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ABSTRACT

The flow of technology out of the United States is discussed. Methods of technology flow, such as licensing and investing, are identified, and the advantages and disadvantages of technology transfer are discussed, especially in relation to the government's role. (MLH)

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INTERNATIONAL TECHNOLOGY TRANSFER

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INTRODUCTION

"Technology has become the preferred currency of foreign affairs." This is a recent statement by Edward E. David, formerly Science Adviser to the President, and it challenges engineers and engineering educators to consider their profession in a new, global framework. Technology no longer serves only to fulfill the needs and help raise the standard of living of our own citizens. To quote Dr. David further: "Technology is the bedrock of detente with the Soviet Union, improved relations with China and our ability to dilute centuries-old issues in the Middle East .... Tomorrow's security will come not from mutual fear of MIRVs and ICBMs but from mutual dependence of each on the other's technological resources, natural resources and markets." And

just three weeks ago Secretary Kissinger stressed this mutual dependence when he told the Ministers assembled at the International Energy Agency in Paris, "No issue is more basic to the future than the challenge of energy." He predicted that in developing new, non-conventional energy sources, the Agency's program of cooperation in research and development "may make its most important and lasting contribution."

The Office of Technology Policy and Space Affairs in the Scientific Bureau at the Department of State is one of the offices in the Department concerned with technology and foreign affairs. The opinions expressed in this paper are those of the author and do not represent the official position of the Department of State.

Scientists and engineers are somewhat rare at the Department of State but their presence there is not widely known either inside or outside the Department. And they haven't been there very long, considering the Department is the oldest in the Government, dating officially from 1789, and unofficially since Benjamin Franklin's Committee of Correspondence in 1775. Scientists have appeared officially on the roster, which now numbers some 14,000 people here and abroad, since the 1950's, when the Office of Atomic Energy Affairs was headed by a Science Adviser to the Secretary. This organization became the Science Office in 1962 and a full-fledged Bureau of International Scientific and Technological

ffairs in 1965. Congress created by statute the present Bureau of Oceans and International Environmental and Scientific Affairs, which was formed in October 1974. Dr. Dixy Lee Ray, former Chairman of the Atomic Energy Commission, serves as Assistant Secretary with overall responsibility for international aspects of oceans, fish and wildlife, the atmosphere, the environment, energy, population affairs, space and technology. In addition to about 40 professionals in Washington there are 22 science attaches at key embassies and missions abroad.

INTERNATIONAL TECHNOLOGY TRANSFER

In the Office of Technology Policy and Space Affairs we assist in making and carrying out policy guiding the transfer of technology from the U.S. to other countries. This transfer is of two types--transfer of sophisticated technology that is largely subject to government controls, and transfer of technology as a form of assistance to developing countries.

At this point it is useful to give two definitions. The study of technology transfer is still so inexact that the terms used are not even properly defined. I use Dr. Richard Roberts's definition of technology: The result of the application of knowledge to produce a practical result or product--an airplane, a chemical compound, a communications satellite or an assembly line for trucks. Technology includes the hardware that is produced as well as the software; it also

includes the know-how: the skills that enable a job to be done efficiently, the recognition of what to do if something goes wrong, the knowledge of innumerable little procedures and tricks derived from experience that must be done properly if a system is to function, but which are rarely written down. An aspect of technology development often overlooked is the difficulty, even within a single enterprise, of moving applied science or technology from a laboratory to the manufacturing plant floor, from design to production.

Perhaps the ultimate goal of technological development is the same in advanced countries importing sophisticated machines as in developing countries buying more rudimentary or commonplace equipment. This goal is the achievement of a technological capability allowing the importer to become independent and self-sufficient or competitive. An importer must master the available technology, adapt and improve it with time and produce it efficiently in order to attain such a goal.

Transfer of Technology signifies the application of technology under a new set of conditions--a new social setting, a different economic structure or a varied availability of resources or markets. An essential element of the process is that the technology always must be adapted to suit the new environment. Even a complete turnkey plant will be operated with a different type of labor and worker attitudes, different management techniques and a different relation

with the community and government in its new environment.

The simple sale of hardware is not strictly a transfer of technology unless some aspect of the hardware (not the hardware itself or its utilization) is integrated into the importer's technological capability. Although sales of hardware or so-called "high-technology" items are frequently referred to loosely as technology transfer, it is more accurate to restrict consideration to hardware sales where subsequent integration occurs. Technology is more frequently transferred by licensing of proprietary rights than by hardware sales.

Computers stand at the pinnacle of United States technological achievement and their export probably receives more attention than that of all other high-technology items put together. In some respects it is difficult to apply the definition of technology transfer I have just given to computers, which shows why it is so hard to define. Computer exports are much in the news and frequently referred to as technology transfer. Because of the computer's inherent integrability with other systems, whether with machine tools or in a nuclear power plant, nearly all computer exports are technology transfers. However, one can imagine the export of a computer for use in an insurance company which would not constitute a transfer of technology since it would not enhance the country's technological capability. A near-perfect example of a transfer

which could lead to competition or self-sufficiency is export of a computer to be used on-line to control the various steps in a production process.

Scientific and technological knowledge changes with time. Today's miracle device or unique process is tomorrow's standard product. To retain markets and to fulfill the needs and the desires of a larger proportion of the world's population, engineers and scientists need to innovate, drawing on the pool of results from research and development. This pool must be replenished by a healthy and well-supported research establishment. The most useful transfers of technology enable importers to innovate, improve on the state of the art and more toward becoming technologically independent. They are also the most difficult and hence should be the easiest to regulate.

Management is the key component of any but the most trivial transfers of technology: many items have to be ordered, designed, built, assembled and made to work together, then operated efficiently to produce items of the desired quality, quantity and cost.

The process by which technology transfer, innovation and management combine to produce technological independence and the measurement of its impact are the primary subject of technology transfer studies.

ADVANCED COUNTRIES

In addition to the licensing of proprietary rights

and limited hardware sales, the flow of technology out of the United States takes place by means of direct investment in affiliate companies, training and education, information transfer, the sales of services and the use of consultants.

It is worthwhile to note two interesting facts about the magnitude of technology transfer: it is relatively small compared with our total trade, but we export far more technology than we import.

Royalties and fees for U.S. technology (excluding hardware exports) transferred abroad in 1973 reached about $3.5 billion, and in 1974 about $4 billion; in 1973 we imported $300 million, and $400 million in 1974.

Much of the technology we export is in the sophisticated areas of aircraft, computers, chemicals and machinery. Technology transfer contributed to the overall 1973 balance of trade for these areas of $11 billion.

For comparison, our total exports in 1973 and 1974 were $71 and $98 billion, within $2 or 3 billion of imports. In manufactured items, we increased exports from $45 to $64 billion between 1973 and 1974, and they exceeded imports in 1974 by over $7 billion.

The computer sales alone were $4 billion in 1973, with civilian and military aerospace hardware and technology amounting to $3.8 and $1.4 billion, respectively. (Together with machinery and chemicals, these made up the $11 billion

positive trade balance.)

During 1973 our total exports to the Soviet Union were $1.2 billion, mostly in grain; manufactures made up a small $300 million. Even if Eastern Europe were completely open to U.S. computer sales, the estimated market is only $200-$400 million/yr. And if we increased our total exports to Russia from the present 2% to 5% of the U.S. total, it would still be small with respect to our trade with Canada, Western Europe and Japan.

Multinational corporations play a prominent role in technology transfer because they operate by virtue of foreign (i.e., U.S.) direct investment in affiliate companies and they/heavily emphasize high-technology manufactures. In 1969, net technology exports by multinationals contributed $1.3 billion to the U.S. total of about $2 billion.

Technology exports from the U.S. are regulated mainly by provisions of two Acts. The Export Administration Act of 1969 provides for control of exports of items to controlled (mainly Communist) countries for reasons based on short supply, national security and foreign policy. Embargoed items are on the Commodities Control List, and the responsibility for the control is in the Department of Commerce. Munitions, weapons and implements of war on the Munitions List are embargoed by provisions of the Mutual Security Act of 1954. Export of items on this list is controlled to all countries in furtherance of

foreign policy, national security and world peace. The Department of State administers these controls. The Commodities Control List is becoming shorter, and exceptional exports are frequently permitted. Both lists specifically embargo technical assistance, know-how and other forms of technical transfer pertaining to controlled items. Export licenses are granted on a multiple or single-case basis after government review of the request.

A Coordinating Committee (COCOM) deriving membership from NATO members plus Japan (but without Iceland) reviews exports to the East from all members in an attempt to standardize Western export policy.

The pertinent Acts are under constant review and are frequently revised (the Export Administration Act, as recently as last year). The make-up of the Commodities Control List is regularly scrutinized and so is the international list of the Coordinating Committee. Policy studies underway at all times provide guidance in the implementation of the Acts.

BENEFIT INDICES

The advantages and disadvantages of technology transfer are difficult to measure in quantitative ways. I have already mentioned that we export ten times as much technology as we import ($4 billion vs $400 million) and that this is a strong positive balance of trade that most economists believe to be good. Even in this area of straight dollar flow measurements,

the data are incomplete since much technology transfer is accomplished by mutlinational corporations, and it is hard to identify in the corporations' financial statements.

Our tax laws provide that foreign subsidiaries of U.S. corporations may credit their foreign taxes paid against the income tax liability on foreign-source income. Both those in favor and those opposed to the practice generally admit that these laws as a matter of U.S. policy encourage foreign investment and thus reduce U.S. tax revenues.

Labor Unions fear the export of American jobs along with the technology; Mr. George Meany, President of the AFL-CIO, has called technology exports a "giveaway program...a welfare program for the Soviet Union." A report on the subject by the Tariff Commission offers evidence to the contrary, but the long-range effects on U.S. employment are very difficult to predict or even to measure.

Technology transfer may in certain cases provide us with a political advantage. Export to France of certain features of the GE jet engine for the B-1 bomber contributed to our improving relations with the French.

We could obviously suffer a strategic disadvantage if certain key items were exported to potentially unfriendly nations.

But we return to the main problem: determining the long-term economic impact technology transfer will have

on the U.S. This impact will, of course, have second-order effects politically and strategically.

Because of their importance, the benefits or penalties of technology transfer have already been the subject of studies carried out by or for the Department of State, the National Science Foundation, professional societies, intelligence agencies, the Department of Defense, the Department of Commerce and Congress. Nevertheless, the subject has scarcely been touched. Bibliographies of significant work produced so far are significantly short. Teams combining expertise in science and engineering, economics and political science are urgently needed to treat the problem in a meaningful way.

APPREHENSIONS

Because of the unsatisfactory state of our understanding, genuine apprehensions have arisen concerning the way we export technology--whether we are selling our birthright or tapping vast new markets.

Some representatives of industry point to the difficulty of competing with foreign firms subsidized or otherwise supported by their governments, and call for amended U.S. tax laws or modification of antitrust law. They recognize the clear disadvantage of bidding against each other in an artificial monopsonistic market of many sellers and one buyer--i.e., the Communist country's official trade organization.

Incidentally, business and industry often deplore the maze of bureaucratic procedures they must go through in Washington in order to obtain an export license. I have already referred to organized labor's fears of job exports which may accompany U.S. investment abroad, licensing and coproduction.

In the Executive Branch, the Defense Department is extremely sensitive to technology transfers that it perceives may prove to be of military value to the importer. High-level groups assess the implications of export of U.S. technology to U.S. defense. A Commerce Department analyst is circulating a paper in which he assesses the technological development of the Soviet Union in terms of output per worker--the larger the technological development, the larger will be the output per capita. The U.S. productivity (output per man) is 1.5 to 10 times that of the Soviet Union. But the Russian growth rate of productivity is twice as great as the U.S. rate, for the economy as a whole, and the same is true for engineering products industries.

Congress voices fears about our relative loss of advantage in wide-bodied aircraft, computers and semiconductors. Horror stories are related about X-ray photograph analyzers for hospitals which can be used to extract precise detail from satellite reconnaisance pictures and about serial purchases of the same item for assembling into one master system when the export of the whole system would have been prohibited.

The Military Procurement Act of 1975 gave the Secretary of Defense a veto on exports of technology developed with Defense Department support. This authority was modified but also made more extensive in the 1974 amendments to the Export Administration Act. Congress also controls the interest rates and credit limitations for loans to Eastern Europe by the Export-Import bank. The interest rate was recently raised and the credit limitation lowered for the Soviet Union. We offered the Soviet Union to exchange most-favored-nation trade status for its willingness to liberalize its emigration policy in the 1974 Trade Bill; the deal was rejected by the Soviets.

U.S. foreign policy has been conducted since the early seventies on the basis that a lessening of tensions between the two superpowers could be achieved if the Soviet Union had a stake in a wide spectrum of negotiations--promotion of commerce, peaceful settlement of differences, settlement of the Lend-Lease debt, opening of ports and, of course, SALT. The objective was for Russia to become convinced that it was to its own advantage if the whole group of negotiations prospered. "We have sought," as Dr. Kissinger put it, "to create a vested interest in mutual restraint."

One short-run danger of trade for détente is loss of military advantage; a long-term danger of a program of non-strategic exports is the gradual loss of U.S. technological and

economic advantage.

GENERAL CONCLUSIONS

I do not think our present program of technology transfer will lead to our long-term disadvantage if we meet the following conditions:

a) We follow approximately our present control procedures for exports of technology with military relevance, but speed up the licensing process;

b) We seek to make good "deals," receiving as good as we get--high prices, cash, reverse flow of technology or other reasonable concessions;

c) We keep the U.S. research and development results pool full by means of adequate support for our technology base by government, industry and universities.

My reasons for thinking that under these conditions we need not fear technological challenge are based on these observations:

a) technology transfer is poorly understood; we can't do it perfectly every time, even at home, so it will be even harder to transfer it overseas. We understand many of the necessary conditions - information availability, training etc. - but not the sufficient conditions;

b) most hardware sales, although loosely termed technology transfer, don't really influence the growth of

technological capability very much;

c) the importer's infrastructure--including everything that he must draw on to complete the transfer--just isn't up to the task. The non-market economy, the society's bureaucracy / burden, the productivity of the workers, all conspire against achieving effective transfers.

Technologies intermesh. The most sophisticated U.S. technologies are the least vertically organized. As such they are dependent on other technologies for extensive support. Firms supplying these "other" technologies don't exist in Eastern Europe; slow, inefficient, laborious vertical integration must be achieved for each product line before the technology really does the importer any good. Everything has to be available at the same time, has to work at the same time and has to work together.

The real key to achieving competitiveness or self-sufficiency is continued development of a technology once transferred--constant improvements on the state of the art. These improvements require even to a greater degree the expertise lacked by the importer that necessitated his purchase of a state-of-the-art system in the first place.

Most of the technology transfer attention seems to be focused on exports to Eastern Europe of items on the Commodity Control List. Items on the list are embargoed for shipment to Communist countries. Items on the Munitions List are

embargoed for shipment to any country, and include space hardware and technology for missiles and satellites. Access to U.S. space industry expertise by Japan, France and other member countries of the European Space Agency is controlled in somewhat the same manner as Communist-country access to American computer know-how.

LESS-DEVELOPED COUNTRIES (LDCs)

If in technology transfer to Europe and Japan there is the apprehension that importers will close the economic gap between themselves and the U.S. to our disadvantage, behind the program of technology transfer to the developing countries there is the apprehension that the gap is already too wide and must be narrowed. The rich nations get richer faster than the poor nations, so that the gap between their respective incomes is ever widening.

Although the U.S. has a long tradition of foreign aid and technical assistance, there is a new project of special importance. This is the implementation of the technology transfer proposal in the New Dialog begun by Secretary Kissinger with Latin America shortly after he became Secretary of State in September 1973.

Science and technology for development has been an objective of nations of this Hemisphere since the Presidents of the Americas met at Punta del Este in 1967. Following Secretary Kissinger's call for a new dialog, the United States

suggested at a meeting of foreign ministers in Tlatelolco, Mexico, that there be established an Inter-American Commission on Technology. The foreign ministers convened a Working Group to study the possibility of creating a Committee on Science and the Transfer of Technology when they met at Washington in April 1974.

The Working Group met at Brasilia, established objectives and set up four subgroups to deal with the following issues:

1) strengthening the internal S&T system;

2) utilization of the potential of the developed countries;

3) transfer of (commercial) technology; and

4) creation of an institutional mechanism.

The Subgroups met in Bogotá, Guatemala City, Brasilia, Caracas and Santiago (Subgroup 3 met twice to discuss the knottiest problems connected with commercial transfer.) The Meeting of the foreign ministers to hear the Working Group's report, scheduled for March, 1975, was postponed by the Latins because of their resentment of features of the U.S. Trade Act of 1974. This Act excludes members of the Organization of Petroleum Exporting Countries, including Venezuela and Ecuador, from new tariff preferences.

Some conclusions have been reached on the basis of U.S. experience in the foreign assistance field and on the basis of the deliberations of the subgroups of the Working Group on Science and Transfer of Technology. There is

considerable agreement on factors which influence the success of technology transfer to less-developed countries:

a. Choice of Technology - As mentioned in the definition of technology transfer, the technology must be adapted to fit social and economic conditions in the receiving country and to take advantage of the local market and availability of resources--manpower as well as raw materials. The same manufacturing techniques used so successfuly in a U.S. factory simply may not work at all in Thailand, but need to take into account the different local conditions.

Secondly, the technology should be appropriate. A parent company will likely have better relations with the host country in the long run if it produces items needed locally and exportable to the near vicinity. Construction goods or clothing are frequently more appropriate for filling these local needs than color TVs or hand calculators. Nor must the sophistication level of the technology in all cases be as high in the host country as in the transferring country. More mature technologies are often quite appropriate and may even be more profitable since their development costs have been paid.

b. Presence of Adequate Infrastructure - The appropriateness to needs just mentioned assumes that the needs may be identified and priorities established before technological developments are selected and taken into the

economy. This assumption is not justified unless there is a minimal scientific and technological administrative organization. Such an organization will insure there are educational and training institutions, programs and exchanges, and it will take care there is an establishment for standardization and quality control. It will also provide for exchange and dissemination of technical information and provide for a patent system. Overall governmental policy toward foreign sources of technology and their regulation or restriction will be based in part on recommendations from this body. Without it, the technical and economic development of the country will be formless and uncoordinated, falling short of the high potential goals made possible by modern invention.

c. Separate Consideration of Each Case - We might paraphrase Tolstoy: Developed countries are all alike; every undeveloped country is undeveloped in its own way. There are no valid generalizations--even the ones given here! --for all LDCs. Economic development, cultural values, geographical features all conspire to demand treatment of each technology transfer as a separate case.

Labor-intensive technologies are often cited as ways of providing employment in countries where manpower is underutilized. In the very long run these technologies may not be able to compete against more efficient capital-intensive

ones, except perhaps in agriculture or in service industry functions not susceptible to industrialization. One suggestion is to devise ways where, figuratively, 1000 workers making things in 1000 little pots can approach the efficiency of 100 workers making things in 100 big pots.

HOST COUNTRY APPREHENSIONS

The apprehensions in the U.S. concerning transfer of technology abroad are matched by apprehensions in developing countries concerning technology imports, but for different reasons. We fear to lose too much by selling, they fear to lose too much by buying. Third World action in many of the component bodies of the United Nations is directed toward establishment of a new international economic order based in part on exacting increased prices from advanced nations for the raw materials of the developing world. Part of this action is driven by resentment against perceived abuses and over-restrictive business practices of developed-nation companies carrying out operations in the developing world. Members of this latter group list the following conditions imposed by technology exporters as most objectionable:

a) restrictions of export of products to third countries in order to protect the transferor's market;

b) having to accept package deals, taking expensive or unnecessary goods in order to get the desired technology;

c) exclusive sales or representation agreements with transferor;

d) setting of the selling price by the transferor; payment of royalty based on the selling price rather than just on the number of items sold;

e) loss to the exporter of rights to improvements made in the product by the importer.

There have been sufficient abuses in the past and there is enough dissatisfaction with the present state of affairs in less-developed countries so that this action, this movement toward a new international economic order, may not be taken lightly. It manifests itself in calls for legally binding international codes of conduct governing the operations of developed nations' industries doing business in the third world, a liberalization of world patent law, a global plan for locating industrial plants and a scheme for increasing industrial output of the developing nations to 25% of the world total by the year 2000.

Argentina, Brazil and Mexico have already passed laws which seek to provide their local industry more parity in dealing with technology exporters in advanced countries. The laws set ceilings on royalties and place time limits on licensing agreements and serve as possible models for the broader international code of conduct agreements under discussion.

ROLE OF U.S. GOVERNMENT

Conclusions may not be drawn here as readily as in the case of sophisticated technology transfer to advanced nations; there is much less experience to draw on and policy is still indistinct. The New Dialog has become a whisper; the Secretary's trip to Latin America scheduled for April was postponed because of the Viet Nam crisis. A resumption of the meetings of the Working Group on Science and the Transfer of Technology seems likely after his visit; the atmosphere is also improved by favorable Latin reaction to gathering evidence of a more forthcoming U.S. policy on normalization of relations with Cuba within the Hemisphere. This latter factor was an unspoken ground for the postponement of the March 1975 foreign ministers meeting.

A lack of understanding of our governmental process seems to stimulate some less-developed countries' actions, like the abrupt postponement of the foreign ministers meeting. The Department of State had recommended against the portion of the Trade Act the Latins Found offensive, but had not way to redress the grievances expressed over the Act except to promise to press Congress for repeal.

The Government as a whole plays a relatively small direct, official role in trade relations between U.S. corporations and their foreign customers. It does, however, possess more moral power than is generally recognized, which

it can exercise effectively as a catalyst between industry and foreign buyers, as a referee in disputes and as a persuader. It also fulfills roles as a purveyor of information and proprietary or patent rights developed with government support, as a major performer of research and development pertinent to developing countries' needs and as a traditional arranger of educational and training programs for foreign teachers, workers, managers and governmental officials.

The U.S. has taken direct action by concluding formal intergovernmental agreements for scientific and techological cooperation with 17 countries and also has a large number of agreements and memoranda of understanding in force between agencies here and abroad.

The Agency for International Development (AID) continues to administer an effective program of technical assistance, much of which is directed toward the essential establishment of the infrastructure--schools, roads, utilities, standards, research institutes, training programs and science policy apparatus.

American products are exhibited at trade shows sponsored by the Department of Commerce. The Department also arranges missions for manufacturers and technical information seminars about new product areas such as cryogenics, food processing and communications.

The U.S. government represents the interests of

American business as well as American foreign policy in international forums discussing a binding international code of conduct for technology transfer. It generally favors the adoption of nonbinding guidelines rather than a legally binding code, guidelines that would also take into account the point of view of the exporter and the responsibilities of the importer.

We seek full national treatment for U.S. investment abroad; that is, that U.S. companies be subject to the same laws and enjoy the same privileges as local firms. The American Ambassador abroad and the State Department at home take the initiative in seeking to resolve disputes between U.S. companies and foreign countries or companies.

Tax treaties with other countries reduce the tax for non-resident investors, reduce double taxation and assure non-discriminatory treatment for nonresidents. We have few so far with developing countries.

The U.S. Government takes the view that antitrust law is a powerful tool for controlling over-restrictive business practices of American companies abroad.

SUMMARY

The transfer of technology is more important in international relations than just its monetary value would suggest. Transfer to advanced countries can be related to political objectives; emerging countries stress their need

of technology for development, but press for advantageous terms. Many transfers are controlled by law for purposes of national security and foreign policy. It is difficult to assess the long-term impact of technology transfer to the United States because its definition, evaluation and regulation are so imperfect; the subject deserves greater attention from government, industry, labor and universities. Threats to the U.S. economy are probably not great because of the difficulties importers have in integrating technology into their productive establishments. Future transfers to developing countries will most likely be made under stricter regulations or guidelines imposed by importing nations acting together in international organizations.