Different View of Third World

Matrix disciplines reveal opportunities for improving or extending activities in developing nations

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Technology has a twofold content in broad outline. Technology is the application of science to the solution of practical problems. This notion refers to a process of development. Technology also refers to a set of techniques, both hardware and software, that are used in society. In fact, the two notions are inseparable; the application of science creates new techniques that are then added to the set of techniques for use. This combination would lead to an ever increasing stock of techniques, but for another process that is active in society: the dispensing of technology. So the complete picture is composed of three interlocking parts: creation, use, and disposal of technology, the whole firmly embedded in society. (See Figure 1.)

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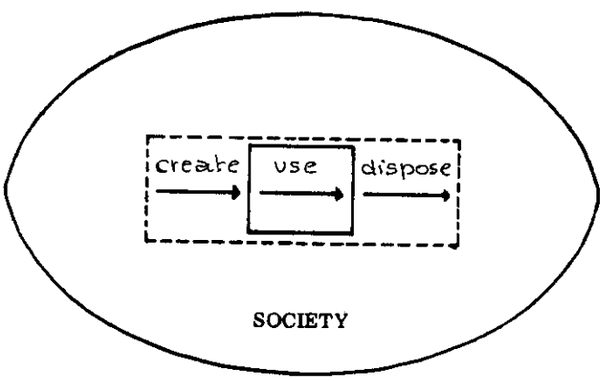


Technology in Society

Figure 1

In short, technology is something that exists within society and is in a state of constant change. There is a strong relationship between technology and society.

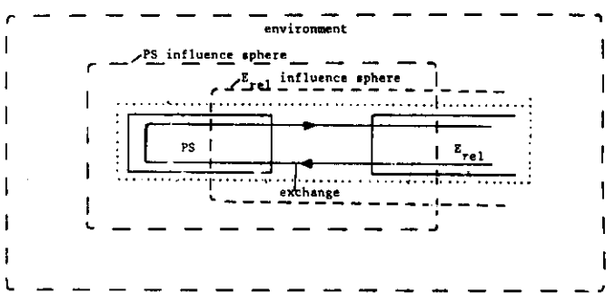
**Lector in the Department of Industrial Engineering, Eindhoven University of Technology, Eindhoven, The Netherlands; paper delivered at the LES International Conference at Utrecht, May 1978.*

The latter uses the fruits of technology, but it is influenced by technology at the same time. Hence, we find a dualistic relationship between technology and society.

However, when we go deeper into this subject, we notice that technology does not exist alone. It is connected to a variety of organizations that either use or change technology, or they influence its development. Technology exists predominantly in a particular sector of society, namely industry. Industry is a complex structure of which the building blocks are industrial enterprises. Technology has a real meaning only when understood within this particular context.

To achieve its objective, producing and marketing goods and services, an industrial enterprise combines a number of inputs which are acquired from its environment in order to produce something else. Seen in another way, an industrial enterprise is a system that maintains an exchange relationship with its environment. This exchange concerns both the inputs of industry and its outputs.

In general, six types of exchange commodity can be discerned: Finance, equipment and utilities, personnel, materials, energy, and information. Managing an enterprise, then, will be associated with maintaining the flow of these commodities between the enterprise and its environment and with changing the commodities within the enterprises in order to create the required products or services. Yet again, both the enterprise and its interacting environment belong to a wider environment which is society at large. (See Figure 2.)



The production system and its relevant environment within the wider environment.

Figure 2

It is obvious that technology is concerned with all the exchange commodities. This leads to the understanding that the usual identification of technology, with the materials transformation process only, is a very limiting association! Nor should the notion of technology be restricted to the enterprise itself.

PHASES / FLOW ELEMENTS	ACQUIRE	PREPARE & MAINTAIN	PROCESS	DISPOSE
FINANCES	procedures are complicated; interest costs are relatively high	control and calculation methods are old fashioned and are not applied adequately	no scientific investment selection; no effective control of allocation of the finances	insufficient control of the use of the finances
PERSONNEL	methods for personnel selection are not appropriate	lack of adequate training; traditional habbits are strong; lack of plan for development	personnel not used to modern production methods	rules for firing are not appropriate
EQUIPMENT	desired tools are difficult to obtain; delivery times long; spare parts are not available anymore	inappropriate: .instructions for use .policy for maintenance .lay-out	incorrect use of equipment	old equipment not disposed in time
MATERIAL	desired quantity & quality often not available; long delivery times; sub-contracting impossible	inefficient control of stocks	low productivity	low quality and relatively expensive products; lack of a marketing policy
ENERGY	insufficient controled supply			
INFORMATION	lack of information about market, modern production methods, appropriate designs	lack of flow of information within the firm	absence of: effective quality control, information processing, work preparation and planning	absence of supply of information about the products

Summary of the major internal problems of metal industry.

Figure 3

Technology on the enterprise level, in my view, has to be associated with the use and change of all techniques which together bring about the flow and transformation of the six exchange commodities mentioned. I prefer to think of a technology — pattern which exists within the enterprise and that such technology patterns characterize enterprises in fact.

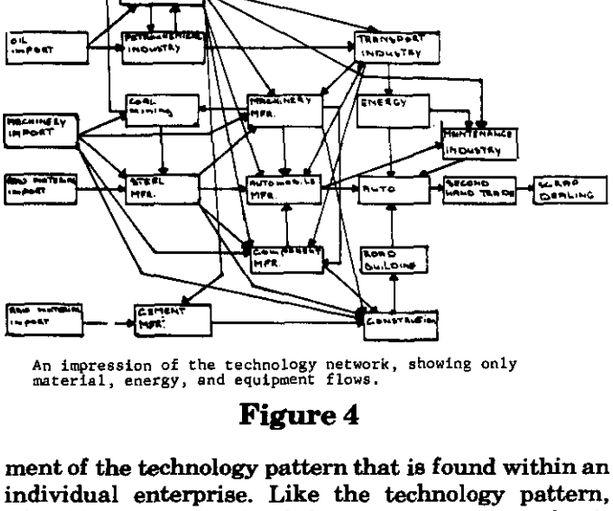
A specific version of that pattern appears when the exchange model is further elaborated from the point of view of the management engineer. Within the enterprise four main sequential functions can be distinguished: Acquisition, preparation, processing, and disposal of each of the exchange resources. Outside the enterprise, in its exchange environment (also called its relevant environment, since it consists of that part of the environment which is relevant to the functioning of the enterprise) a number of sectors can be discerned. These are finance, the labor market, suppliers, customer groups, government agencies, competitors, and research organizations. The composition and size of the exchange environment will depend on the type of enterprise under consideration, of course. The situation can be visualized in a picture showing the various activity points of the enterprise's technology pattern. (See Figure 3.)

The two matrices provide an instrument for analyzing enterprises with the purpose of designing and monitoring improvement strategies. They also represent a map or ground-plan on which the technology pattern can be designed and projected.

Following the line of thinking mentioned above, we can see technology in its proper structure, as an integrated set of techniques which extend from the enterprise into its exchange environment.

So far, for the sake of analysis, I have discussed only the single enterprise but, as was mentioned before, enterprises are the building blocks of a complex structure called industry. Hence, another step will be necessary, namely visualizing a system of enterprises within its wider environment. The exchange commodities thereby provide us with the "bloodstream" of that system in which the various enterprises can be considered to be the specialized "organs" that either transform, store, or transport the various commodities, or influence any of the flows through restriction, delay, or increase. The industrial system itself being a component part of society. As six flows can be distinguished and because of the large number of enterprises, this visualization cannot be depicted easily. However, an impression can be given with materials, energy or equipment flows as a guidelines and the case of a system called the motorcar. (See Figure 4.)

It is useful to consider technology-at-large as being associated with the development and maintenance of a web of resource flows within society. It is the comple-



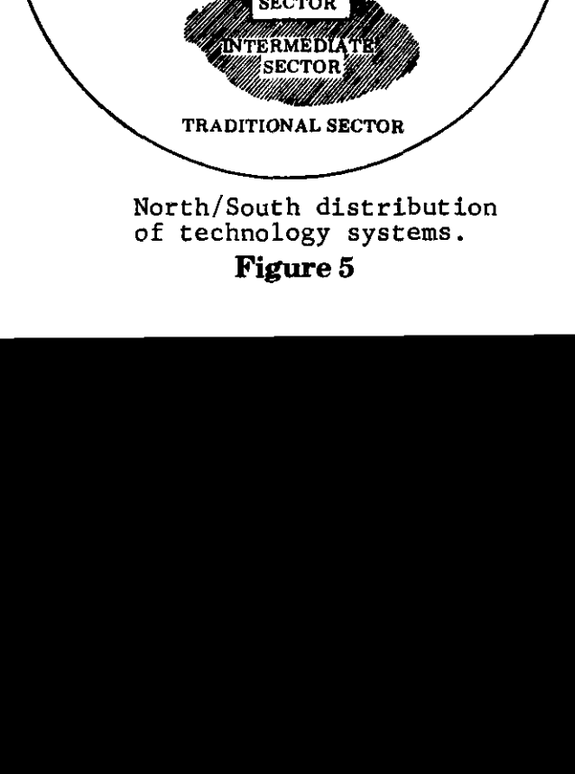
An impression of the technology network, showing only material, energy, and equipment flows.

Figure 4

ment of the technology pattern that is found within an individual enterprise. Like the technology pattern, which is characteristic of the enterprise, the technology associated with the web, or technology network, is characteristic of a particular country.

Network

It should be realized that technology networks are not restricted to the boundaries of any country in the modern world; in fact, we may see technology in a huge network that crosses national boundaries. Therefore, we can speak of a modern technology network. The larger part exists within the Northern Hemisphere and branches extend into the Southern Hemisphere, even into the domain of those countries that are in the course of social and economic development. Within these countries, another type of technology network exists, mainly composed of traditional techniques which are similar to those found in the Northern Hemisphere, but having an entirely different nature. (See Figure 5.)



North/South distribution of technology systems.

Figure 5

Actually, the present, or dualistic, technology network structure of the world is in a transient state. Within the Northern Hemisphere, technology is undergoing a constant change. This is also the case between the Northern and Southern hemispheres. (For the sake of simplification, those countries in the Southern Hemisphere having characteristics similar to those of the north are considered to be Northern Hemisphere countries. I use this geographical notion in a rather loose way, following the habit of international politics.)

The transfer of technology is the process by which the structure of the technology network within national boundaries changes, or, the way that technology patterns change at the enterprise level.

Technology transfer presupposes a structure in which new technologies can be embedded.

As technology networks are concerned with the development and maintenance of the web of resource flows, no technology transfer can occur on a large scale unless the entire technology pattern is involved. If that is not the case, the absorbtion capacity of a nation for technology will be very limited and the functioning of the technology when transferred will not develop to its full potential. In fact, many technology transfers do not transfer the entire technology pattern, nor does the national environment behave entirely as the exchange environment. What results in many developing countries is a sort of mutilated technology pattern, the larger part of which remain within the country of origin. I can illustrate this with a case study from Indonesia, in the year 1972. (See Figure 6.)

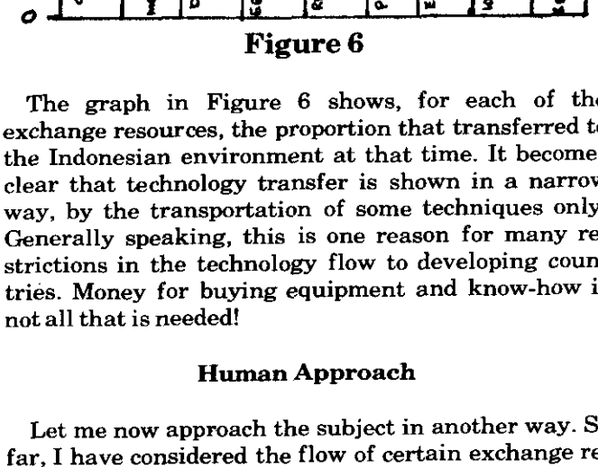


Figure 6

The graph in Figure 6 shows, for each of the exchange resources, the proportion that transferred to the Indonesian environment at that time. It becomes clear that technology transfer is shown in a narrow way, by the transportation of some techniques only. Generally speaking, this is one reason for many restrictions in the technology flow to developing countries. Money for buying equipment and know-how is not all that is needed!

Human Approach

Let me now approach the subject in another way. So far, I have considered the flow of certain exchange resources and technology networks in which these flows are shaped. I will illustrate further with human beings.

Soon, the Earth will be inhabited by five billion peo-

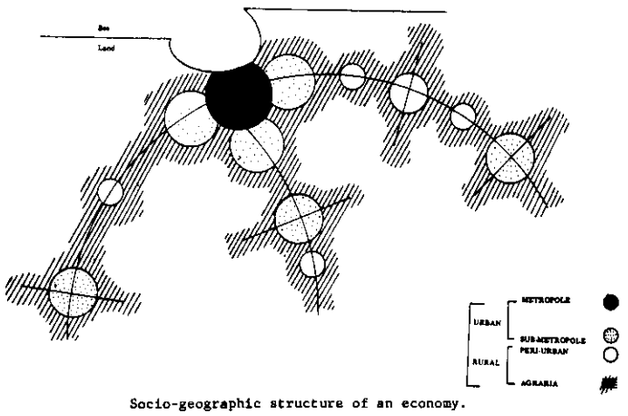
ple. Two billion live in the Northern Hemisphere and they are about equally divided between the so-called First and Second Worlds. Three billion people live in the Third World. Modern technology networks encompass approximately one billion people who live mainly in the Northern Hemisphere. In other words, 4/5 of the world's population lives outside this system! This 4/5 lives in a large variety of traditional systems that are generally less efficient than modern systems; poorer in many respects.

For the reasons mentioned earlier, extention of the modern technology network into developing countries is restricted. Over the past few decades, global population growth was much faster than the development of new technological systems.

Still, although their lives are rugged and based on scarcity, people who remain outside the modern systems somehow manage to survive. And in many areas they develop, although not along the lines of modernization and the growth of a modern technology network. It seems that between a restricted modern sector of developing society and the traditional sector there is an intermediate sector emerging in some countries. (See Figure 7.)

Looking more closely into this threefold description of technological develoment in Third-World countries, I shall refer to work done in Indonesia in 1977, where a map of the prevailing techno-geographic structure of Java was drawn. This provides us with a more detailed picture of the situation in a developing country.

It indicates that the technology structures are even more dispersed than was suggested earlier in this paper. One can even think in terms of distinct economies within the national boundaries. The diagram in Figure 8 shows the proportion of the Javanese population living in each of 12 distinct sections. For the sake of simplicity, I shall stick to the threefold structure of



Socio-geographic structure of an economy.

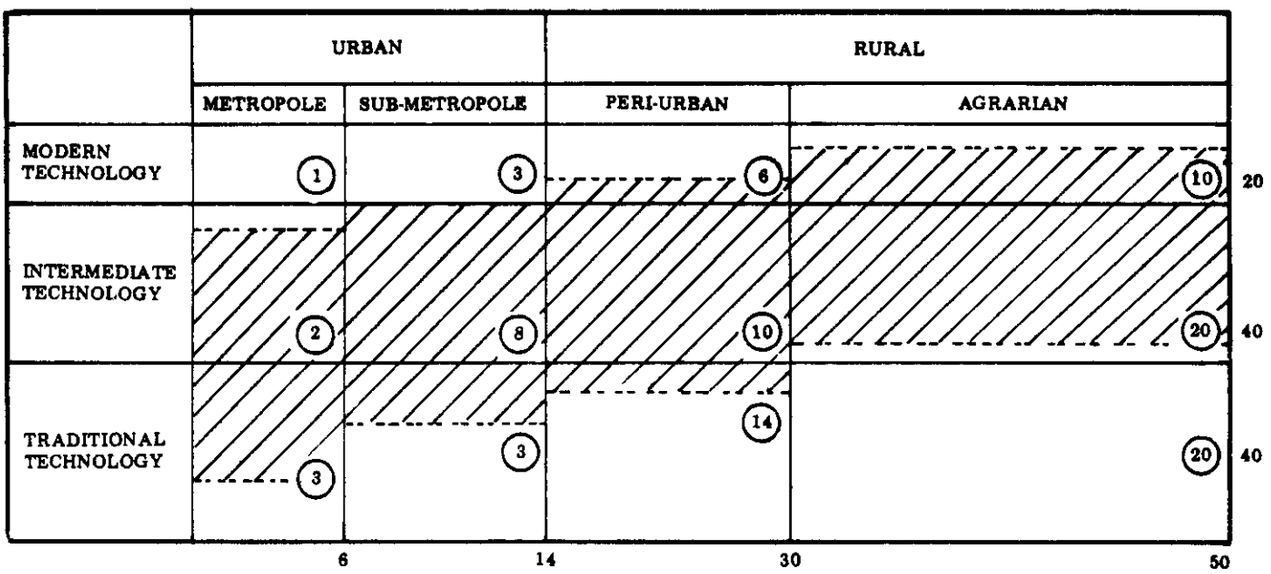
Figure 7

Figure 7, but using the proportions given in Figure 8 and taking the Javanese population of 80 millions. Then, the number of persons living in each of the sectors can be calculated. The result of such calculation is: in the modern sector eight million, in the intermediate sector 42 million, and in the traditional sector 30 millions.

Each of these sectors has its own nature and the technology transfer will differ. The prevailing structures will largely limit the possibility of introducing new technology. However, both the types of technology that can be absorbed and the rate at which new technology can be introduced will differ, too. But there is still another problem, in my opinion.

Another Need

Technology offered by the northern countries is most suitable for the modern sector of a developing society. I



Estimated proportions of the population of Java living under various geographic-technological conditions. (Hatched area: the "Intermediate Sector.")

Figure 8

suggest that there is a need for quite another type of technology that fits into the intermediate sector.

This is not a technology that has to be invented, but due to various reasons, it is difficult to find in developing countries. It is the kind of technology that has been used in the smaller enterprises of the northern countries for a long time.

Let me depict this in another graph. Assuming a scale of technology, with traditional or low-grade technology in one hand, and modern or highly-productive technology on the other hand, and assuming a sequence of steps in the development of a productive process; I arrive at a diagram in which technology options can be projected at different points on the plane.

There seems to be a structure which subdivides this plane of technology options. In the upper-left corner, where technology is highly effective for producing essential materials, there seems to exist little possibility for trading in technology. The originators of this technology will not sell their production secrets, although they may be willing to provide the materials to enterprises for processing. Then, there exists a portion of the technology options that are tradable, but they are generally too complicated to be simply copied, yet are transferable. And, finally, with the lower part terminating in the area of traditional techniques, there are technology options which are commercially unimportant. (See Figure 9.)

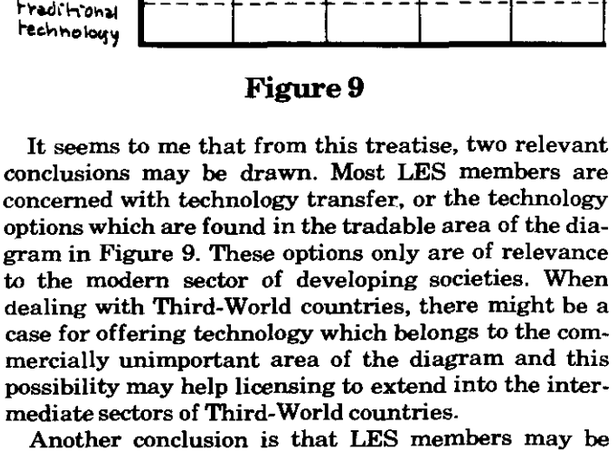


Figure 9

It seems to me that from this treatise, two relevant conclusions may be drawn. Most LES members are concerned with technology transfer, or the technology options which are found in the tradable area of the diagram in Figure 9. These options only are of relevance to the modern sector of developing societies. When dealing with Third-World countries, there might be a case for offering technology which belongs to the commercially unimportant area of the diagram and this possibility may help licensing to extend into the intermediate sectors of Third-World countries.

Another conclusion is that LES members may be able to improve or extend the range of their activities if they are aware of the need of countries or enterprises for technology that can complement the existing technology patterns or networks. (See Figure 10.)

		PRODUCTION PLAN	ENTREPRENEURS PRODUCTION SYSTEMS DEVELOPMENT			
			PRODUCTION + DISTRIBUTION	TECHNO-LOGY	PERSON-NEL	FINAN-CIAL
NATIONAL PLAN		1	2			
GOVERNMENT INFRASTRUCTURE DEVELOPMENT	FINANCES	3	4			
	EQUIPMENT					
	PERSONNEL					
	MATERIALS					
	ENERGY					
	INFORMATION					

The various components and stages of interactive development.

Figure 10

Finally, it may be interesting to know that there is a gradual change in the conditions for developing industry in most Third World countries. This change refers to an increased control over processes.

At the same time, the modern industrialists are being confronted with a growing complexity when dealing with developing countries. In my view, such complexity is often thought to be bureaucratic interference, but this is incorrect. Using the model explained earlier in this paper, the problem of setting up an industrial enterprise in a developing country is related to organizing the appropriate technology pattern.

In doing so, not only the enterprise proper has to be considered, but also the exchange environment. In a complex environment, such an endeavor will succeed only when tackled in close cooperation with the national offices and relevant organizations of the country in question. This approach can be called an iterative approach.

Looking at the model frame in a different way, four consecutive steps can be distinguished. They are 1) setting the Terms of Reference for the venture; 2) selecting the correct elements for the technology pattern to be developed after consulting the national environment and the enterprise experts; 3) detailing agreements with the various sectors of the national environment, and 4) developing the technology pattern.

I can not elaborate further on this subject within the context of this paper; however my point of issue for LES members is that when making technological contracts for developing countries, much work has to be done, and this work requires a detailed examination of the environment, as well as of the technology patterns that will develop in it.