Moving Technology About

Two meanings seem to be attached to technology transfer: Using ideas from one field in another, and using ideas from one country in another.

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It is easy enough to make a general case for technology transfer. It's fully as important as discovery or invention. Because technology deals with knowledge as well as goods and services, whenever it travels from one place to another it carries with it hope and opportunity; not just merchandise. Technology is, therefore, a truly revolutionary force. While it is unrealistic to expect technology to solve all the world's problems, I think most of us see technology as one bright spot that can improve the human condition in dramatic ways.

It is also easy to make the case that of all the areas of research, chemistry and biochemistry are especially fruitful ones for attention. A marketer would say chemistry has high value-in-use.

What, then, are the conditions in which research and development can be successfully applied and dispersed across national boundaries? There is much misunderstanding both in the U.S. and around the world about the *process* of technology transfer; *obstacles* to worldwide diffusion of privately owned technology; and finally, *incentives* motivating multinational corporations. Unless all three of these factors are dealt with successfully, the transfer of technology will flounder.

Innovation

The first thing we should recognize is that while basic ideas may emanate from such sources as the academic community, the payoff must ultimately come from industrial application. Until ideas are translated into products and services, produced in quantity at fair prices, there is little if any social utility. Pharmaceuticals, plastics, synthetic fibers, protective coatings, chemicals to increase agricultural yields — these and many other products spread throughout the economy are the end product of our science and they are almost invariably produced by profit-making industry.

Further, the road from science to final product — from conception to commercialization — is long and costly. The innovative process starts with scientific discovery and invention and proceeds through the submission of patent applications, process development, small-scale manufacture, test marketing, and today various government clearance procedures.

Along the way, even before we know if we have a marketable product, we must also think about financing and engineering requirements, applicable laws and regulations, and competing patent positions.

The following five points about this innovative process deserve special emphasis:

- The cost curve is geometric. Tens of thousands of dollars become hundreds of thousands of dollars, then millions of dollars and often many millions of dollars as we go from laboratory to commercial production.
- There is no payout until the total process is complete. Only upon successful completion of all the steps I have described, and others, are costs recovered and, finally, profit is made.
- The money by and large comes from the private sector, which generally pays the bill for innovation in chemistry and biochemistry. In the U.S., government funds cover more than half the nation's total bill for R&D, but in the chemical industry more than 90% of the bill is paid with stockholders' money. Chemical and pharmaceutical companies quite naturally look upon the results of this work as their private property, to be protected where possible with legal means, and in no case to be distributed to others without at least trying to turn a profit.
- Transfer and transition are an integral part of the process of innovation, even on an in-house basis. Believe me, it is no easy trick to maintain momentum as an idea passes through many hands, even within a single company; and finally, and most importantly,
- *If any one step in the innovation process fails, the entire process fails.* With costs increasing geometrically as you go along, it is essential that risk be controlled at each step to ensure insofar as possible that costs will eventually be recovered.

Transfer

It is obvious that conditions have to be conducive to much more than the transfer of basic ideas and patents. Engineering know-how, the training of nationals, and the adequacy of supporting facilities also are important to success.

As an illustration, there is a cellophane plant in Yugoslavia that was built by a Japanese firm. After the Japanese ran the plant on a test basis and everybody could see that it was in good working order, the Japanese went home. They had fulfilled their contract; but obviously the Yugoslavs needed help because they were unfamiliar with the new process. Eventually, my company was brought into the picture. We brought

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their people to our cellophane plants in the U.S., and sent some of our people over there. After a period of time they picked up the skills necessary to run a cellophane plant. Now they are doing fine. The moral of the story is not that there is anything wrong with Japanese technology — they built a good plant — or that there is anything wrong with the Yugoslavs — they had never seen a cellophane plant before; the moral is that the useful transfer of technology depends on every link in the chain being solid, and in this instance that required a get-acquainted period.

Because this process is so time consuming and expensive, most of the technical work leading to new applications of chemistry is done in large business units that have the required resources and can take the necessary risks. It is for these reasons that multinationals have become a preferred mechanism for the transfer of technology.

Beyond these basics, however, there are several other points that deserve to be included in any treatment of the process of innovation and technology transfer. They represent limitations and in some cases real obstacles to success. One is the fact that technology is becoming increasingly complex as well as increasingly costly. Take a common example: For years we used only cotton to make the cord for automobile and truck tires. The technology of cotton cord is simple and classical. Almost any country could put it together. Then the switch was made to rayon; more complex, but still not beyond the ready reach of a nation with rudimentary technical experience.

When the technology stepped up to nylon and polyester, however, there was a quantum jump. Capability in handling polymer chemistry predicates much more of an infrastructure of education and craft skills than is required for handling cellulosics. We are now looking at a new generation of fibers, the aramids, with still better physical properties, but their production stretches technology even further. Our own people in Du Pont are complaining about the complexity of making aramids — and we invented the fiber!

The point is clear enough. The world market wants products that best fill the needs, and increasingly, more complex technologies are required.

Multinational corporation

Most research in multinational chemical companies is pointed toward production that is capital intensive, moderate to large in scale, and technologically complex. Technology seems to transfer without too much difficulty among nations geared to work on that basis.

Less-developed nations frequently want quite a different kind of technology, pointed toward production that is labor intensive, smaller in scale, and less complex. Most big multinational companies are not very good at supplying that. We're programmed 180 degrees out of phase.

For another thing, economies of scale that exist today also make the problems of the smaller, less-developed nations more difficult to solve. In some areas, like agrichemicals, a small-scale operation can operate efficiently. In other situations, a larger investment is required. Take methanol as an example. Twenty-five years ago a large methanol unit produced 500 tons per day. Now, to keep costs competitive, you would design for 2,000 tons per day capacity.

This does not frighten a Japanese or German company, but where would less-developed countries — unless they are oil producers — get the $120-180 million, and the people and the supporting structure and the marketing experience that it takes to build and operate such a plant? Do they build a smaller plant — and throw a protective ring of tariffs around their borders to protect the home industry? Do they invite in the Germans, Japanese, and Americans, try to export the excess output the home market cannot absorb — but remain dependent on somebody else's technology?

Let me hasten to add that while scale *is* a factor, it can be overdone. Not every plant has to be a methanol plant. Working in many types of markets, in many parts of the world, with many interrelated technologies to draw upon, multinational corporations can identify some applications that fit the situation in very different countries. We must keep in mind, though, that scale, like complexity, is one of parameters with which we must deal. Ignore it and you may break the chain.

Differences in economical and social structures complicate the problems. We are not always successful in technology transfer even when operating in our home countries, where we all speak the same language and have the infrastructure established. When we transfer technology to countries where the language is different, where the infrastructure does not exist, and where marketing information is less complete, the risk is bound to be greater.

This is a particularly important factor in a heavily market-oriented technology. In the U.S. and other free nations with significant chemical industries, the driving force for innovation has been the civilian marketplace. It should surprise no one that this has been the energizing factor not only in developing technology but in moving it geographically. Comparable marketplaces in size and sophistication simply don't exist in many areas of the world.

Two other key factors — capital intensity and proprietary rights — are closely related. Because chemical industry is so capital intensive, there is heavy reliance on proprietary rights. Only with such rights can we justify traveling that long and costly road from idea to product and have a chance of recovering the initial investment.

Ours is a competitive industry, which is why, in negotiations with potential purchasers of technology, chemical companies make such an issue of patents, trademarks, and secrecy agreements.

Realities

While this litany of the complexities may sound negative, they are recited primarily as hurdles to be overcome. We are in favor of sharing technology around the world, but the transfer of technology has to be set against competitive realities. It will go where incentives call it, and nowhere else.

Many countries are taking steps to discourage technology transfer. Such steps include diluting the value of patents by compulsory licensing, shortening terms, and excluding products; forcing disclosure of proprietary technology; raising the specter of expropriation; mandating low royalties and providing cumbersome procedures for their determination; and restricting the withdrawal of profits.

Whatever the reasons behind such steps, the result is that risk increases and multinationals are less likely to transfer technology or invest in those countries.

Why is it then that multinational corporations manufacture abroad? Clearly it is the opportunity to make a profit. This certainly does not mean exploiting the poor and helpless or draining more out of a country than is put in. That road is short and ruinous. No, to the multinational technology transfer offers straightforward market benefits such as an additional use for already developed, costly innovation. It also provides added markets that can't be served solely by export and furthers participation in the growth of expanding economies by satisfying market demands.

We can see then that where product, competitive alignment, and the market combine to make it worthwhile, multinationals commit resources to manufacture abroad. This not only introduces new products and technology into other countries, it also increases exports from the home country, whether in the form of other components of product lines, raw materials, or intermediates.

Let me give you an example of how such things work. More than 50 years ago my company began operations in Mexico. At that time Mexico was much less advanced than it is now, and what was needed were basic materials such as explosives to build roads and clear land; so that was our first product line — explosives — the same as it had been our first product line in the United States in the previous century, for identical reasons.

As Mexico progressed our technological relationship became more extensive and technically more elaborate. We now produce — often in conjunction with Mexican partners — highly sophisticated textile fibers, agricultural chemicals, pigments, finishes, fuel additives, refrigerants and other products you associate only with a fairly advanced economy. Some of the most up-to-date technology first made available outside the U.S. was involved. The market called the shots, and a half century of experience says the results to date have been mutually satisfactory.

Benefits

Of course, the multinational corporation benefits from this process. So does the host country, through more and better jobs, an infusion of outside capital, a more solid technological base, new products, and a generally higher standard of living for its people.

Putting it all together, it is my belief that much of the debate over technology transfer and multinational corporations results from a lack of understanding on the part of some participants. Perhaps we haven't done a good job of communicating; I don't know.

If for the benefit of all concerned the barriers to technology transfer are to be lowered — just as tariffs are being lowered — we must conduct this debate with a fuller appreciation of all facts.

Let me sum it up this way.

The multinational corporation is not all powerful or all knowing. It cannot solve all the problems of development. But we can do some things very well and are glad to have the opportunity to try.

When the terms of the contract, implicitly or explicitly, are one-sided, where the infrastructure will not sustain a technology of high complexity; or where the market does not beckon, the success of technology transfer is doubtful.

But where there is a sense of common purpose, where people on both sides are determined that both shall gain from a cooperative venture, then technology transfer can be made to work in both developed and developing countries for the benefit of all.