design/redesign, adapt, test and develop, and completely fabricate a device. Internal sourcing of technology depends on a most crucial factor; the establishment of *investment structures for local technology production.* In the language of cybernetics, an "investment structure" is defined as a positive feedback structure (positive cyberon), wherein the magnitude of the output itself directly determines the speed of production during next production cycles. Presence of a positive cyberon explains why economic growth is proportional to capital formation (see Figure 1B). Examples of investment structures in knowledge production are: graduate schools, research and development (R&D) institutions, technical normal schools and inventschools. Investment structures may be likened to the "mother geese which lay the golden eggs".

Take a graduate school. Once the number of Ph.Ds in a particular field of specialization exceeds a critical mass (around 5-7) in one department, then there is the capability to produce more Ph.Ds for use elsewhere as well as for self-sustaining self-replenishment of the complement of graduate faculty. Spreading around the same number of Ph.Ds over several places or departments will fail to produce the above result. This is true when considering other national resources for setting up similar investment structures for technology production. A minimum concentration to achieve self-sustaining critical mass of resources is necessary. These processes are diagrammed in Figure 2.



Double-line arrows indicate information flow. Dashed-line arrows indicate control flows exerted over valves or flow control points shown as ⊗ . Rectangles are information pools or compartments; special sub-pools therein indicated in dashed line rectangles are investment structures operating via positive cyberons.

Figure 2

Four Types of Investment Structures (and Five Positive Feedback Loops) Involved in the Creation of New Knowledge and Information.

USE OF TECHNOLOGY

There is a prevalent notion, which is correct but vague, that there must be a close linkage between science and industry or between the producer and the user of technology. This general notion needs to be sharpened into a more specific and operational formula.

We fall back on the Schumpeterian thesis that entrepreneurs are the most important actors responsible for making economic development possible. Entrepreneurs are the people who make decisions on *whether, when and how to establish new productive capacities* in an economy, at least in market-oriented economies. In a mixed economy, government planners share in making such decisions, in addition to shaping the policy environment within which entrepreneurs operate.

We now extend the Schumpeterian thesis by observing that it is an entrepreneur who makes decisions on whether, when and what technology to use in a given productive undertaking. Therefore, *entrepreneurs are the primary technology users.* "Primary" is used here to emphasize the fact that they use technologies for production, in contrast to consumers who buy and use technologies for consumption.

It can now be seen that the linkage, or lack of it, between entrepreneurs as technology users and the scientists, researchers and inventors as technology suppliers is a crucial one. This linkage may be weak. Scientists conceive of "applied" research projects and topics mainly according to their disciplinal biases and with untrained regard for real business world needs, demands and opportunities – resulting in numerous research findings with little or no usefulness in the marketplace. Third World businessmen, on the other hand, not aware of the researches taking place in their countries, have the observed habit of looking first to developed countries for needed technologies, or may be biased towards types of ventures which require Western technologies.

In the Philippines, the Minister of Science and Technology has initiated a "demand pull" strategy as one of the means for prioritizing R & D. However, this policy could be further fine-tuned to bring together more directly technology users with technology suppliers. Something like a technology clearing house, or a technology market and exchange is needed. Here at the Philippine Invention Development Institute, technology innovation or adaptation needs of businessmen and industrial users is linked through a new program to R & D efforts of local inventors. Through these and other mechanisms, tighter linkage between sellers and buyers of technology is effected.

There is also a need to give inventors a better "feel" of the needs and demands in the marketplace, in the same way that entrepreneurs have trained themselves to "smell" new business opportunities ahead of others. Inventors must be, besides being problem-solvers, also "problem-finders" sensitive to existing and emerging needs and problems. This consideration is incorporated in the Technological Creativity and Invention Development (TCID) courses developed by the Philippine Invention Development Institute and by the Asia-Pacific Inventschool (TAPI). The numerous inventors who have devoted their energies to redesigning/reinventing the common cooking stove year after year show that there is a need to give training courses in technological creativity not only in problem solving but also more importantly in problem-finding.

The *inventschool concept* pioneered in the Philippines and Sweden is an institutional mechanism that other Third World countries can study and adopt in order to develop indigenous capabilities to produce needed technologies.