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# US-Brazil Private Sector Cooperation in Science and Technology for the 1980's

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ACKNOWLEDGEMENTS

This conference grew out of discussions between the National Science Foundation and the U.S. Department of State in January, 1983. From the start, this effort was conceived to take a sounding of the opinions of knowledgeable representatives of the private sectors of Brazil and the United States about the benefits to be derived from the U.S.-Brazil intergovernmental agreement in science and technology. For results to be useful to renewal of this agreement, the time frame for organizing the conference was extremely short.

Several U.S. participants in the conference played a large part in identifying knowledgeable representatives of the private-sector, and in general making such an effort possible within the time constraints. They deserve much of the credit for seeing the task through to completion.

This conference was also a product of group deliberation and collective effort over many years. The project grew out of the extensive program of productive collaborative research developed by the National Science Foundation and the Brazilian National Research Council (CNPq). It added to a history of the efforts of U.S. universities, industry, professional associations and government agencies over the last decade, to advance research capabilities and infrastructure in Brazil.

We wish to thank the many individuals who shared with us the knowledge and sources of information they had developed about science and technology relations between the U.S. and Brazil.

We are especially grateful for the encouragement and financial assistance to the conference provided by the U.S. Trade and Development Program (TDP). The dual goals of this program--trade and development--helped greatly in the design and execution of the conference.

Without the cheerful and efficient assistance of SRI International support staff, th complex logistics of the conference and this volume could not have been accomplished. We wish also to express thanks to the moderators of the sessions, who played an important part in eliciting from the participants many pertinent and illuminating questions and comments. We also acknowledge the scribes for their unflagging attention and thoughtful note-taking. That the participants contributed generously and effectively is evident from the record.

## DISCLAIMER

Any issues, views or opinions contained in these materials do not in any way represent any official policies or positions of the United States Government, or the National Science Foundation or its Directors.

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## EXECUTIVE SUMMARY

A Conference on U.S.-Brazil Private Sector Cooperation in Science and Technology was held 23-26 March, 1983. This conference grew out of the plannning process for renewing the current U.S. Brazil inter-governmental agreement in science and technology. Renewal of the agreement created an opportunity to consider whether and how the private sectors of both countries can benefit more than they have in the past from the agreement.

The conference included four sessions: Case Studies in Cooperation; Issues Affecting Cooperation; New Directions for Future Cooperation; Government/Industry/University Roles in Future Cooperation. Background papers were prepared as the basis for discussion in these sessions. A fifth session allowed for a summary of the preceding sessions and concluding remarks by participants.

### THE FUTURE OF U.S.-BRAZIL TECHNOLOGY RELATIONS

A recurring theme of the conference was: U.S.-Brazil technology relations are not going as well as they had in the past. This decline is partially due to Brazil's limited ability to pay for technology imports with foreign currency. Consequently, there is a need to restore the buying power of Brazil. But there is also a need to explore ways for the Brazilian private sector to compensate U.S. firms for technology other than with foreign currency. Suggestions included arrangements between U.S. and Brazilian firms in which U.S. technology is bartered for access to Brazil's markets, more traditional goods for goods barter, and forms of joint ventures between the firms of both countries.

Limitations on payments for technology licences, lack of protection of confidentiality, and possible new market reservation clauses are not encouraging to U.S. firms. The wideninng gap between U.S. and Brazilian firms is also a result of competitive pressures from countries such as Japan on transfers of U.S. technology.

U.S. export controls play a role in depressing U.S.-Brazil technology relations. Reverse technology transfer which negatively affects U.S. suppliers also is having negative impacts. However, structural changes in some U.S. industries are at least partially responsible for U.S. industry failure to maintain competitive advantage.

## U.S. AND BRAZILIAN INDUSTRIAL DEVELOPMENT POLICIES IN THE 1980'S

A major issue in Brazil today is how government can generate private-sector capacity to succeed in a competitive environment. The use and effectiveness of protectionism to develop indigenous technological capabilities was extensively discussed. But protectionism was viewed as part of a package which government can use to encourage domestic industry. The attention Brazil has given to science and technology policies in its development strategies was also considered.

There was extensive disagreement about the effectiveness of protectionism in the Brazilian computer industry. The trade-off between waiting for trickle-down advantage from multinationals and playing the "catch-up" ball that will continue to occur without the competitive stimulus of foreign technology was touched on. One alternative is Brazilian industrial development based on indigenous R&D capabilities, complemented through the licensing of foreign technology.

The areas of consulting engineering and aircraft were also subjects of discussion. Joint private sector ventures in consulting engineering were viewed very positively. The aircraft industry was considered a good example of a successful strategy to develop Brazilian industry.

## OPPORTUNITIES FOR EXPANDING PRIVATE SECTOR COOPERATION

One approach to improving technology relations is to increase participation by U.S. and Brazilian smaller enterprises. New and improved strategies to encourage cooperation among smaller firms were discussed. Improved information about sources and users of technology is likely to

help. But another key is the value of the technology to the buyer. In this respect, private sector technology brokers can play an important role in the future.

It was agreed that while small firms are excellent sources of technology, they often lack capital. Venture capital as a source of funds for expanded cooperative activities was discussed extensively. There was a suggestion that the U.S. and Brazil can pool resources for venture capital initiatives in high technology.

Some areas in which the private sectors of both countries can gain are strategic materials, bioengineering, and alternative fuels. Electronics and the automobile industry were also considered.

Bringing universities, industry, and government together and linking them internationally was assessed as a good idea to advance cooperation. Brazil needs institutions to help bridge the gap between what industry wants and what universities can provide.

ROLE OF THE AGREEMENT IN PRIVATE SECTOR COOPERATION

As an umbrella for public and private initiatives, the agreement can in the future provide a forum for a wide exchange of ideas for cooperation. The agreement will be used by the private sector, if it advances the common interests of U.S. and Brazilian industry. Some suggestions for elements to include in the agreement in order to advance common interests were:

- Representation of private sector, including smaller enterprise, interests;
- Provision of a forum for continued discussion of issues;
- Acknowledgement of the role of U.S. and Brazilian policy agencies;
- Recognition that a goal of the agreement is improved technology relations between the U.S. and Brazil;

- Sponsorship of cooperative research, and science and engineering programs, relevant to U.S. and Brazilian industry needs, and supportive of university-industry cooperation in both countries;

- Acknowledgement of the role of existing programs and organizations such as the U.S. Trade and Development Program (TDP) and the Federation of Industries of the State of Sao Paulo, in private-sector technology trade and development;

- Stimulation of private and public funding for new cooperative areas and mechanisms for cooperation.

## SUMMARY OF THE PROCEEDINGS

### INTRODUCTION

Under the joint auspices of SRI International and the National Science Foundation, a Conference on U.S.-Brazil Private Sector Cooperation in Science and Technology was held 23-26 March, 1983 at the Sheraton International Conference Center in Reston, Virginia. The conference grew out of the planning process for renewing the current U.S.-Brazil inter-governmental agreement in science and technology. A primary objective of the agreement has been to generate and disseminate basic science and engineering knowledge. Renewal of the agreement created an opportunity to consider whether and how the private sectors of both countries could benefit more than they have in the past from the inter-governmental agreement.

Conference participants came from widely diverse backgrounds and fields, although each had experience with either the theory or the practice of research and innovation in the private sector. Approximately thirty people attended, respresenting government, industry, and universities in both the U.S. and Brazil. The variety of interests and viewpoints brought by these participants provided a uniquely rich opportunity for an illuminating exchange of ideas and experiences.

The need for such an interchange was clear. The conference participants were in agreement that U.S.-Brazil private sector cooperation was not going as well as it had in the past, and an improvement in these relations would be, on balance, beneficial to both countries. Further, continuing discussion of these issues by the private sector would be needed to improve relations. The discussions ranged broadly from the philosophical to the nuts-and-bolts of private sector cooperation between the two countries. Major areas of agreemment were found although important differences of opinion also emerged on several levels.

The conference included four formal sessions. Background papers were prepared as the basis for discussion in these sessions. The fifth session allowed for a summary of the preceding sessions and concluding remarks by participants. The background papers and the summary of sessions are included in this volume.

All sessions were organized so that participants informally exchanged views. In the following pages, the major ideas and views presented at the conference are summarized and, where appropriate, related to the background papers. The major recurring themes of the conference were:

- The future of U.S.-Brazil technology relations;
- U.S. and Brazilian industrial development policies in the 1980s;
- Opportunities and strategies for expanding private sector science and technology cooperation between the two countries; and
- The role of the U.S.-Brazil inter-governmental agreement in science and technology in future private sector cooperation.

## THE FUTURE OF U.S.-BRAZIL TECHNOLOGY RELATIONS

This recurring theme was introduced early in the conference by a Brazilian participant: U.S.-Brazil technology relations are not going as well as they had in the past. This decline is partially due to Brazil's limited ability to pay for technology imports with foreign currency. Brazil has a trade surplus today. But it has to import foreign currency to service its debt.

Consequently, from the Brazilian perspective, to improve technology relations, there is a need to restore the buying power of Brazil through economic policy. But there is also a need to explore ways for the Brazilian private sector to compensate U.S. firms for technology other than with foreign currency. Suggestions included arrangements between U.S. and Brazilian firms in which U.S. technology is "bartered" for access to Brazil's markets, more traditional goods for goods barter, and forms of joint ventures between the firms of both countries.

To accomplish joint ventures, Brazilian markets can be more readily shared with U.S. firms than is the case presently. On the other side, the U.S. can further open its markets to Brazilian goods. To begin with, Brazil is one of the largest markets in the world, and makes an excellent target for U.S. industry. Agreements between U.S. and Brazilian firms can take this market access into consideration and not always require royalty payments for technology. One barrier to such arrangements is the mistrust between U.S. and Brazilian firms in some fields, particularly electronics.

Other Brazilian participants added that Brazil is interested in changing the terms of its trade through more high value added exports such as technology. Private sector cooperation can encourage government policies which allow Brazilian firms to purchase in dollars those technologies that produce dollars through exports. Emerging technologies, export industries, small- and medium- sized firms can be the focus of such policies. Better identification of particular technologies which can add value to exports are needed; this may be relevant to NSF policy research interests, it was suggested. It is important to link public goals with private sector interests, one U.S. participant commented, and technology provides a bridge.

Some U.S. participants felt that the limitation (five percent was the figure mentioned), by Brazil on payments for technology licenses is too low, and a major block to transfer of technology. But lack of protection of confidentiality after license agreements are reached also contributes. The long time required for negotiating license agreements also plays a role; two years to register licenses in fast moving technologies is a major time lag. Finally, the new market reservation clauses being considered by the Brazilian government in computer-related areas are not encouraging to U.S. firms. In general, the "costs" of doing business in Brazil have increased. There are now twenty government agencies, for example, dealing with coal. One participant suggested the possibility of a "one-stop" service for U.S. firms which conduct business in Brazil.

While Brazilian participants acknowledged these constraints, they pointed out that the widening gap between U.S. and Brazilian firms is attributable to other factors than time-delays and government regulations. It is also a result of competitive pressures from other countries on transfers of technology by U.S. firms to Brazil.

Unbundling technology packages is a lot easier with Japan, Holland, Italy, Great Britain and other countries than it is with the U.S. Brazil does have constraints, but Europeans manage to do business in spite of these constraints. There was a clear feeling among Brazilian participants that European firms "try harder," and sometimes are assisted by subsidies provided by their governments; this gives them an edge over U.S. organizations. The attitudes of U.S. firms towards Brazilian policies do not help; it is important for U.S. business to understand the reasons behind Brazilian policies and aspirations.

The shift in bargaining leverage toward Brazilian firms is attributable only in part to the proliferation of alternative sources of industrial technology from Western Europe and Japan. The expanding size and value of the Brazilian market also improves the bargaining position of Brazilian industry today.

Some U.S. participants commented that the matrix organization and high degree of compartmentalization of some large U.S. firms makes it difficult for them to assess these long-term opportunities in the Brazilian market. Large organizations sometimes lack the full picture, because they are split into functional areas, and you have difficulty finding a decision-maker. But some U.S. firms, it was pointed out have new enterprise ventures officers who look at 20-30 year long-range opportunities.

Several Brazilian participants strongly expressed the view that U.S. export controls play a major role in depressing U.S.-Brazil technology relations. Several cases were noted in which U.S. restrictions on third-party users led Brazilian firms to go to Europe for technology, and there was some consensus that U.S. export control policy is very destructive of trade and competition. The Brazilians reiterated that

Brazil is on the same team as the U.S. and that Brazilian firms could not export to Eastern Block countries.

There was clear disagreement among participants from both countries about the negative impacts on U.S.-Brazil relations of reverse technology transfer. Some U.S. firms are no longer cooperating with Brazilian industry because the technologies they have transferred are allowing, for example, non-ferrous metals produced in Brazil to compete with U.S. suppliers. One way or the other, one U.S. participant said, the U.S. is helping Brazil to weaken the U.S. position in ores. Brazilian participants argued that this was not a good example of "unfair competition."

It was further pointed out that steel is very well-developed in Brazil, while there has been little innovation in the U.S. for about thirty years. The innovation today is from Japan and Germany. The Japanese offer better loans, secure higher ores, process more efficiently, and then sell back to the U.S. at lower than U.S. domestic prices. Several Americans agreed that structural changes in U.S. industies, such as minerals, and not Brazilian trade policy, are at least partially responsible for the U.S. failure to maintain competitive advantage. But nevertheless they added, in other areas, technology transfer may be used against the U.S. in competition, and the problem is not only in smokestack industries.

Some discussion touched on the need to assess current and future U.S. import restrictions as they specifically impact on U.S.-Brazil technology transfer and commercial relations. One note on which this discussion ended was the question of whether the patterns of international competition in steel would repeat themselves in high-technology. Some said that high-technology will develop differently than areas such as steel. It was unlikely Brazil could become a significant international competitor with the U.S. The serious threats to U.S. markets from transferred technologies in the future will come from other countries.

Several participants were somewhat wary of such a generalized conclusion; they pointed to the fact that Japan, for example, is increasingly concerned about transferring technology to Korea. There is

high risk in transferring emerging technologies, was one opinion. Frontier technologies are not being patented but are being held closely. In spite of these concerns, the overall tenor and conclusion of this line of discussion, from the perspective of both U.S. and Brazilian participants was that there is room for joint partnerships in a variety of areas, where both U.S. and Brazilian firms can gain. These opportunities will be discussed in a later section of these proceedings.

## U.S. AND BRAZILIAN INDUSTRIAL DEVELOPMENT POLICIES IN THE 1980s

A major issue in Brazil today, as pointed out by Brazilian participants, is how government can generate private-sector capacity to succeed in a competitive environment. There was extensive discussion at the conference of the use and effectiveness of "protectionism"—tariffs, market restriction clauses, quotas to develop indigenous technological capabilities.

Brazilian participants explained at an early stage in these discussions that they viewed protectionism along with financing, support services, research, as a package which government can use to encourage domestic industry to succeed. Government policies to develop computer-related fields is an issue in Brazil today which has not been resolved.

There was extensive disagreement among U.S. participants about the use and effectiveness of protectionism in the Brazilian computer industry. Considering the expensive equipment and extensive research support required by this industry, it is not a bad thing to restrict, was the viewpoint of one U.S. participant. In contrast, another U.S. participant said that the ultimate government subsidy is protectionism, not capital or research support. It was also pointed out that without the stimulus of some foreign competition, it was unlikely the Brazilian economy could achieve the benefits of rapid technical change and cost reduction. Much of this discussion was in the context of conference reflection on a case study detailed in the background papers: a technology transfer agreement between a relatively small U.S. mini-computer manufacturer, Sycor, Inc. and COBRA, a Brazilian computer company owned in part by the Brazilian government.

One Brazilian participant observed that, historically, the U.S. used protectionism to shelter domestic industries from foreign competition, for example, at the turn of the century against British imports. U.S. policy today, however, is quite different, with protectionism only used selectively. Protectionism in the U.S. today is aimed at advancing the interests of declining industries, added a U.S. participant. The background paper for Session IV describes some of the extensive attention to industrial policy in the U.S. today, and the role of protectionism in these discussions.

Current policies in Japan, France, Singapore, and the Netherlands were turned to as possible models for the Brazilian government to follow in developing high-technology industries. Comments included: Japan is not a proper model for the Third World to emulate. France is very protective and this has not worked successfully. The aircraft industry in Brazil is a better example of development policies to follow. Singapore's policy of open entry to foreign firms in computers and computer services is successful.

One important concern was the size of the market in Brazil for high-technology. From the Brazilian perspective, if there is a limited market in Brazil for high technology, then, without subsidies, the government will not suceed in getting Brazilian industry involved. The Netherlands which has a small market and is not protective was suggested as a counterexample to this line of argument.

Some questions raised concerning Brazilian development strategy were: Is it government policy in Brazil to develop high-technology that will be internationally competitive, as in the case of Singapore or other countries with small domestic markets? What time-frame are we talking about? One U.S. participant posed the question of the trade-off between waiting for trickle-down technical advantage from multinationals and playing the "catch-up ball" that will continue to occur without the competitive stimulus of foreign technologies.

Other U.S. participants discussed the large initial investments that are required to establish advanced technology companies; financing these industries are only affordable to multinationals was one conclusion. In addition, these euterprises encourage many beneficial spillovers: they create ancilliary industriec; encourage volume suppliers; and upgrade university faculty and technical manpower.

Mexico is making extensive use of these ventures in development. Mexico, for example, asks a number of companies to bid on establishing an industry which is competitive worldwide. Products sell out of Mexico to almost any country in the world; economies of scale aare encouraged, as is a balance of payments favorable to Mexico.

Brazilian participants pointed out that this process is well-known and used in Brazil. But the alternative of importing buildiing blocks, such as integrated circuits, to develop Brazilian industry is also possible. There are markets in Brazil, for example, in telephones, to allow economies of scale in production. These represent oppportunities for U.S. firms to come in on a marginal basis. The history of the development of the aircraft industry in Brazil is testimony to the effectiveness of this development path. It is an example of development based on Brazilian R&D efforts, complemented through the licensing of foreign technology.

The extensive attention Brazil has given to science and technology policies in its development strategies was also discussed. But there is still much to be done in this area,was one conclusion, including increases in the availability of trained manpower.

Developing the field of consulting engineering was then considered. The case study, "Pullmman Kellogg's Supply of Ammonia Technology to PETROBRAS" provided some of the background for this discussion.

In the next GATT round, one Brazilian participant commented, there is likely to be strong pressure for regulation of consulting engineering. Consulting engineering, it was pointed out, covers very different activities such as civil engineering and process engineering. Process

engineering is increasingly important because it opens up new areas, such as production technologies, beyond infrastructure construction. The traditional development model involved detailed engineering done locally, assisted by foreign ideas and consulting. Some consulting firms, however, made efforts to transfer technologies such as in petroleum engineering. It is very difficult for private engineering companies in developing countries to raise capital, was one comment, and so there are significant possiblies for cooperation.

Another U.S. participant explained that process or systems engineering originated in World War II in the United States. There were no restrictions, and U.S. firms took this expertise overseas. Participation by foreign firms probably began at a 20% participation ratio, but over time this has changed. However now a number of governments are building protective barriers to shelter their engineering firms, and are starting to exclude the U.S.

Joint private sector ventures in this area were viewed very positively by Brazilian participants. In the last twenty years, it was pointed out, the government in Brazil has been a strong participant in consulting engineering projects. In the future, government can play less of a role and allow the private sector a larger share in both creativity and risk. Brazil is a large country and is aware that there is not enough private capital for all the investing that needs to be done. But even limited sources of private capital can identify opportunities for joint ventures, with licensing and capital participation by U.S. firms.

Another Brazilian participant added that joint ventures work, and they work even better if they are on a project basis rather than a permanent relationship. Mining and metallurgy are new growth industries in Brazil. Petrochemical industry is now probably saturated, and the strategy is to go to other areas.

There was some U.S. participant concern that there are problems on the demand side for capital-intensive technology projects in Brazil. Several questions were raised: What are the market opportunities in government and

the private sector at the current time? What obstacles to stimulating market demand are there. Cooperation between the U.S. and Brazil in building institutions such as market and supply channels for technology and educating the market are going to be necessary to build private sector demand.

The development of the Brazilian aircraft industry was then considered. The case study of Piper's industrial cooperation agreement with EMBRAER provided the background for these discussions. To better understand the current situation, it was explained the history of the Brazilian aircraft industry began in the 1950s and 1960s. The Brazilian government encouraged foreign companies to make aircraft in Brazil. Brazilian private sector investment was very uncertain due to the small market. The Institute of Aeroneutical Engineers took the initiative, and pressured the government to start up and invest in a Brazilian firm, EMBRAER. A significant EMBRAER decision was to focus on designing a turboprop airplane. This decision was very much to the advantage of EMBRAER, when in the 1973 oil crisis, the world looked for turboprops. This gave Brazil an opportunity to penetrate world markets. From the Brazilian perspective, government protectionism was not targeted toward developing the aircraft industry. It was rather intended to cut down on imported products across the board. For example, there is a 300% duty on imported cars, but only 50% on airplanes.

One U.S. participant commented that the aircraft industry is a very good example of a successful strategy to develop Brazilian industry. This industry developed because there was extensive support for training of human resources. U.S. insitituions participated in the development of aeronautical engineering in Brazil, as did the Brazilian air force through the creation of an excellent engineering school. This example argues against a country becoming self-sufficient in every area. The strategy rather is to specialize in those technologies in which the country has competitive advantage. EMBRAER produces for a market, which is small and was neglected. There are specific requirements from each customer for custom made aircraft. EMBRAER can be responsive to this need for customizing aircraft production.

The next section considers opportunities for private sector cooperation in light of these development strategies and technology relations between the U.S. and Brazil.

## OPPORTUNITIES FOR EXPANDING PRIVATE SECTOR COOPERATION

This was a highly lively discussion in which there was a lot of brainstorming about possibilities for future private sector cooperation.

### Size of Firm

Conference participants agreed that one approach to improving technology relations is to increase the participation by U.S. and Brazilian small- and medium-sized firms in joint ventures. There is a large pool (170,000) of U.S. medium- and small-size firms with potential as partners in technology agreements. It was generally acknowledged that high technology, know-how, and small firms have a natural affinity. The need is to develop approaches to tapping into the abilities and capabilities of these firms. These companies, almost always, lack the information required to initiate cooperation with foreign firms. While small enterprises may have other problems, such as limited capital, the important barrier is that they just do not know how to get started in foreign markets.

### Technology Brokers

Both U.S. and Brazilian participants suggested new and improved apprroaches to encourage cooperation among smaller firms. Ireland, for example, has offices in the U.S. to attract U.S. capital; Brazil could usefully implement this strategy. Brazil has state trade bureaus, such as the Federation of Industries of the State of Sao Paulo that can serve the function of encouraging appropriate U.S. participation in Brazilian firms. Partnerships of like-industries also can be very productive in matching private sector interests.

Some Brazilian federal government agencies, such as the Agency for the Financing of Studies and Projects (FINEP), are also vehicles for reaching medium-size companies in Brazil. Trade associations were also mentioned, as was the U.S. Trade Consul in Sao Paulo which was assessed to be very well informed about U.S. companies. Access to the U.S. Trade and Development Program (TDP) is also available through U.S. missions in Brazil. Export of U.S. products to Brazil is of high-priority to this program currently.

One U.S. participant felt that weak demand on the Brazilian side remains a problem. Others held the view that the market exists, but U.S. firms cannot reach it. The people and time constraints faced by small firms in going abroad to do business, and in identifying contacts for technology transfer or partnerships were reiterated. Improved information access is likely to help, one U.S. participant said. But the key is the value of the technology, and this is going to depend on how useful it is to the buyer. The important role of the technology broker is to find customers to whom the technology is valuable; only then will resources be galvanized for the process. "Supply-push" in the case of technology, on the other hand, has a low rate of success, and it is especially hard to accomplish with small enterprises.

In this respect, there is room for private sector technology brokers to play an increased role in U.S.-Brazil technology relations. There are only a few companies doing this in the U.S. today, it was pointed out, while the Japanese have engaged in this kind of activity for a long time. There was some feeling expressed by Brazilian participants that brokering technology is more appropriately a function of the private sector; for one reason, entrepreneurship is important.

Brazilian and U.S. trading companies were also mentioned as possible technology agents. It was pointed out that antitrust constraints on these organizations were recently removed in the U.S. In response to these changes, companies like Sears were expanding their operations in these directions.

One U.S. participant proposed that what was needed was a consortia of generic industries, to act as a vehicle for dialog and definition. Associations on both sides could "pitch" and "catch"in an organized fashion.

## Funds and Capital

It was agreed that while small firms are excellent sources of technology, they lack capital. The question of payment and negotiation of investments is an important one. With respect to banks as a source of capital, one U.S. participant said that U.S. banks had provided 55% of the $80 billion debt capital for Brazil. There has been $5 billion in additional funds, and there is likely to be more coming. A surplus of funds is available to loan for feasible projects if interest exists. Commercially viable projects will continue to be funded; this would join dollars and available technology.

Venture capital as a source of funds for U.S.-Brazil cooperative activities was discussed extensively. There was a suggestion that the U.S. and Brazil could pool resources for venture capital initiatives in high technology. Some thought this impractical in light of the constraints on foreign currency in Brazil today. Other participants thought it worthwhile to look at possibilities beyond the next three or four years. In general, according to several participants, there are available sources of funds, both government and private. What is needed are new ideas in which to invest these funds, markets created or developed in Brazil for technologies, and increased use of, for example, demonstration projects, to determine the feasibility of success and lower risk.

## Industries/Technologies

The term "win-win" was created early in the conference for areas and technologies in which the private sectors of both countries could gain. Some participants expressed the view that sunrise industries in the U.S. do not fit well into this category. They still have room to expand, and are not interested in going abroad. The television and the automobile industry

where the U.S. is being pushed aside in its own markets, perhaps are better options. A Brazilian participant suggested that high-technology areas should not be neglected. In electronics, for example, it was again emphasized that Brazil will probably not become a big exporter, but will provide the large market for U.S. products which U.S. firms will need in the future.

In the minerals industry, strategic materials, such as manganese and berilium were suggested as areas to explore. In these areas, the U.S. has the technology and Brazil could benefit. Alternative fuels was suggested as another possibility; this would help lower fuel costs in both countries. The need for Brazil to generate a professionally done shopping list was one suggestion. Others thought that common sense was the best guide, and there is no magic to drawing up lists. Brazil knows its priority areas, at least in general, and U.S. firms know what Brazil wants, was a commonly held view. There is agreement, for example, that electronics is important. One Brazilian participant suggested that it might be useful to turn the question on its head and ask: What do U.S. firms want to offer, rather than what does Brazilian industry want?

Bioengineering was also suggested as a"win-win" area. The tissue culture technologies of U.S. firms can help accelerate tropical crop production. The productivity of sugar cane can be increased through tissue cultures, and this process is transferable to coffee, cocoa, and to other countries. A major barrier here is the limit of 12% capitalization on remitances; this is incompatible with this kind of technology transfer. There was some agreement that there is strong ground for cooperation with Brazil in agrobusiness.

There was general agreement that the time limitations on the conference constrained more in-depth and broader discussion of other technologies which offer possibilities for cooperation.

University-Industry Relationships/Training

There was agreement on both sides that bringing universities, industry, and government together and linking them internationally is a

good idea. Both the solutions and the problems faced in the U.S. in industry-university cooperative efforts need to be explored for their applicability to Brazil.

From the U.S. perceptive, there is a general need in Brazil for more highly trained people. Electronics, one U.S. participant said, is one area where there is the possibility of cooperation between the academic communities of both countries. In Brazil, a current problem is shortage of faculty in some areas. Students need the relevant research and managerial experience that can allow them to more easily start their own firms. There was a strong feeling among the Brazilian participants that the country needed institutions to help bridge the gap between what industry wants and what universities can provide. This encourages exploration of U.S. private and public funded programs for university-industry cooperation.

ROLE OF THE AGREEMENT IN PRIVATE SECTOR COOPERATION

In the closing session, several Brazilian participants expressed their general views of the role of the agreement: As an umbrella for public and private initiatives, the agreement can in the future provide a forum for a wide exchange of ideas for cooperation. Cooperation between the U.S. and Brazil is important and can be increased. U.S.-Brazil trade relations can regain the ground they have lost, and science and technology can play a role. To accomplish this, private sector views can be promoted by the agreement including the views expressed at this conference. The agreement will be useful, and will be used by the private sector, if it advances the interests of both U.S. and Brazilian industry.

One Brazilian participant reminded the group that Brazil was producing a large number of products using U.S. technology. In the majority of cases, Brazil always looks to the U.S. when it needs technology. Therefore it might be beneficial to use the agreement to strengthen the appropriate trade bureaus in each country. Other Brazilian participants added that Brazilian firms sometimes had difficulty in knowing precisely what U.S. technology is available. Better communication, as could be encouraged through the agreement, is needed to match technology with needs. Another

point made was the different roles played by U.S. policy and mission agencies. The distinction is important because the regulations of policy agencies are sometimes the major obstacle in technology trade.

The importance of participation by small- and medium-sized firms was reemphasized as was the role they could play in fostering cooperation. This is an important requirement in Brazil. Experience has shown that large corporations can take care of themselves, but that small business needs access to information about on-the-shelf technology which could be made available. On the Brazilian side, the Federation of Industries of the State of Sao Paulo can be helpful in making and facilitating appropriate contacts in Brazil.

Several U.S. participants expressed their ideas of the roles that could be served by the agreement. First, there continues to be a need for an institutional mechanism to maintain contact between the two countries on issues and possible areas for future cooperation. Second, the private sector should not ignore looking into the possibilities of using the government umbrella agreement to encourage expanded or new private sector initiatives for cooperation. Third, an agreement covering industrial concerns expands university research from the basic sciences and fundamental problems, to research which is geared towards applications and cooperation with industry.

There was strong feeling expressed by both U.S. and Brazilian participants that there is a problem of public information. Reporting in newspapers, such as The Wall Street Journal, on Brazil is very selective, and mostly financial problems are reported. The international business community has very limited knowledge of Brazil, and vice versa. In Brazil, for example, all that is seen is the multinational corporations in the U.S. The agreement can serve a useful public awareness function.

Finally, public officials sometimes do not fully understand what drives the private sector to make decisions for innovation and technology. Government and its managers are driven by important social and political needs rather than by commercial interests. One question raised was how to get the results generated by this conference to policy makers for results.

In summary, there was consensus that if the agreement reflected the common interests of the U.S. and Brazilian private sectors, these communities could benefit from the agreement more than they had in the past. Some suggestions for elements to include in the agreement to advance common interests, as generated by conference discussion, were:

- Representation of private sector, including smaller enterprise, in order interests;
- Provision of a forum for continued discussion of issues;
- Acknowledgement of the role of U.S. and Brazilian policy agencies;
- Recognition that a goal of the agreement is improved technology relations between the U.S. and Brazil;
- Sponsorship of cooperative research, and science and engineering education programs, relevant to U.S. and Brazilian industry needs, and supportive of university-industry cooperation in both countries;
- Acknowledgement of the role of existing programs and organizations such as the U.S. Trade and Development Program (TDP) and the Federation of Industries of the State of Sao Paulo, in private-sector technology trade and development;
- Stimulation of private and public funding for new cooperative areas and mechanisms for cooperation.

## FOREWORD TO THE BACKGROUND MATERIALS

## U.S.-BRAZIL PRIVATE SECTOR COOPERATION IN SCIENCE AND TECHNOLOGY FOR THE 1980's

### BACKGROUND

There is now a decade of U.S.-Brazil scientific and technological (S&T) cooperation. An early program (1969-1974) was designed to upgrade Brazilian chemistry by means of a large exchange program between US and Brazilian chemists and students.

The NSF-CNPq program, initiated in 1972 under the U.S.-Brazil Agreement for S&T Cooperation, has been oriented toward the scientific strengths of both countries,with the attainment of mutual benefits as the perceived objective. To date, about one hundred projects between U.S. and Brazilian scientists and their universities have been funded.

These joint projects cover most fields of scientific specialization: life sciences, social sciences, engineering;mathematics and computer sciences; chemistry and physics; earth sciences. Major U.S. and Brazilian universities and research facilities have been involved in these cooperative efforts.

An especially fruitful major project is the on-going Projeto Flora Amazonica, the Brazilian Amazon Flora Project. It includes the most comprehensive effort made, thus far, to inventory rain forest species in order to find out how to deal with fragile ecosystems threatened by urban and industrial development. Other cooperative projects in radio-astronomy and in particle physics also offer the potential of significant contributions to world-wide scientific advance by both countries.

The pending renewal of the U.S. Brazil Agreement for S&T Cooperation offers an opportunity to review this history, and plan cooperation for the



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remainder of the 1980 s. This means systematically identifying future directions for on-going efforts in scientific cooperation and identifying ne specialties--information/computer science, biotechnology, engineering research—in which the two scientific communities can work together to advance knowledge.

A primary objective of the agreement has been to generate and disseminate a broader reservoir of basic science and engineering knowledge. As a general rule, there has been little involvement of industry representatives in the initiation and implementation of scientific cooperation between the two contries. There have, of course, been technical repreesentatives from industry invited to serve on advisory committees, and this has served to link current industrial research to the activities of the cooperative agreement. Renewal of the agreement, however, creates an opportunity to consider whether the industrial research efforts of the private sector of both countries can benefit more than they have in the past from increased interaction through the agreement.

A major priority in planning cooperation for the 1980's then becomes to examine expanded participation by the private sector in joint activities that might enhance productivity of the research and development process, and more generally, industrial productivity in the two countries. This includes exploring: (1) the feasibility of greater interaction betweeen the industrial research community and the activities of the agreement, (2) suggestions for activities within the agreement as seen from the perspective of the private sector, and (3) opportunities for cooperation in different types of industrial activity: high-technology; basic science activities (chemicals and metallurgy, for example); and non-competitive areas (standardization).

The objectives of private industrial research are not the same as those of governments. There are obvious limitations to what government action can do to encourage cooperation between private corporations in technological activities. Planning future cooperation should consider government policies in both countries which affect joint technological activities, define issues and problems, and explore possible cooperative mechanisms responsive to these issues.

Also beneficial would be more general discussion of current issues in research management facing both countries. Severe foreign debt problems and world-wide recession are cutting into Brazil's R&D growth and capabilities. Principles upon which to allocate scarce resources among science and technology areas becomes an important issue for Brazil. For the first time in a decade, Brazilian R&D and technical personnel face unemployment and dislocations. This may demand new relationships between Brazilian industry and the universities of that country.

In the U.S., stringent limits on government budgets have focused more attention on determining priorities in science and assessing scientific activity for excellence and relevance. Industry is playing a larger role than formerly in funding U.S. university progams in research and engineering. Although demand for many engineers and scientists is very high, how to train and retrain scientific manpower for a rapidly changing technological society remains a question.

GOALS AND OBJECTIVES

The goal of the conference is to identify future opportunities for U.S.-Brazil scientific and technological private sector cooperation for the 1980's, and in particular, opportunities relevant and applicable to the pending renewal of the U.S.- Brazil Agreement for S&T Cooperation.

The objectives of the conference are:

(1) to assess on-going U.S.-Brazil research cooperation (university, government, industry) for their future direction and impact, and identify existing environmental barriers to expanding private sector R&D;

(2) to identify scientific and technological specialties, and types of cooperation, for university, industry, government which offer the greatest potential for future productivity in the two countries;

(3) to exchange views about current science and technology-related policy issues of common concern to both countries which affect cooperation specifically and the maintenance and growth of the scientific and technological base of both countries in general;

(4) in particular, to explore prospects for expanding private sector exchanges within the framework of a government-to-government umbrella S&T agreement.

## ANTICIPATED BENEFITS

Anticipated benefits from the conference include the following:

(1) A renewed U.S. Brazil Agreement for S&T Cooperation with S & T priorities and thrusts which will continue the productivity of this arrangement;

(2) Overall (industry, university, goverment) S&T cooperation in the 1980's which takes advantage of the scientific and technological strengths of both countries;

(3) Future modes of S & T cooperation which acknowledge science and technology policy-related issues facing both countries; and

(4) Advance of overall relationships between the two countries through scientific and technological cooperation.

## CONFERENCE FORMAT

A group of about 20-25 experts, half from each country, representing a mix of scientific and technological specialties, and university, industry and government expertise, will meet for 2-3 days.

The conference will consist of a series of "roundtable discussions" focused on four specific topics:

- CASE STUDIES IN COOPERATION: LESSONS TO BE LEARNED FOR THE FUTURE
- PRIVATE SECTOR VIEWS ON ISSUES AFFECTING FUTURE COOPERATION

- NEW DIRECTIONS FOR FUTURE COOPERATION IN SCIENCE & TECHNOLOGY
- FUTURE COOPERATION: GOVERNMENT/INDUSTRY/UNIVERSITY ROLES

The aim of these discussions will be to encourage exchange of perspectives between representatives of the U.S. and Brazilian private sector and government across scientific and technological specialties and institutions (university, industry, government) on these topics. Each discussion will be guided by one or two moderators.

The following material provides short background statements for each of the topics listed above, based on available information and documents. These statements were prepared to provide a starting point for the discussions; it is hoped that participants will modify, amplify and comment upon this material during the conference sessions.

Summaries of the sessions, together with the pre-workshop documents will be integrated into an overall report of the meeting to be distributed to participants, sponsors, and other interested parties within one month after the workshop.

## BIBLIOGRAPHY

Fusfeld, Herbert I. and Haklisch, Carmela S., editors, Industrial Productivity and International Technical Cooperation, New York: Pergamon Press, 1982.

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## SESSION 1: CASE STUDIES IN COOPERATION: LESSONS TO BE LEARNED FOR THE FUTURE

### INTRODUCTION

The limitations of case studies as a source of policy guidance are well-known. These case studies are only a very small sample of U.S.-Brazil private sector cooperative efforts. The Brazilian-American Chamber of Commerce, for example, lists over two thousand firms, subsidiaries, and affiliates operating in and/or having interest in the U.S. and Brazil. "Lessons learned," however, particularly from projects that have continued for several years, do represent a sort of practical wisdom. One objective of conference discussion is to assess the wider applicability of these examples.

As a working definition, industrial scientific and technological cooperation is an arrangement between a U.S. and a Brazilian organization in which the U.S. is either a joint partner or a source of technology embodied in plant and equipment or of engineering and management capabilities. U.S.-owned organizations operating in Brazil, Brazilian organizations and multinationals are also considered to the extent they transfer "unbundled" technology. This includes licensing arragements, royalty fees, or management contracts.

University cooperation includes:

- cooperative research: projects designed jointly and conducted collaboratively by scientists and engineers from the U.S. and Brazil;
- research-oriented seminars and workshops: jointly organized meetings of small groups of scientists or engineers from the U.S. and Brazil; and
- scientific visits: visits by researchers to Brazil or by Brazilian researchers to the U.S. These may vary in terms of duration and purpose, such as short-term visits for purposes of planning joint projects or exchanging information and longer-term visits to conduct research at an institution in the cooperating country.



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In terms of the objectives of this conference, case studies focus on four types of questions:

- What was the role of national government programs and policies in the U.S. and Brazil on private sector cooperation? What was the role of government-government international scientific and technological cooperation?

- What were the characteristics and responsibilities of the participating organizations and the arrangements between them? What level of science or technology and kinds of R&D activities were involved?

- What was the role of university research, education and training in the cooperative effort?

- What were the impacts? On the organizational level? On the industry level? On the discipline level? On the national/societal level? On the international level?

TECHNOLOGY TRANSFER

SYCOR's Technology Transfer Agreement with COBRA, S.A.

Sycor, Inc. (since merged into Northern Telecom Systems Corp.) is a relatively small mini-computer manufacturer based in Ann Arbor, Michigan. In 1976, the company entered into technology transfer, technical assistance, training and product purchase agreements with Computadores e Sistemas Brasileiras, S.A. (COBRA), a Brazilian computer company owned in part by an agency of the Brazilian Government. Collectively, these agreements commit Sycor to assist COBRA in developing the self-sufficiency necessary to manufacture and market the Sycor 400 series of clustered processing systems in Brazil. This series can communicate with larger computers or can be used as a "stand-alone" small business computer system.

The agreements exempt Sycor from import controls and effectively give the company exclusive access to the growing Brazilian mini-computer market. In the early phases of the relationship, Sycor sold complete systems to COBRA, with a later transfer to kits or modules for final assembly in

Brazil beginning in April 1978. Approximately $5 million had been obtained by the end of 1978; of this amount, $500,000 represented an advance on royalties and the balance, equipment sales. Brazilian service and installation personnel are receiving intensive training by Sycor in its Michigan facility in the system's software, field engineering, marketing and management. As COBRA acquires greater experience and technological capabilities, a progressively larger portion of the modules will be manufactured in Brazil. In the final phase of the contract, it is envisaged that COBRA will be producing complete equipment.

COBRA was established in 1974, by a Brazilian Government-owned holding company, known as Digibras, in an effort to foster the development of a domestic computer industry.

Sycor's agreement with COBRA is Brazil's second attempt at developing a mini-computer industry with foreign technological collaboration. An earlier and quite similar affiliation with Ferranti, Ltd. of the U.K. was unsatisfactory, due in part to Ferranti's inability to service a broad section of Brazilian industry as well as its lack of experience in vertically integrating computer production and thereby proving inadequate in developing the supplier parts industry, which the Brazilian authorities felt to be essential. This second attempt was initiated by COBRA in the fall of 1976 through a series of negotiations held with several U.S. computer companies, for a license to manufacture a mini-computer, to be designated Argus 400.

Aside from Sycor, Data General Corporation was the only other serious contender for the role. In fact, at one point, COBRA appeared to be on the brink of signing an agreement with Data General for its "Nova" technology, but the negotiations broke down over an irreconcilable dispute on ownership rights to the technology. The Brazilian Government required that ownership of the Data General technology--Nova patents, blueprints, and other related matters--be transferred to COBRA at the end of the license period. These terms were unacceptable to the U.S. company which continues to operate a wholly-owned sales subsidiary it established in Sao Paulo in 1975. No orders received since the negotiations with COBRA broke down have been

shipped, however, as they are awaiting import license approval by the appropriate regulatory agency, known as CAPRE--Comissao de Cordenacao das Atividades de Processamento Eletronico (Coordinating Committee of Computer Activities).

Data General's decision seems in line with the company's marketing and production policies. The company is the second largest independent mini-computer manufacturer in the world, and in fiscal year 1976, derived forty-one percent of earnings through export sales. Almost all its overseas markets are supplied from U.S.-based production facilities. (The one exception is a manufacturing license Data General granted a Japanese company for manufacture and sale of some company equipment in Japan.) Approximately 2,400 of the company's 6,000 jobs are related to its export business. Despite the firm's international outlook, it chose to forego participation in the growing Brazilian market rather than release its technology to COBRA. In this decision, the case is similar in many respects to Cessna's in the aircraft industry in Brazil.

IBM is another U.S. company which felt that the terms offered by Brazilian development authorities were unacceptable. To ensure that the new Argus 400 product was not immediately overtaken by foreign competition, CAPRE developed guidelines for approving new entrants into the small computer market in Brazil. Priority was given to companies which had Brazilian capital participation and were prepared to transfer advanced technology. Favor was also extended to manufacturing projects that made greater use of Brazilian-made components and did not require massive imports.

IBM's plans to manufacture its new System 32 small business computer in Brazil, announced in 1976, failed to meet these new guidelines. IBM has a policy of generally not associating itself with national investors, insisting upon retaining full administrative and final control of its products. Likewise, the technology transfer requirement was not acceptable to IBM. And, finally, the requirement for low levels of imports posed considerable difficulties for IBM's well-established system of international interchange and production. Brazilian authorities were asking too

much departure from IBM traditions, and IBM therefore chose to forfeit the mini-computer market range in Brazil.

IBM do Brasil incurred certain political as well as commercial costs associated with this decision. The Brazilian subsidiary competed vigorously against the company's Japanese and German subsidiaries to be selected by the corporate headquarters as the major manufacturer of the System 32. IBM Brazil has hoped to serve the growing national mini-computer market as well as export markets with the new equipment. To be denied access to its "home" market reflected on its ability to maintain harmonious relations with the Brazilian Government.

IBM's predicament seems to have created considerabe division and aroused different loyalties within various government and private Brazilian institutions. Some elements of the private sector were skeptical of COBRA's future and, consequently, were reluctant to see IBM excluded from this segment of the market. Bradesco, however, the country's largest private bank, indicated that it would withdraw its financial support from COBRA if the government did not demonstrate its commitment to developing a national computer industry by effectively eliminating the threat of IBM competition. Digibras, of course, advocated protection of the Argus 400, and CAPRE indicated that it felt that direct competition between IBM and COBRA was unrealistic.

BoaStruct (Rio de Janeiro, Brazil)

This case demonstrates how technology can be transferred when there is an effective receiver. The International Executive Service Corps (IESC)'s client firm, BoaStruct, had a history of technological development and importation, and was well prepared to receive engineering skills and to use these skills to establish a new product and service activity. The characteristics of the industry and the local environment led to rapid external diffusion of the technology to government agencies and competitors, resulting primarily from the demonstration effect of the capabilities and characteristics of the new product. The specific know-how transferred did not lead to a dramatic change in the management activities

of the user firm, which was already quite sophisticated in its overall management orientation and procedures.

Immigration to Brazil played an important part in the establishment of BoaStruct. The father of the present chief executive officer came to Brazil after the Second World War and started a small business that supplied suspended scaffolding to the construction industry, acting as the agent for an American firm. His son, following his education in the United States and service in the American military, joined the business and in 1964 bought out the interest of the foreign joint venture partner.

At this time the total sales of the firm were only $75,000. Three years later, sales had reached $180,000 and the firm introduced a type of tubular scaffolding to replace its suspended scaffolding technology. The rapidly expanding Brazilian economy allowed for more growth, and in 1968 the firm began initial manufacturing of panels and frames for its scaffolding. Local tubing was purchased and then cut and finished in the plant. The growth potential of the firm encouraged the owner to travel abroad in search of new ideas and techniques for his business. Between 1969 and 1972, a number of technological changes were introduced, especially in the area of stronger and more efficient joints for the framing. In 1974, the firm reached a sales level of $1.5 million, which grew to over $4 million by 1976. The BoaStruct work force increased rapidly from 1974 to 1977, at a rate of over 20 percent per year. By 1977, the firm employed 330 permanent employees.

The technological history of the firm seemed to follow the growth in sales and demand. The principal start had come from the American firm, whom the family represented until 1964. Suspended scaffolding technology provided the base for growth and change. The senior management of BoaStruct later traveled extensively to Canada, the United States, and Puerto Rico to visit plants and look for new systems. Many foreign firms opened their doors to them since BoaStruct was small and the companies were interested in the possibility of future joint ventures with BoaStruct. A Canadian firm permitted BoaStruct management to film one of its plants. The Brazilians were thus able to bring back an entire plant on film, which was used to improve manufacturing and service capabilities.

In 1974 1975, BoaStruct was approached by two American firms and a Japanese company, which were interested in establishing joint ventures. The Brazilian owner decided against this approach since he felt the firm could get technology from other sources. Although the company needed additional capital for growth, the management decided to wait until it was absolutely necessary before they gave up ownership or control. By 1976, BoaStruct was quite large and foreign firms were not as willing as they had been earlier to share information and concepts with the company. Foreign enthusiasm for participation also diminished as the Brazilian government began restrictions on foreign capital and technology.

To expand into new product areas, the firm had to find a source of the technology suited to this specific process. The sales department and senior management knew their steel frame system was cheaper and more effective than the tube and coupler systems of their competitor, which had come from Europe. The staff believed that it could use this technological base to move into other areas, such as shoring and elevator towers.

BoaStruct found a Swedish firm to supply motors and license other know-how for the elevator towers, but the Brazilian government refused the contract; the government argued that the technology already existed in Brazil. BoaStruct disagreed with this assessment. Knowing the difficulty of changing the views of government engineers, BoaStruct sought other technology alternatives. The firm learned that IESC might supply a trained specialist. Using this expertise, the company could move into the shoring area without licensing techniques or equipment and without forming a joint venture with a foreign firm, thereby avoiding government bottlenecks. After discussions with IESC, an expert with over twenty years experience in steel frame shoring was located and contracted for consultation.

Historically, the firm has not had a problem finding technology when it needed it. Rather, its problem has been that of finding management personnel and technicians who can absorb and manage technology. This problem has persisted even though the firm has spent significant resources in supporting the education of many engineers and staff. The problem seems to hinge on developing firm-specific and system-specific expertise for the

business. The president of BoaStruct now believes that as the firm continues to grow, he may have to form a joint venture with a foreign firm to stabilize his access to technology, as well as to generate new capital, which is the other major problem inhibiting growth of the firm.

## CONSULTING ENGINEERING

### Pullman Kellogg's Supply of Ammonia Technology to PETROBRAS

Kellogg, the engineering and construction division of Pullman Incorporated, is a corporation, frequently prepared to enter into technology transfer agreements with newly industrialized countries. At the same time--partially due, in fact, to its extensive range of experiences in this area--the company has acquired caution in approaching these new agreements and an awareness of the myriad problems they pose. An increasing portion of Kellogg's new markets are developing in newly industrializing countries, and its management has articulated a pragmatic policy for responding to these opportunities.

Kellogg's policy on sharing technology and design-engineering functions with purchaser enterprises was given specific articulation at the Second Latin American Petrochemical Congress held in November 1978 in Mexico. Before that forum, company representatives distinguished among three basic progressive steps that may be taken by a purchasing enterprise toward realizing an independent plant design capability. In step one, the process, analytical, and layout phases of engineering are carried out by a foreign contractor. Production design details are done by a local organization with major assistance by the contractor. Step two limits design by the foreign contractor to process and analytical functions only. All layout and production design is handled by the local organization with little or no assistance by the contractor. In step three, the capability for independent process and analytical design is achieved by the local organization's engineers.

Kellogg has had direct experience with each of these progressive steps. It is really only in the "step three" phase of process plan design

described above, however, that technology transfer actually takes place. In this phase, the company seeks to provide a local organization with the procedures, coordination, and technology used in plant design through lectures, philosophy, and direct calculations in all the engineering disciplines. Emphasis is placed upon the analytical design functions rather than upon the production design functions. The program includes lectures and design work in the engineering disciplines of process, systems, vessels, furnaces, and exchangers. Excluded, typically, are the production design of foundations, structural steel, piping, electrical, insulation, and similar work.

This particular involvement falls clearly within the "step three" phase of process plant design. In a technology transfer contract signed in 1975 with PETROBRAS, Brazil's state oil company, Kellogg agreed to supply Brazil with the know-how, design, and engineering for a series of nine ammonia plants, to be used in the production of synthetic fertilizer each one slated to have progressively more and more Brazilian involvement. The process know-how of the plants is based upon Kellogg's high-capacity, single-train, all centrifugal ammonia plant design which, since its introduction in the 1960s, has predominated in world markets. Continued upgrading and improvement have maintained this particular process' reputation for reliability and cost competiveness over the years.

The plants are to be built in the northeast State of Bahia, a region of Brazil which has become the focus of one of the government's most ambitious efforts in industrial planning and integration. PETROQUISA (PETROBRAS Quimica, S.A.), a subsidiary of PETROBRAS, is the coordinating agency for the development of and investments in Bahia, as well as two other so designated "poles" for petrochemical facilities--one located in the Rio Grande do Sul and the other, an older one, located outside Sao Paulo. Kellogg is no stranger to these "poles." The technology transfer agreement represents but one of several projects which it has either underway or completed in Brazil, including three ammonia-urea plants and six catalytic cracking units for installation in oil refineries.

Kellogg figures among the numerous U.S. firms which, wishing to participate in petrochemical development in Brazil, have accommodated to the tripartite model devised by PETROQUISA. The model requires that an equal share of the equity in any new investment be evenly distributed among three parties: the state, Brazilian private capital, and foreign capital. In practice, the requirement that one-third equity be owned by Brazilian nationals often means that the U.S. firm must work with a local partner whose traditional field of activity is other than design, engineering, or the operation of petrochemical facilities, given the relative newness of the industry in the Brazilian economy. The fiscal incentives and protection offered by the presence of a "strong" state partner (PETROQUISA) provide the essential inducements to attract the Brazilian entrepreneur to this field.

As mentioned earlier, Kellogg has already extensively sold its design engineering and process know-how to Brazilian enterprise, yet those contracts were designed primarily to impart an operational capability to the purchaser. The essential distinction in the technology transfer agreement is its intent not only to provide Brazilian industry with nine operational ammonia plants, but, ultimately, to impart the essential capabilities needed to design and engineer its own plants in the future. A duplicative capability in this highly specialized and complex industrial activity will be achieved only through a carefully scheduled and flexible phase-in of Brazilian participation in all functions of the design and installation of the facilities.

At this time, Kellogg has completed the process design and engineering for only two of the nine plants, but none has actually been constructed yet. The contract assigns primary responsibility to Kellogg, at least for the first few plants, for the process know-how and the process and detail engineering, although the latter will be physically performed in Brazil. Brazilian engineers are being given all basic chemical engineering details, as well as instruction by Kellogg engineers in process design. PETROBRAS has sent twelve of its most promising engineers to Kellogg's engineering center in Houston for ten-month training sessions in basic engineering. The process design being supplied for the plants is the current generation

developed by Kellogg, but the contract does not obligate the company to transfer major improvements developed in the process over the course of contract. Minor innovations, such as maintenance or improvements in thermodynamic efficiency, will be incorporated into the Brazilian plant's design.

In contracting to impart detail and process engineering skills to Brazilian nationals in connection with the ammonia-producing facilities, Kellogg is consciously contributing to the build-up of Brazil's indigenous capabilities to design and engineer future industrial systems. Many tasks required for the construction, assembly, start-up, and operation of petro-chemical facilities can be performed adequately by a number of Brazilian companies. It is in the process engineering, as well as process design, however, that the Brazilian labor force is severely lacking--fields which, once mastered, it is now believed, will provide the critical link between attaining an operative capability in a particular technology and obtaining a duplicative and, ultimately, innovative capability. Kellogg's agreement with PETROBRAS is explicitly designed to assist Brazil to overcome this obstacle and achieve greater self-sufficiency in the petro-chemical sector.

The most unusual feature of the contract is in the provision for payment. Implicitly recognizing that Brazil is buying progressively less technology with the completion of each plant, based on the assumption that Brazilian engineers will perform an increasing portion of the functions and acquire greater understanding of the process as each successive plant is completed, the contract calls for payment of the know-how fee on the reducing scale, spread over the period of time during which the plants are being built. The $1 million figure, paid as the lump-sum know-how fee for the first plant, is scheduled to drop to $400,000 by the ninth plant, and the $3 million figure for drawings, specifications, and blueprints will drop to zero.

Kellogg is prepared in this case to accept not only less compensation for its know-how and services as Brazilian engineers accumulate the necessary experience, but also to accept a declining role in the projects by Kellogg personnel, as the functions previously performed by them are

assumed by Brazilian nationals. At any stage during the execution of this massive, nine-plant undertaking that PETROBRAS feels competent to go it alone, it can relieve Kellogg of part or all of its duties. After completion of the ninth plant, Kellogg will permit Brazil to duplicate, without additional costs, as many plants as it wishes, but prohibits the licensing of others.

Petroquisa's development is typical of recent trends in the Brazilian petrochemical industry and is a good illustration of the complementary roles of state, foreign, and national capital. First, from the point of view of the multi-national firm, a major petrochemical venture in the Brazilian Northeast has many "risky" dimensions. Foreign capital was persuaded to join in the scheme because the state, in the guise of Petroquisa, was prepared to underwrite much of the risk. Perhaps most important was the fact that Petroquisa assumed a lot of the direct risks. That is, it took responsibility for those parts of the project which were likely to sustain losses in the early stages of production. For example, it underwrote the construction of such infrastructural facilities as electrical generators and water supply systems. These were absent in the underdeveloped Northeast (the location of the petrochemical complex) and are precisely the type of investment that private entrepreneurs dislike. In this particular case, infrastructural facilities were bound to lose money until all the plants were operating at full capacity.

Petroquisa was also able to negate some of the more indirect risks associated with this venture. It guaranteed that the move to Bahia would be a collective one and would, therefore, carry with it many of the external economies normally associated with location in a more developed area. Particularly important was the fact that the new complex would be large enough to attract a skilled work force and capable of generating a market for intermediate and even final goods. Another indirect benefit of having Petroquisa as a partner was its minimization of the problems inherent in securing access to inputs. The availability and the price of raw material inputs to the petrochemical industry obviously depend on Petrobras and on government policy. A favorable resolution of problems in both areas was (and is) greatly facilitated by partnership with a wholly owned subsidiary of this state firm.

Such are the advantages gained by the multinational in going into partnership with the state. What does the state get in return? The main contribution of the multinational firm is technological. Given the sophisticated and advanced nature of production techniques within the petrochemical industry, foreign capital was (and is) essential. Theoretically, it is always possible to purchase technology, but this is rarely an efficient solution when that technology is highly complex and constantly evolving.

The participation of multinationals has also had a significant financial impact on the viability of the petrochemical complex in the northeast, the total costs of which are estimated to be three-quarters of a billion dollars. Not only have multinationals contributed directly as partners in the project, they have also added international credibility to the venture and have facilitated the raising of funds on the private international capital market. Petroquisa has had access to an enormous financial capability through Petrobras, but, for much of the recent past, the Brazilian government has preferred to expend its own resources on oil exploration. For this reason, financial help from the multinationals has not been redundant.

The advantages of national private capital in joint ventures are clear-cut. Participation in a petrochemical project with foreign and state capital enables domestic industry to capture part of the action in a sphere where, left to themselves, they would be squeezed out. It should be obvious from what has been said above that both state and multinational firms have a competitive edge over domestic firms. Particularly important in the sphere of petrochemicals are the scale, time horizons, and resources of state enterprises, and the command over technology enjoyed by multinationals.

The contribution of private national capital is more difficult to gauge. Some local groups (for example, the construction firm Camargo Correa) seem to have been brought into the petrochemical industry for no obvious reason. Others have a more convincing function, for example, the

Grupo Ultra which managed to gain an important niche in the industry through political influence, good management, and some initial experience in the bottled gas business.

In the main it seems that the private domestic capital contributes to joint ventures in a loosely defined "political" manner. Some offer relevant industrial experience. Many supply knowledge of the local bureaucracy and help interpret the numerous regulations and incentives of the Brazilian state. All help legitimize the project in the eyes of the segment of public opinion in Brazil that still supports the national bourgeoisie. This latter role is not without its detractors; some commentators in the international press have accused the Brazilian government of inefficiency by subsidizing national capital and including it in these joint ventures.

To make a final point on this topic, very few national private concerns can take advantage of joint ventures. Generally, the more efficient or politically advantaged firms are incorporated in the tripartite arrangements.

RAW MATERIALS

Companhia Vale do Rio Doce

The subsidiaries of the Companhia Vale do Rio Doce provide another example of joint ventures--in this case, linking state and multi-national firms. CVRD is an impressive concern. With 21,500 employees the company is a giant even by standards of concerns in industrialized countries. It is the world's largest exporter of iron ore. The company has budgeted investments of $10 billion. This represents about 10 percent of the total investments in the Brazilian economy.

Over the last few years CVRD has established various joint ventures with European, American, and Japanese companies in such spheres as metal pelletizing plants, bauxite mining, aluminium production, pulp manufacturing, and iron ore excavation. The latter project is typical:

Designed to exploit the vast ore reserves of the Amazon basin, it had as its major partners both European and Japanese firms. (Originally, the major partner of CVRD in this project was U.S. Steel.) In all these ventures CVRD has retained 51 percent of the equity.

How has CVRD managed to construct this empire? In this sector the principal economic advantages of the state are vested in its control over national resources, specifically, the vast Brazilian reserves of iron ore. The multinational corporations need the raw materials CVRD can provide for their Brazilian operations and for their industrial activities elsewhere in the world. For them, involvement in exploiting this significant source of iron ore is an integral part of a global strategy of profit maximization.

The strength of the contribution of the multinationals once again lies in access to advanced technology and additional sources of finance. However, it should be pointed out that the technological superiority enjoyed by multinational firms is not so pronounced as it is in the petrochemical industry. Techniques employed in mineral extraction and processing are less volatile and less complex, and are thus more accessible to domestic firms than those typical of the petrochemical sector. Because of this, CVRD is in a much more dominant position than Petroquisa and can exercise greater control over the rules of the game.

Why have joint ventures in the iron ore sphere tended to exclude national private capital? First, CVRD's important local customers are state-owned and foreign-owned steel companies; the national capital share of the Brazilian steel industry is small and shrinking. Second, national capital appears to play a much less important political role in the iron ore sector than it does in the petrochemical industry. The very strength of CVRD's position vis-a-vis the multinationals means that the state does not need a domestic ally, and the legitimacy question is not so urgent. Iron ore simply does not trigger the same sort of reaction as that associated with oil. It is at least conceivable that there is no need to artifically incorporate national private capital in this particular joint venture, precisely because the pressures to legitimize foreign participation are not acute.

## The Explosive Metalworking Program

A loan agreement between the state of Sao Paulo and USAID was established on 30 May 1973 for $15 million to further overall science and technology cooperation. This loan agreement provided the mechanism to use personnel from the United States and to provide contract support for research institutes. One of the participating institutions was Institute de Pequisas Tecnologica (IPT) a state-supported research institute, which was to initiate four demonstration projects, one of which was identified as "Explosive Forming, Cladding, Bonding, and Welding." The state placed these demonstration programs and others under the jurisdiction of a Program of Science and Technology for Development (PROCET) to support engineering development, product design, market analyses, and applied research.

Personnel from the Denver Research Institute (DRI) visited IPT in January 1974 to discuss a formal linkage with IPT and to prepare a proposal under the PROCET objectives. A direct link between the metallurgy divisions of the two research institutes was proposed. The demonstration projects selected were explosive metalworking, packaging, the surface quality of deep-drawing steels, and weathering steels.

Work started on the Explosive Metalworking project in July 1974. The scope was: to develop processes to re-form metal plates or sheets into controlled shapes; to laminate dissimilar metals, such as titanium or stainless steel, onto steel, or to bond lead to steel; to weld oil and gas pipelines; and to produce dished heads of aluminum and steel for fuel tanks and chemical processing tanks.

Explosive metalworking, in its broader sense, may be defined as the use of the energy released by a detonating explosive to change the shape of a metal part (explosive forming); to join similar or dissimilar metals (explosion cladding or welding); to cause changes in the metallurgical and engineering properties of a material (explosion hardening); to separate metals (explosion cutting, shearing, and punching); and to compact metal or ceramic powders (explosion powder compaction). Explosives provide a

relatively cheap and readily available source of power. Hence, for the types of metal working mentioned above, the use of explosives as the source of power is attractive because of the versatility, low capital investment, and unlimited growth potential.

As applied to current commercial practice, the widest areas of use of explosive metalworking are explosion forming, explosion cladding, and explosion hardening.

The process has been employed successfully in hardening railroad frogs made from Hadfield steel. It has also found use in hardening hammers for rock-crushing equipment. Explosive hardening has the advantage of being easily used in remote locations on massive machinery.

Technical Solutions. In the beginning, IPT had no capability in the field of explosive metalworking but had an on-going metallurgy division with forty years of experience. The implementation of the program was divided into: (1) original market survey; (2) training of IPT personnel; (3) facility development; (4) production of clads; and (5) related production.

Market Survey. The initial market survey was conducted during July and August 1974 in the United States to determine products and users of the technology.

A survey followed in Brazil. In-depth interviews were held with thirty-four industrial organizations, the majority of which were considered potential users or specifiers of the technology.

The initial survey indicated that the easiest market to penetrate was for clad products. This market was highly variable, but general trends and forecasts were made in market size projected on the annual increase in Brazil's GNP in 1974. Another factor was the large expansion underway in the Brazilian steel industry, which was projected to reach 30 million tons per year by 1980. The closely allied heavy-mechanical industry, a user of clads, had been growing at a rate of about 16 percent a year between 1969

and 1972. It was concluded that the demand for clad products would follow the trend for primary metal users and heavy equipment manufacturers.

Other factors were considered. Brazil was planning to start the production of stainless steel sheet and plate in 1976, which would assist in developing the clad market. However, the projected stainless steel mill did not start operations until September 1977. Also, expansion of the Brazilian petrochemical industry would increase the demand for clads.

In Brazil the most logical explosive-forming area was for storage and pressure-vessel heads. At the time of the initial survey, many firms were using gore segments, in which the gores were welded together to form large heads. Of the 1,000 heads per year being made, it was thought that 750 could be produced by explosive forming. Other heads that were manufactured by spinning and thin-stainless heads could be explosively formed, too. The initial survey, however, indicated that the market would be hard to penetrate due to the existing technology.

Subsequent surveys were conducted by IPT personnel. On one survey, the market was found to be unfavorable. The manufacture of heads in Brazil was based upon a wide number of international specifications that varied enough to give a large product mix. the product mix in turn meant that a large number of dies would be required rather than just a few of standard size. The result was that it was not economically feasible to explosively form heads in the one to two meter diameter sizes. Subsequently, a 6,000 ton press, capable of making most heads, was installed in Brazil. This press precluded the development of explosive-forming facilities by IPT.

A market survey was also conducted for explosive hardening of railroad cross-overs (jacares). The jacares for heavy-duty use are made of manganese (12 percent) steel and are explosively hardened by many railroads and suppliers throughout the world. This survey indicated that about five hundred jacares a year would constitute the Brazilian market when it is developed. One drawback in introducing the technology, though, is the lack of data comparing explosive hardening with other hardening methods, such as hammer or roll hardening. The potential market value was estimated at

$50,000 to $100,000 per year (1974) based on a cost of $100 per jacare. However, costs for hardening per jacare have risen since the survey to better than double the original figures (1979).

Training. Seven IPT personnel were trained in explosive metalworking at DRI in two different groups. The first group of four Brazilians was trained in all aspects of explosive metalworking. Three IPT engineers were assigned to the Explosive Metalworking Project. They received on-the-job training at Campo Experimental do Lorena in explosive welding. These Brazilian engineers subsequently were sent to DRI for training in explosive forming and theoretical aspects of explosive welding. However, a turnover in trained personnel occurred, indicating one of the problems in insuring continuity of the project. Progress was consequently delayed. Moreover, none of the engineers who left IPT were able to use their training in their new jobs.

Another phase of the technology transfer was the presentation of course work in explosive metalworking at the University of Sao Paulo (USP). Seven graduate students completed a course in explosive metalworking, but alternate schools for the presentation of course work in explosive metalworking were not instituted.

Facility Development. A facility for explosive metalworking was developed by IPT near Lorena, Sao Paulo, in the Vale de Paraiba. The site, called Campo Experimental do Lorena, is midway between the industrial centers of Sao Paulo and Rio de Jeneiro and is accessible to the state of Minas Gerais.

The four most important explosive manufacturers in Brazil are in the vicinity of Lorena. The largest steel mill in Brazil, CSN, is located at Volta Redonda, less than one hundred kilometers from Lorena. The second largest steel mill, Usiminas, is located near Belo Horizonte, as is Acesita, the mill that produces stainless steel plate. Lorena is also midway between the ports of Santos and Rio de Janeiro, which would be the ports for exporting explosive clads if the requirement arises.

Plans have been formulated for the construction of a new port eighty-five kilometers from Lorena, which will serve the southern part of the state of Minas Gerais as well as the Vale do Paraiba. A railroad spur is located three kilometers from the site. Thus, Campo Experimental do Lorena meets all of the requirements of being remote but has good access to supplies and market.

The site at Lorena, consisting of 360,000 square meters of land, was donated to IPT by the municipal government of Lorena. A local engineering firm was employed to develop the site. The roads, drainage, and welding site were developed first, followed by the buildings for setups and explosive storage. The planned explosive-forming facility was not built due to market conditions. However, a large materials-handling building was erected. The facilities at Campo Experimental do Lorena include laboratories for complete metallographic examination and nondestructive testing of clads.

Production of Clads. The main product produced by IPT at Campo Experimental do Lorena has been tube sheets for use in heat exchangers. IPT takes the manufacturers' materials and performs the explosion bonding. The clad composite is then returned to the manufacturer for fabrication (see Figures 14.4 and accompanying photographs). Materials clad on the carbon-steel substrate have included naval brass, stainless steel, and cupronickel.

The process has allowed for a reduction in the importation of clad tube sheets into Brazil. Also, some manufacturers using weld overlay and brazing, which are not too satisfactory, have supplemented these processes with explosion bonding and obtained a cost reduction.

The first tube sheets were explosion bonded by IPT in June 1975. Since then, the number of tube sheets produced and the quality of bonding has steadily increased as has the number of customers. Early tube sheets were not tested nondestructively, and the only quality control was whether or not tapping on the surface gave evidence of voids. Ultrasonic inspection equipment is now used to determine if the tube sheet is totally

bonded. Reject rates are on the order of less than 3 percent of the total tube sheets welded.

Other Production. Explosion-clad sheets of 304 stainless steel to carbon steel were made for evaluation by one fabricator. These clads were formed with no problem into the desired configuration.

This type of clad was evaluated for applications by Petrobras. Conventional tests as specified in the American Society of Testing Materials (ASTM) 262 were conducted on the clads. These tests indicated that clads of nineteen millimeters and greater met all specifications.

Tube to tube sheet expansion was carried out on two heat exchangers. Over four thousand tubes were expanded successfully. Hydraulic tests were conducted after expansion to insure the quality of the expansion process. Eight leaks were repaired mechanically. Wax was used as the transmission media, which is less costly than the molded polyethylene plugs used in other countries.

Bimetallic thermostat materials were explosion bonded. Billets were first melted and rolled at IPT, then explosion bonded. After welding, the composite was rolled to size. These materials provided another market for IPT that formerly required the material to be imported by Brazilian industry.

The hardening of jacares for a manufacturer of railroad hardware has been done successfully. Several jacares have been hardened and are currently being evaluated on Brazilian railroads. It is anticipated that this market will expand after further evaluation.

Technical Competence of the Staff. IPT products currently rely on explosive metalworking, cast-products technology, and foundry techniques. An increase in the volume of these products has required IPT to demonstrate their capabilities to industry.

In the Explosive Metalworking Project, which introduced an entirely new product to Brazil, time and perserverance were required to show that good-quality "clads" could be made. The project staff needed to gain necessary experience, but present evaluations indicate that the IPT personnel recognize the problems of their industry. A sampling of industrial sponsors indicates a high level of confidence in this IPT group. The staff is now stable and has a capable marketing ability.

The Explosive Metalworking Project was one example of introducing totally new products and services into Brazil. IPT and DRI agree that the success in this area was due in part to the training program.

Explosive metalworking is one kind of example of the transfer of a "new" technology to Brazil. The goods produced have been accepted by Brazilian industry. However, industry must continually be convinced that a quality product is being produced, which means that manufacturing techniques and continued experience must continue to be developed by IPT.

## TRANSPORTATION

### Piper's Industrial Cooperation Agreement with EMBRAER

The Brazilian Government in 1974 put an option to the country's major suppliers of general aviation aircraft. Continued participation in the Brazilian market, which, at that time, represented the single largest export market for U.S. light aircraft (general aviation) manufacturers, was made contingent upon a firm's willingness to take on a Brazilian partner and begin a light aircraft production program in Brazil. The domestic production program, it was understood, would enjoy all the government support and protection it needed, including the establishment of prohibitive tariffs on import competition. The potential savings in foreign exchange reserves alone were compelling, in that approximately five percent of the country's total expenditures on imports in 1973 went to the U.S. aerospace industry, and the figure was even higher in 1974.

In spite of the fact that Cessna held more than sixty percent of the Brazilian market and enjoyed, as a result, a slightly more favored negotiating position, it was Piper that was prepared to accommodate the new set of conditions for continued involvement in the market. In midsummer 1974, Piper entered into a wide-ranging industrial cooperation program with Empresa Brasileira de Aeronautica, S.A. (EMBRAER), the state-owned aviation development and production firm. The program is actually based upon two separate agreements--one for single engine aircraft and the other for twin engine aircraft--which permit EMBRAER to select any Piper model it wishes for local production. Toward the end of their five-year agreement (1975), EMBRAER has already undertaken assembly work on Piper's popular Pathfinder, Cherokee, Cherokee Six, Lance, Seneca II, and Navajo, and Piper had shipped over 1,000 kits to Brazil.

Piper is responsible for providing the necessary assembly and parts manufacturing know-how, as well as for assisting in such areas as quality control, materials handling, and manufacturing. Piper has an option to use its international distribution system for aircraft that may be exported from Brazil. The U.S. firm's compensation is primarily a percentage return on the components it ships to EMBRAER. As the licensee progressively substitutes local content for these imports, the returns will diminish. However, even at 100 percent production in Brazil, Piper will be paid a fee for service in support of those aircraft. With the exception of those items that cannot be economically produced in Brazil, local substitution is expected to proceed smoothly.

At the present time, the Piper program is basically a licensing agreement; but in the medium and long term, it could provide for the cooperative development of new aircraft. The agreement specifically permits EMBRAER to: (a) fabricate Piper aircraft for sale in the domestic market and, on occasion, to produce jointly with the U.S. company for foreign market sales: (b) replace on a gradual scale Piper-supplied components with EMBRAER-fabricated products; (c) initiate joint programs, sharing development and production of a new aircraft aimed at domestic or foreign markets; and (d) market one another's products through individual distribution networks.

Production capability for the Piper models is being transferred to EMBRAER in three phases. During Phase I, completed structures such as fuselage, empennage, and wings are shipped to EMBRAER for final assembly and installation of all systems and components. Phase I was completed for the single-engine models in six months and Seneca is now also in Phase II. At Phase II, EMBRAER receives structured sub-assemblies for mating in jigs in addition to the functions achieved in Phase I. By the third phase, all component parts will be shipped by Piper for assembly by EMBRAER, followed by three sub-phases: (a) begin replacement of Piper-supplied parts by Brazilian-made equivalents, including interiors and fifty percent of both fiberglass and acrylics; (b) complete replacement of all remaining fiberglass and acrylics and produce all harnesses; and (c) produce the aircraft completely with Brazilian-manufactured parts and components with the exception of those that cannot be economically produced in Brazil. Upon completion of Phase III (c), EMBRAER projects that from sixty-six to seventy percent of of Piper aircraft product will be Brazilian in origin, based on U.S. price.

A comparative look at the specific bargaining stances taken by Piper, Cessna and Beech in negotiating with EMBRAER provides contrast. As mentioned earlier, Cessna enjoyed the lion's share of this rapidly growing market which, combined with the fact that it operated an extremely effective distribution system in the country, gave it a slight advantage in the negotiations with EMBRAER. However, the Brazilian Government sent a mission to the U.S. to meet with all the major small aircraft producers and solicit proposals for a production program in Brazil.

According to EMBRAER, the three principal firms involved (Piper, Cessna, and Beech) were fully apprised of the "rules of the game." That is, the Brazilians made explicit their intent to develop their own technical, managerial, manufacturing, and marketing capabilities in small aircraft production and to reserve the domestic market for Brazilian-produced aircraft in the future. The latter, it was explained, was not so much an intent to create a protected industry but an effort to achieve foreign exchange savings. Implicit in these rules was that, eventually,

only the foreign firm prepared to enter into an agreement with EMBRAER would be permitted continued participation in the large Brazilian market.

In the early phases of the negotiations, competition among the three U.S. firms was spirited, especially between Cessna and Piper. Beech dropped out as a serious contender quite early, asserting that if Brazil wanted its aircraft, it would have to import them from its U.S. facilities. From all appearances, Cessna entered into the negotiations in complete earnestness, with a preparedness to at least seriously entertain the idea of releasing technology and managerial control to EMBRAER for production of its aircraft. It ultimate position, however, was not unlike that of Beech's.

Evidence of this was Cessna's refusal to grant EMBRAER authority to make modifications as it deemed appropriate in the Cessna aircraft model the company might choose to manufacture. To Brazil's goals in developing its own aircraft industry, such authority would be expected to be a core feature of the kind of industrial cooperation agreement sought by EMBRAER. Cessna's attitude on this suggested its concern that quality or performance standards of its aircraft would suffer if it agreed to this term. A second difference that arose in negotiations between Cessna and EMBRAER concerned royalty payments. EMBRAER wanted no royalty obligation for manufacturing know-how acquired from the foreign partner, and Cessna felt this a legitimate term to the agreement.

As was portended by Brazilian authorities prior to entering into the negotiations, a fifty percent tax (raised from seven percent) was imposed on imported small aircraft in 1975, and importers were required to make a one-year, interest-free deposit to the government covering the full price of the aircraft brought in from abroad. Cessna's sales in the Brazilian market, which in 1973 exceeded 400 aircraft, plummeted to only five in 1976. Cessna has, however, registered strong protest through public channels, such as congressional hearings and press conferences, against EMBRAER's efforts to penetrate the U.S. market, arguing that Brazil must permit comparable ease of access to its own market for small aircraft if it intends to sell its products in the U.S.

Piper and EMBRAER seem to favorably assess their respective experiences with one another, both through the negotiating stages and now in the production phase. Piper attributes this to early appreciation of the need to demonstrate flexibility on a number of levels. For example, Piper indicates that it recognized the importance EMBRAER attached to obtaining authority to modify the chosen models as it felt necessary and readily conceded this point. Any upgrading or improvements which Piper develops in its know-how for these models' production are automatically transferred to the Brazilian partner through documentation sheets and specifications.

One important economic benefit which the Brazilian authorities hope to gain by creating a national aircraft industry is the quite significant multiplier effect such a development can be expected to have on supplier industries. (Some forty to forty-five percent of the cost of an aircraft is represented in purchase parts.) Piper has proven to be most accommodating in this area as well, particularly in advising the Government on how best to set up a supplier network for aircraft parts that is responsive to the growing needs of EMBRAER. Piper engineers have also provided on-site training and technical assistance to the component supplier industries. Those items which cannot be economically produced in Brazil, Piper will procure for EMBRAER from its own suppliers.

At present, EMBRAER and its related components industries are not fabricating many detail parts, such as the engine, propellers, radios, or instrumentation. Yet the Brazilians have been fully integrated into assembly of the aircraft kits, welding of airframe parts, some acrylic forming, all of the fiberglassing, all riveting, and nut and bolt assemblies. Piper assesses favorably the speed with which the Brazilians have absorbed the technology and phased local content into production for the model ranges chosen.

It is important to note the there are distinct limitation on Piper's ability to influence many facets of EMBRAER's operations. The marketing of aircraft to domestic purchasers, for example, is a function which EMBRAER

has reserved exclusively for itself, despite Piper's well established marketing network in the country. Not only does the Brazilian enterprise insist on performing its own domestic marketing, but also on avoiding the traditional distributorship system through direct factory sales. It is not clear that there is any correlation, but EMBRAER is only recently coming out of a sales slump that it has been in for the past two years. Certainly one contributing factor to the dip in sales has been the extremely tight control the Central Bank of Brazil has held over the available money supply—and the improvement may be attributed to a new program being instituted by the government to assist private entrepreneurs in financing the purchase of small aircraft. It is yet too early to tell whether EMBRAER will be able to sustain this upswing in sales.

Several additional observations seem relevant to the growth and performance of the Brazilian aircraft industry.

- Military orders provided both the "start-up" capital for the fledgling industry as well as protected it from the drop in civilian demand in 1978. Nevertheless, the industry is strongly promoting sales of both civilian and military aircraft to further expand its clientele througout the world.

- Government support and direction of Brazilian aircraft manufacturing has resulted in a "national aircraft industry." The large number of private shareholders, horizontal integration of NEIVA and AEROTEC into EMBRAER, and over 300 Brazilian subcontractors to the industry demonstrate that military production is supported by a broad base of Brazilian institutions and investors.

- Brazil has exported both military and civilian aircraft, the civilian aircraft going primarily to aviation markets in developed countries and the military aircraft entering service with several Third World armed forces.

- Airborne electronics and turboprop/turbojet engines can represent over fifty percent of aircraft cost. The majority of these components have been imported by the Brazilian industry. Thus, Brazilian aircraft manufacturing, including military production, is still dependent on foreign suppliers.

- The Brazilian aircraft industry is rapidly increasing its technological sophistication and capabilities. The industry still relies heavily on government support for costly R&D and military orders for aircraft.

- The Brazilian aircraft industry provides direct employment of over 5000 individuals and to a larger number if one takes into consideration the employment in 300 supplier firms. Its contribution to the development of the transportation infrastructure and to agriculture has been of significant value. It could be argued, however, that aircraft for such uses could have been bought at lower costs from outside the country. While this may be true for some types of aircraft produced, Brazil would not have been able to develop an indigenous technological capability and to enter the highly competitive international market for aircraft.

- The Brazilian aircraft industry employs a well-developed advertising and sales/service organization worldwide to market a variety of civilian aircraft and nonaviation products. The technical base provided by the aircraft industry is now being used to advantage by Brazil to feel its way into a variety of space-related activities.

OTHER: PHARMACEUTICALS

As an example of the Brazilian state as producer, the case of Centro de Medicamentos (CEME) is included. Unlike the ventures already described, CEME was not a success story and serves to illustrate some limitations of state enterprises.

CEME was created in 1971 by the state in an effort to fill a major gap in social welfare—the provision of basic drugs to the mass of the Brazilian people. The INPS (Institute Nacional da Previdencia Social) provided some minimal hospital care and also enabled poor patients to consult with physicians. But patients, more often than not, lacked the money to buy the drugs the doctors prescribed. CEME was designed to make medication available to the poor.

Thus, CEME was justified in welfare terms from the outset. This flew in the face of the main thrust of state policy and created huge problems. For example, it was awkward for the state to make profits by selling medications. CEME, therefore, defined its purpose as the distribution of medications without charge to those whose family income did not exceed the minimum wage. Pregnant women, nursing mothers, and children under five

were also included. Generally speaking, however, it was low-income families that took advantage of CEME.

The venture was restrained by the fact that the state lacked sources of leverage or competitive strength. For example, the Brazilian state controls no significant natural resource relevant to pharmaceuticals. Indeed, the inputs of the industry tend to be produced by multinational firms. The overall technological edge enjoyed by multinationals in this sector is enormous. The volatility and sophistication of the production technology, the emphasis on product differentiation, and the importance of marketing techniques made the gap between CEME and the leading foreign firms--in terms of production capability--truly impressive. CEME did manage to bring together the production capability of twenty publicly owned pharmaceutical laboratories, but they were able to produce only eighty types of medication compared with the thousands of products produced by the subsidiaries of multinational firms. Indeed, CEME's laboratories were unable to produce the advanced antibiotics, steriods, and hormones needed in modern medical practice.

Some of these limitations did not matter. After all, the aim of CEME was to distribute essential medicines that would help cure common illnesses. Many of the more sophisticated products of multinational firms were irrelevant to this goal. However, CEME's weaknesses in the sphere of production undoubtedly undermined its raison d'etre in the eyes of Brazilian critics and made it vulnerable to displacement by multinationals.

CEME failed because it was seen as a threat by multi-national corporations operating in Brazil, and because the state was not a sufficiently strong supporter of its role and function. In essence, foreign firms wanted CEME to go away, and the Brazilian state was not entirely convinced that it wanted or needed CEME.

Objectively speaking, there was no real competition between CEME and the multinationals. Their markets and products were quite different. Multinationals sold expensive, highly differentiated, and sophisticated drugs. CEME distributed a small range of basic medications free of charge

to the poor, many of whom lived in the underdeveloped Northeast. Indeed, CEME even helped the multinationals--indirectly by educating future consumers and directly by buying the products of multinational firms. For example, one-third of the drugs CEME distributed in 1973 could not be produced in their own laboratories and had to be purchased from the private sector. In short, CEME actually increased the profitability of multinationals operating in the pharmaceutical sector. However, buying their products was not enough to turn the multinational corporation into CEME's ally. -- CEME defined the purposes of the pharmaceutical industry in a threatening way and was looked upon as a potential competitor in the long run.

By mid-1975 CEME had been dismembered. The job of distributing drugs was placed under the Welfare Ministry and CEME's research activities were transferred to the Ministry of Industry and Commerce. The history of CEME shows that the growth of state enterprises is far from automatic. Created to serve welfare goals, CEME was a long way from reflecting the main thrust of state policy or priorities. Its only unequivocal support came from the needy. CEME also lacked the wherewithal to sustain itself as an independent firm. Its existence hinged upon a distributive rather than a profit-maximizing function. Unlike other "profitable" state enterprises, it could not generate its own investment funds. It therefore could not become an autonomous and self-sustaining entity.

The role of CEME was further compromised by the fact that it attempted to enter an industry where the competitive strength lay firmly with multinational corporations. CEME might have been permitted its welfare function if it had successfully combated foreign penetration of the pharmaceutical industry. For technological reasons, however, the pharmaceutical industry was firmly in the hands of foreign capital, and CEME did little to alter this.

## SCIENCE AND ENGINEERING RESEARCH/EDUCATION

Projeto Flora. The most comprehensive effort to inventory rain forest species is under way in Brazil. The project there, called Projeto Flora

Amazonica, is one example of over one hundred joint U.S.-Brazilian scientific projects over the last decade. It represents a major attempt to collect plants in rain forest areas being threatened by development.

The United States became involved in Projeto Flora at the invitation of Brazil's Conselho Nacional de Pesquisas (National Research Council); three expeditions to the Amazonian rain forest, coordinated by Ghillean T. Prance of the New York Botanical Garden, took place in 1977 and 1978 and six more are planned for 1979 and 1980.

Prance and his Brazilian and North American colleagues "collected more new species on these trips than on any expedition in which I ever participated," Prance reports. "The largest number cam from an endangered area along a new north-south highway linking Santarem on the Amazon River with Cuiaba, 1,400 kilometers to the south. We are screening our collection from there and from other locations, looking for new insecticides, food crop varieties and drugs."

Several plants from the Amazon have yielded insect repellants, says Prance, and there is special interest in tropical species as a potential source of drugs for difficult-to-cure diseases. "Recently discovered compounds effective against leukemia come from the tropical periwinkle, which grows mainly in Madagascar," Prance reports, and "it is not far fetched to believe that we might discover other drugs effective against cancer."

Amazon Indians introduced Prance and his colleagues to the beka vine (Curarea tecunarum), the bark of which is used by Indian women in a contraceptive preparation. Prance turned the plant over to be testing program, sponsored by the World Health Organization, at the University of Chicago. So far, test results are positive; components of the bark prevent laboratory rats from becoming pregnant.

Projeto Flora expeditions also collected along part of the Tocantins River, which will be dammed at Tucurui in 1982 to create a new lake 175 kilometers long. The dam will provide hydroelectric power for the city of Belém and for an iron mine in the Carajás Mountains.

"Hydroelectric power in that area is a good balance between conservation and development," Prance observes. "It is pollution-free and, placed in a location with few or no endemic species, it does minimum damage to the ecosystem."

For other areas in Brazil, the match between development and the ability of the ecosystem to sustain it may be less fortunate. One U.S.-owned, international conglomerate has cut heavily into its 400,000-hectare (million-acre) Amazon forest holdings, replacing native species with plantations of fast-growing Caribbean pine and and gmelina trees. At the southern edge of the rain forest, a European concern has killed 200,000 hectares of trees by chemical spraying and burning, planting grass in the ashes in the hope of raising cattle for the low-grade beef/hamburger franchise market around the world.

Had the initiators of these and similar operations consulted tropical biologists in advance, they might have had second thoughts. Cutting down the trees destroys most of the nutrient-conserving mechanisms of a tropical forest ecosystem. Rainwater carries off vital nutrients; the soil becomes sterile, often in two or three years.

Current commercial enterprises, biologists agree, are likely to fall far short of expectations, besides doing considerable, if not irreparable, damage. Exploitation of humid tropical ecosystems is possible, they say, but it must take the characteristics of the ecosystems into account. The knowledge base for such system-sensitive exploitation is among the goals of the joint U.S.-Brazilian Projeto Flora Amazônica.

"On Projeto Flora, our objectives are not confined to collecting plants, storing them in museums and writing papers about them," Prance notes. "We attempt to get information useful for planning both conservation and development, and to make this information available for the social and economic benefit of all concerned."

The Brazilian Government is not unreceptive to conservation efforts, France observes. "A new, high-level department has been set up under a Secretary of the Environment, and preserves established by this secretariat have saved a number of species from disappearance. The Brazilian Forest Service plans to create large national parks in the Amazon. A 400,000-hectare park in the Tapajos River basin is under way; others exist on paper." Future results of Projeto Flora are expected to be extremely useful in protecting fragile ecosystems.

## BIBLIOGRAPHY


Baranson, Jack. North-South Technology Transfer. Mt. Airy, Maryland: Lomond Publications, 1981.

This volume includes a detailed country study of industrial development and technology transfer issues in Brazil. Three of the case-studies in the background materials are summaries of material in this volume: Piper's Industrial Cooperation Agreement with EMBRAER, Pullman Kellogg's supply of Ammonia Technology to PETROBRAS, and SYCOR's Technology Transfer Agreement with COBRA, S.A.

Evans, Donald D. and Adler, Laurie Nogg. Appropriate Technology for Development. Boulder, Colorado: Westview Press, 1979.

The Evans-Nogg book is a rich source of the outcomes of transfers of appropriate technology. The IPT Explosive Metalworking Program, as presented here, describes one of the many case-studies available in this book.

Martin, Everett, "Brazil Raises Exports of High Technology, to Pace Third World, The Wall Street Journal, Tuesday, October 6, 1981.

Martin's article provides background for the Piper-EMBRAER case study.

Mosaic, "Crossroads for Tropical Biology". Mosaic (May/June 1979) p. 10 18, Washington, D.C., National Science Foundation, 1979.

This NSF science magazine is the source of the description of Projeto Flora, the case study of science and engineering research presented.

Overholt, William H., et al. The Future of Brazil. Boulder, Colorado: Westview Press, 1978.

Overholt's volume is the source of materials on Companhia Vale do Rio Doce, some of the information on the Pullman Kellogg-PETROBRAS case, and the example of the Brazilian state as producer, Centro de Medicamentos (CEME).

Rao, Nagaraja K. and Ruina, Jack Philip, et al. Disarmament and Development: The Case of Relatively Advanced Developing Countries. (Possible Economic Payoff From Military Production: The Case of The Aircraft Industries in Brazil, Israel & India). Cambridge, Massachusetts: MIT, 1980.

This MIT report contributed to some of the general comments on the Brazilian aircraft industry as reported in the Background Materials.

Vidal, David. "Brazil Declares Computer Independence," The New York Times, Sunday, February 19, 1978.

Vidal's article provides background for the SYCOR-COBRA case study.


 Previous Page Blank

Wallender, Harvey W. II et al. Technology Transfer and Management in the Developing Countries: Company Cases and Policy Analyses in Brazil, Kenya, Korea, Peru, and Tanzania. Cambridge, Massachusetts: Ballinger Publishing Company, 1979.

Wallender and his associates have compiled and analyzed data from case studies based on consulting projects executed in Brazil, as well as in Korea, Peru and other countries. The technology-transfer case of BoaStruct is summarized from this volume.

## SESSION 2: PRIVATE SECTOR VIEWS ON ISSUES AFFECTING FUTURE COOPERATION

### INTRODUCTION

Both the U.S. and Brazil are in the forefront of countries recognizing the significance of technology in national growth and development. In both countries, there is increased attention to the role of foreign enterprises in national technological development, and an increasing tendency for governments to intervene in "private" technology transfer channels for overall national interest.

In the U.S., technology companies, beleaguered by steadily increasing foreign competition, are increasingly requesting government assistance. The growing government response and political interest in technology stems in large part from a feeling that the United States economy is undergoing a major transformation, away from the basic manufacturing industries that spurred growth for the last century or so toward a more technology-intensive economy. Many of the lost auto and steel jobs will never return.

In contrast to the situation in autos, steel and textiles, economists say that the United States still has a competitive edge in technology. They use the term technology broadly, to encompass a wide range of industrial activities characterized by rapid innovation, including electronics, medical technology, genetic engineering, and new materials development. "We have got to change our national policies to reflect those trends and not assume that economic recovery will return us to where we were before," comments Representative Timothy Wirth, Democrat of Colorado, one of the so-called "Atari Democrats" who favor shifting priorities to encourage the newer industries.

But even U.S. technology industries are suffering. In part the cause is the recession, but there is a more worrisome factor at work too: an erosion of American competitiveness. The Japanese have made strong inroads

in semiconductors, robots, computers, copiers and other office equipment and telecommunications. According to a Commerce Department study soon to be published, the United States has slipped from a position of dominance to being "strongly challenged" and the situation will get worse if nothing is done about it.

Moreover, according to industry and Government officials, it is not just the attack from foreign competitors that is upsetting, it's the way the attack is being conducted. Many foreign governments, particularly Japan and France, are focusing on industries for development and offering low-cost financing, trade protection and other measures to help develop them. This government backing has convinced some U.S. executives that they should seek help from their Government.

One area in which there is conflict within U.S. industry is in trade policies. Many favor domestic-content bills designed to help the auto industry by insuring that products sold in the United States are made at least partly in this country. The electronics companies fear that such a measure would result in a foreign backlash that would hurt exports in high technology products, in which the United States still has a comparative advantage.

Most technology executives favor free trade but their commitment often varies with how severely their own companies are under attack from abroad. They want to stave off protectionist measures designed to help other American industries that would hurt their own exports. They want renewed efforts to open foreign markets to American goods and they worry that existing trade agreements are insufficient to achieve this objective.

U.S. executives also say that the American effort to restrict the flow of technology to the Soviet bloc has made it too difficult to export even to friendly nations. Domestic manufacturers say they lose business to Japanese and European competitors, which are not bound by cumbersome licensing procedures and restrictions.

In Brazil, the traditional modes of foreign investments in manufacturing facilities are being challenged, and foreign firms are encountering considerable difficulties--including mounting restrictions on required imports, barriers to the expansion of manufacturing operations, and growing demands by governmental authorities to increase Brazilian exports of manufactured goods and to share sophisticated (internationally competitive) technology with Brazilian enterprise.

The reasons for these changes are articulated in national development objectives, which are aimed at expanding Brazilian-owned and controlled enterprise and the technological self-reliance of the economy at large. These objectives are viewed as an important contribution to the dynamics of economic growth in Brazil. The progressive development of a domestic capital goods industry, with ancillary design and engineering capabilities, is regarded as another vital ingredient of growth dynamics and the drive toward technological self-sufficiency.

The "technology component" looms large in Brazil's national development objectives. It is considered a vital ingredient of dynamic economic growth and industrial competitiveness in world markets. To Brazilian Government officials responsible for economic growth and national development, the "technology component" has come to mean the development of indigenous capabilities to adapt or redesign product and component designs and related manufacturing methods acquired from foreign sources, or, if necessary, to design and engineer products and processes to the needs and conditions of the Brazilian economy. An integral part of national technological development policies is to intervene in technology flows from foreign sources with a view toward limiting foreign investments and industrial licensing arrangements that would inhibit or be harmful to the growth and development of indigenous design and engineering capabilities and suporting infrastructures (such as capital goods industries that contribute to domestic design and engineering activities).

Particularly in high technology industries, such as aircraft, computers, and the design of engineering of petrochemical plants, the Brazilian Government is pursuing policies aimed at precluding foreign

enterprise considered to constitute overpowering competition to the emerging Brazilian industry. At the same time, Brazil is anxious to have U.S. enterprise participation in the Brazilian economy as minority shareholders, yielding the management of industrial facilities to Brazilian control. The U.S. firm is being sought as a supplier of essential technology and whenever possible, one that will facilitate access to world markets where Brazilian firms can earn much-needed exchange.

What follows amplifies four issues central to science, technology and development in the two countries:

- U.S. Technology Export Controls
- U.S. Domestic Market Concerns
- Encouraging Domestic Industry in Brazil
- Import of Technology/Outflow of Returns in Brazil

Focus on these issues is not intended to preclude discussion of other elements of the science and technology transfer environment.

ISSUES

U.S. Technology Export Controls

The United States traditionally is strongly committed to a liberal international trade and payments system. The U.S. controls imports as a means of protecting domestic industry, but the level of protection is lower than that of many industrial countries in keeping with the U.S. beliefs in the benefits of wide multilateral trade. Export restrictions are minimal, mainly covering strategic items and general health and safety standards.

The U.S. government's control of goods which may be exported to particular nations or groups of nations is exercised through the Department of Commerce's Office of Export Administration, although several other government agencies must review and concur, notably the Department of Defense. Export controls were instituted and are maintained for the following purposes: to safeguard U.S. national security; to promote U.S.

foreign policy aims; and to protect the domestic economy from abnormal foreign demand for commodities in short supply.

While permanent export controls have been in effect since enactment of the Export Control Act of 1949, the current regulations stem from the Export Administration Act of 1969, as amended and extended in 1972, 1974, 1977 and 1979. The Act limits the restrictions on exports to those products which are not readily available from other areas such as Northern Europe and Japan, unless it can be demonstrated that the absence of such restrictions would be harmful to U.S. national security. Each of the four successive versions of the Act since 1969 has represented a compromise between two different objectives—that of protecting national security and that of promoting exports.

Part of the control mechanisms under the export Administration Act is the Commodities Control List, which contains items with possible military applications for which an export license must be obtained. The decision to grant an export license for any item on that list is made on a case by case basis, with the judgment resting on how likely it appears that the commodity will be directed to military end-use. One of the chief complaints has been that the process is so lengthy and cumbersome that it frequently causes U.S. companies to lose valuable export business.

A Militarily Critical Technologies List, established by the Export Administration Act of 1979, was originally intended to become the underlying basis for the Commodities Control List but has thus far had advisory status only. The list focuses on classes of technologies rather than specific items, the export of which could affect lead-time in military areas in which the United States has a significant advantage The initial list, issued in October 1980 by the Department of Defense, includes seventeen major categories of goods and technologies. A major criticism of the list is that it is too broad and diffuse (700 pages) to provide sufficient guidance to enable government agencies to use the list as the basis for licensing, maintaining or enforcing.

Legislation has been introduced into the Senate, S.2837 "Office of Strategic Trade Act of 1982" (referred to as the "Garn" Bill), which would take effect upon the expiration of the Export Administration Act of 1979 (in September 30, 1983) and replace that law. The "Garn" bill is based upon the EAA, and most sections are very similar if not identical. The most significant change in the provisions of S.2837 is the establishment of an independent executive agency to be known as the "Office of Strategic Trade," which would replace the Commerce Department's Office of Export Administration and take over the functions which Commerce now exercises under the EAA. This would rid Commerce of having the two conflicting functions of promoting exports and restricting exports through regulatory controls. Another change provided for in S.2837 is the erection of a new "Office of Technological Data" to "monitor and review the transfer of unembodied technology and knowledge through cultural exchange, educational, or other programs or means."

Considerable debate has surrounded the question of just how stringent the controls on the transfer of technology for purposes of protecting U.S. national security need be. A recent panel on scientific communication and National Security constituted by the National Academy of Sciences advocated a strategy of "security by accomplishment" as opposed to one of "security by secrecy"--based on the premise that the long-term security of the United States is dependent largely on its scientific, technical, economic and intellectual vitality, which in turn is dependent on a vigorous research and development effort that openness helps to nurture. While the panel did not extend its deliberations to problems raised by scientific communications and military-related technology transfer involving Third World countries, it did note that this entire range of issues is complex and important, and in time might overshadow the Soviet dimension. The panel recommended that further intensive study be directed to this set of problems.

Apart from complicated procedures and lengthy processing periods in connection with licensing requirements under U.S. export control regulations, U.S. exporters have noted a number of other barriers within the United States itself which have the effect of restricting sales by U.S. firms in foreign markets. These include:

- U.S. taxation policy, which, in contrast to the tax policies of many foreign countries, imposes a tax on income and cost of living allowances of U.S. personnel overseas, thus placing U.S. firms which establish overseas operations to facilitate export trade at a competitive disadvantage with foreign companies;

- Difficulties in obtaining financing commitments from the Export-Import Bank, which create a competitive disadvantage for U.S. exporters, particularly small and medium-sized companies, since foreign companies, supported by government aid, are often able to provide complete financing packages;

- Difficulty in securing export licenses for countries with questionable human rights records;

- Lack of assistance from U.S. embassies abroad in negotiating large contracts with foreign governments;

- Ambiguities in U.S. antitrust laws, which deter U.S. companies from engaging in joint bidding or marketing arrangements, thus preventing U.S. exporters from competing effectively with international consortiums.

This last export barrier is perhaps particularly important, in that U.S. antitrust laws have tended to stifle cooperation between U.S. firms not only in bidding and marketing but also in the conduct of research. This has been criticized as causing an excessive duplication of effort in industrial research and a waste of scarce manpower resources.

U.S. Domestic Market Concerns

In the last decade, the U.S. balance of trade has become less predictable and has undergone major shifts in response to world competition and inflationary pressures. In general, the United States has maintained its competitive strength in such high technology commodities as aircraft, machinery, electronic computers, and chemicals, while losing competitive strength in motor vehicles, steel products, textiles, footwear, and consumer electronic products--a loss reflected both in declining exports and in higher import sales in the U.S. In response to these trade shifts,

the government has received mounting pressure from domestic industries suffering from import competition to raise import tariffs and adopt other forms of protection for U.S. industry.

The challenges being presented by foreign competitors have been assisted by the competitive rules which international agreements and domestic U.S. laws and regulations have imposed on U.S. corporations. The legal equation has been considered unbalanced in the sense that U.S. firms are frequently restrained from behavior which is internationally accepted as fair practice. Foreign governments have restricted U.S. firms from key domestic markets on the basis of economic interests as well as national security.

Among the non-tariff barriers affecting U.S. exports in many foreign countries are the following: government procurement procedures designed to favor domestic suppliers; value-added requirements, particularly in developing countries, where the amount of local content added is often a decisive consideration in the award of a contract; differences in equipment and product safety standards from country to country, which normally deviate somewhat from international standards; and requirements for prior deposits and guarantees, again particularly in the developing countries, which inhibit imports into these countries. The Japanese government in particular perceives the national interest as being served by government-assisted penetration of foreign markets, restraints on foreign firms in domestic markets, tax laws designed to encourage research and development, and retention of profits as rewards for successful economic competition.

U.S. trade with Japan has become a particularly impelling motivation behind U.S. protectionist forces. The Japanese "targeted industry" strategy, in which key industries with high export potential have been granted special protection from foreign competition in the home market until gaining sufficient scale and cost parity to price aggressively in the world market, has led to a long succession of industries which the Japanese now control. Most of Japan's successful exporting companies have benefited from special legislation and decrees, such as exemptions from many anti-trust requirements, government funding of a large portion of

their research and development programs, special tax benefits and low-cost loans.

In direct response to Japanese import expansion in the U.S. domestic market, U.S. automobile manufacturers recently succeeded in the passage of local content legislation in the House of Representatives. An industry that is currently pressing for protectionist measures from Japanese competition is the machine tool industry. A small Florida toolmaker, Houdaille Industries Inc., arguing that Japan's machine tool industry is a cartel subsidized by the Japanese government, has petitioned fo. a revocation of the 10 percent U.S. investment tax credit for any Japanese tools bought by a U.S. company, while at the same time making a parallel appeal for protection through the more conventional device of import quotas.

One form of protectionism about which American companies are becoming increasingly concerned is restriction of the free flow of information and data--one of the most sensitive and essential elements of international business. The transmission of information has become for many governments a commodity of sorts--not merely a tool necessary for conducting business. Information transmission creates jobs and it can be used to generate tax revenues as it crosses borders. Brazil, in an effort to protect its own data processing industry and create new jobs, has refused to permit American-based companies operating there to hook into international data bases by satellite, thus forcing these companies to build duplicate facilities in Brazil using local labor. Offshore processing of Brazilian data is prohibited, and companies are required, whenever possible, to purchase Brazilian equipment and software.

Recently the National Telecommunications and Information Administration of the Commerce Department issued a report warning that restrictions on the transfer of information are eroding the American position in telecommunications and high technology markets. The U.S. remains an advocate of free information flows, arguing that any other scheme would ultimately hurt international trade and the world economy. However, demands for "fair" trade are increasingly colliding with arguments

in favor of "free" trade, and in the area of information transfer, as with many other industries, companies long accustomed to moving information at will and at minimal cost are pressing for an exploration of the possibility of counter-measures.

## Encouraging Domestic Industry in Brazil

Brazilian national development objectives place a major emphasis on the achievement of technological self-sufficiency in the economy. Needs for greater energy independence, increased import substitution efforts, reduction of Brazil's dependence on foreign capital, and expansion of the domestic market are receiving increasing attention and recognition. A broad consensus has emerged that it is in Brazil's long-term economic development interest to produce as much as possible of its own production machinery to enhance the international competitiveness of Brazilian private firms.

To achieve technological self-sufficiency, the Brazilian government has instituted a number of measures designed to increase indigenous capabilities to adopt or modify products and component designs and related manufacturing methods acquired from foreign sources, and, when necessary, to design and engineer products and processes specifically oriented toward the conditions and needs of the Brazilian economy. Efforts have been directed at establishing a strong domestic technological base for which foreign technology can be absorbed and adopted, new technologies generated, and training and support services infrastructure developed and established. Specific support to emerging domestic industries has included protection against foreign import competition, the erection of technical support networks to assist with production and marketing functions, and the provision of credit and foreign exchange terms necessary to purchase equipment and obtain expert training.

Brazil's economic development objectives create strong demand for obtaining manufacturing expertise, design engineering, and other technical support services from technologically advanced nations, but unencumbered by the management and control mechanisms typically included in the foreign

investment arrangements by large multinational firms. Recent efforts on the part of Brazilian authorities have focused on developing more effective ways to search for and select technologies among alternative sources that best reinforce the absorptive capacity of Brazilian indigenous capabilities. Efforts have been directed toward ensuring that technology acquired from abroad is not only obtained on the most favorable terms, but is also that which is most needed for the objectives of the economic development plan.

One question frequently raised is the relationship between "dependence" on foreign technology and the development of indigenous science and technology capabilities. Does technological self-reliance depend in large part upon the stage of industrial and technological development in a particular country rather than on reduction of foreign technology? In the post-World War II period, for example, Japan depended heavily upon operational technology from foreign sources, gradually replacing foreign engineering and design with indigenous scientific and technological capabilities to supplement foreign imports. "Unbundling" and redesigning and repackaging was a basic technique used by the Japanese in their industrial evolution.

## Imports of Foreign Technologies/Outflow of Returns in Brazil

Because of its agricultural and mineral potential and large market, Brazil has held a strong attraction for foreign investment. Foreign firms have been at the forefront of the industrial surge in Brazil and currently produce the vast majority of Brazilian manufactured exports. They strongly dominate such sectors as pharmaceuticals, household appliances, automobilies, tobacco and electrical goods. Brazilian state enterprises dominate industries such as steel, electric power generation and other utilities and foreign firms are restricted from certain sensitive areas such as domestic air traffic, printed and broadcast media, and petroleum, coal and uranium production. Apart from these specific areas, however, foreign firms have until the mid-1970s been permitted relatively wide scope in Brazil.

Foreign investment, which has gone mostly into manufacturing, has in the past been viewed quite favorably by Brazilian authorities, because with a shortage of native capital, foreign capital has facilitated growth and filled other genuine needs through the introduction of modern management methods and technology. Until recently, such technology transfers have generally been initiated by Northern suppliers, with direct payments and other contractual terms established on an essentially laissez-faire basis.

In the last decade, however, increasing restrictions have been placed on foreign firms, largely as a result of claims against multinational corporation activity in Brazil. Principal among these claims is that the multinationals take more money out of Brazil than they put in. Foreign corporations have been accused of exporting goods needed in Brazil; of using only imported technology to the exclusion of Brazilian-developed technology; of forcing suppliers to underpay their workers; and of making Brazil a dumping ground for obsolete capital equipment at inflated prices.

In addition to excessive direct and indirect costs, major complaints that have been raised include the following: contract restrictions that reduce the value of imported technology and interfere with national sovereignty; complex packaging arrangements that tie importers into perennial dependence on Northern suppliers; importation of technologies that are "inappropriate" to Brazilian economic and social conditions; centralization of research and development functions in the industrialized nations, thus retarding the development of indigenous technological capacity; and the role of the patent system in preventing technology transfer, thus establishing monopoly markets for Northern exporters. An additional consideration to Brazil is the tendency of most multinationals to retain control of the latest technology in their home country offices.

Since the mid-1970s, measures have been adapted by the Brazilian authorities to regulate the import of foreign technology. Such regulation has generally focused on government review of proposed contractual arrangements with the objective of eliminating excessive direct payments and attempting to ensure the acquisition of the highest available technology at the lowest possible price. Government contract review has

also attempted to screen out restrictive terms tending to limit future options of the purchasing firm in modification and adoptation of the acquired technology, selection of sources of inputs, marketing of outputs, and use of trademarks. In this contractual review, the Brazilian government is also aiming to prevent disguised repatriation of profits in the form of excessive royalty or technical assistance payments, and to ensure that maximum export benefits are gained from technologies transferred to Brazil. Measures have also included curbing the powers of foreign banks, creating trading corporations to get the best prices on imports and exports, requiring competitive bidding arrangements, and requiring multinationals to do more research in Brazil. Import restrictions were stiffened in 1976.

To enhance national acquisition of technology and concomitant industrialization, Brazil then has to some extent attempted to protect indigenous industry and strictly regulate international technology transactions, a so-called interventionist strategy. Other countries have tried to create an environment to encourage international transfers of technology, and have opened their economies to international competition and encouraged their entrepreneurs to compete in international markets, a so-called catalytic approach. The latter approach has proved more successful in countries such as Taiwan and Korea than the former. These approaches are, of course, polar positions. Most countries employ some mix of catalytic and interventionist policies, and within countries emphasis may change with shifts in government policies.

## BIBLIOGRAPHY


Abelson, Philip H. "International Competition in High Technology". Science (March 4, 1983) p. 1025.

Baranson, Jack. North-South Technology Transfer. Mt. Airy, Maryland: Lomond Publications, 1981.

Evans, Donald D. and Adler, Laurie Nogg. Appropriate Technology for Development. Boulder, Colorado: Westview Press, 1979.

Gustafson, Thane. Selling the Russians the Rope? Soviet Technology Policy and U.S. Export Controls. Santa Monica, CA: Rand, 1981.

McCulloch, Rachel. "Technology Transfer to Developing Countries: Implications of International Regulation." The Annals of the American Academy of Political and Social Science (November 1981) pp. 110-122.

Office of the Director of Defense Research and Engineering. "An Analysis of Export Control of U.S. Technology-A DoD Perspective." A Report of the Defense Science Board Task Force on Export of U.S. Technology. Washington, D.C.: ODDRE, 1976.

Overholt, William H., et al. The Future of Brazil. Boulder, Colorado: Westview Press, 1978.

Panel on Scientific Communication and National Security, Committee on Science, Engineering and Public Policy. Scientific Communication and National Security. Washington, D.C.: National Academy Press, 1982.

"Protectionism and Machine Tools." Washington Post (March 16, 1983) p. A22.

Rao, Nagaraja K. and Ruina, Jack Philip, et al. Disarmament and Development: The Case of Relatively Advanced Developing Countries. (Possible Economic Payoff From Military Production: The Case of The Aircraft Industries in Brazil, Israel & India). Cambridge, Massachusetts: MIT 1980.

Sanders, W. J. III. Speech before the California House of Representatives. Tuesday, February 1, 1983. Congressional Record (February 1, 1983) p. E223.

Sanger, David E. "Waging a Trade War Over Data." New York Times (Sunday, March 13, 1983) pp. F1 and 26.

United States International Trade Commission. "A Baseline Study of the Telephone Terminal and Switching Equipment Industry." Report to the Subcommittee on Trade of the Committee on Ways and Means of the U.S. House of Representatives on Investigation No. 332-92. Washington, D.C.: USITC Publication 946, 1979.


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Wallender, Harvey W. II et al. Technology Transfer and Management in the Developing Countries: Company Cases and Policy Analyses in Brazil, Kenya, Korea, Peru, and Tanzania. Cambridge, Massachusetts: Ballinger Publishing Company, 1979.

Wesson, Robert. The United States and Brazil. Limits of Influence. New York, N.Y.: Praeger Publishers, 1981.

## SESSION 3: NEW DIRECTIONS FOR FUTURE COOPERATION IN SCIENCE AND TECHNOLOGY

### INTRODUCTION

Where does technological progress stand today, and in what ways will it, over the next ten years, impact on cooperation between the U.S. and Brazil? In the past five years change has accelerated rapidly in fields such as biotechnology and electronics. Other technological revolutions are occurring in manufacturing and materials, with indications that energy technologies also have the potential to continue to develop rapidly over the next decade.

This acceleration of technological progress will affect scientific and technological relations between the U.S. and Brazil and offer new and expanded opportunities for cooperation.

First, U.S.-Brazil scientific and technological cooperation has traditionally supported science actitivites between U.S. researchers and those in Brazil. "Cooperation" and "science" have a traditional natural affinity. There are no anti-trust laws to maintain rivalry or competition as in technological advance. Scientific communication is open and information available to all. Patent and copyright laws, industrial spies seemingly have no place in the scientific community. Scientific knowledge, in this view, contributes to technology through the application of particular scientific discoveries to technological problems. Technology then is applied and utilized in the products and services which are marketed to bring profits to industrial firms. This is the traditional model. But will the high content of science in rapidly changing technologies change this model of the nature of science and its relation to technology? For example, the traditional publication-patent dichotomy is being challenged by current university activity in the United States to commercialize genetic engineering.

Second, new approaches to research planning are bring developed which attempt to capture the dynamics of rapid scientific and technological change. The scientific and technical literature is being made to yield potentially extraordinarily useful models of research activity and advance. These modeling techniques are sophisticated enough to pick out signal from noise and to control for variables that lead to ambiguity. It is now becoming possible to produce a literature model of research activity that can substantially reduce the degree of uncertainty associated with decisions about the strategic and tactical allocation of scientific resources. Relevant to U.S.-Brazil cooperation, these modeling techniques can yield joint ventures that reflect more accurately the research strengths, capabilities, and needs of both countries. The search by entrepreneurs for optimum technologies to buy, sell, or exchange can be made easier. The complexity and uncertainties associated with technology acquisition and transfer can be reduced.

Third, new technologies are changing the very meaning and significance of the "products" of research and innovation. Transfer of disembodied technology and exchange of research results take on new dimensions. On the technology side, the traditional divison between consumer product versus process innovation is undergoing radical change. The increased consumption of aluminum over the last decades was in part dependent upon advances in the manufacturing techniques for aluminum as well as upon inventions in aluminum narrowly defined. This was particularly so because aluminum is less workable by established production methods than steel or copper. Through these process-inventions, aluminum producers obviously profited and the state of manufacturing technology advanced.

But recent changes have not only been in the quantity of process innovations. Technology now being introduced into industrial tasks--the running of factories with information rather than workers--is a shift away from manufacturing itself. The potential of microprocessors is impressive. The automation of factories and offices, once a futuristic pipe dream, is becoming a reality. Robots have expanded beyond the dangerous jobs into the unskilled and skilled labor market. At Ford Motor Company, robots test engines. General Motors uses robotic welders.

Why is the microprocessor causing such an impact? The reason is its widespread applicability. Earlier computer technology could be applied to some products, electronics, and large scale office information equipment, for example, but not others. Microprocessors can improve almost any process. And it has led to new "products" for traditional industries. Henry Ford used, but never patented and sold, the assembly line concept; others used it freely.

Thus the traditional industrial product is evolving. Current scientific research is also being tremendously affected by new technology. "Big science" such as astronomy and physics involves the construction and use of complex, expensive technology. Major decisions often have to do with the development of this technology. Other decisions have to do with control over, and rights of access to, the technology, whether a national sample survey, a linear accelerator or a radio telescope. In such a context, it makes increasingly more sense to argue that scientific success is going to depend on technological capability.

What follows describes some areas in which technological progress has been rapid, and the potential role these advances may play in future U.S.-Brazil cooperation.

HIGH TECHNOLOGY AREAS

The scope of high technology is very broad. Areas for discussion include: pharmaceuticals, military systems, computer output, security/fire systems, other computer peripherals, genetic engineering, computer periph/printers, telecommunications equipment, process/industrial controls, laser and infrared equipment, discrete components, OCR/voice recognition, passive components, electromechanic components, other medical diagnostics, semiconductor manufacturing equipment, computer memory products, microwave equipment, medical equipment/supplies, mainframe/large computers, mobile radios/paging, analytical instruments, word processor/small business computers, integrated circuits, microwave components, test equipment, CAD/CAM, pacemakers, implants, computer software/services,

minicomputer/distributed data processing, medical imaging equipment, home computers, data communications equipment, CATV equipment, and building controls.

Electronics, as is well-known, is multiplying the productive and creative capabilities of economies. Microelectronics, new composite materials and optical fibres are radically transforming such established industries as telecommunications, transport and the mechanical industry, while creating new ones, such as robotics and office automation.

In ten years, the capacity of integrated electronic circuits has increased a hundredfold, while their cost has dropped a thousandfold. This trend will continue to progress rapidly. The development of bulk storage and the use of laser videodisks improves data processing performance, reduces production costs and creates new consumer goods. Products which were non-existent in 1975 are now available to an increasing number of users (personal computers, videotape recorders, videodisks) and their market is likely to be ten times larger in 1990.

Industrial robotization has begun to be used extensively. Thousands of highly sophisticated robots are in use throughout the world. They increase productivity in many operational sectors, including the automobile, electrical, electronics and nuclear industries. Before the end of this decade, the robot inventory will increase ten to twelvefold, and they will perform increasingly complex tasks, thus changing labor organization, and restating the employment question in radically different terms.

Electronics is a dynamic sector of the Brazilian economy, although it still relies heavily on imports. Possible areas for cooperation here include integrated circuit component assembly machines, connector assembly and processing machines, electroplating equipment, and probing systems. In addition, particular attention may be directed to microelectronics, since the recent revolution in microelectronics provides recently industrialized countries such as Brazil with a unique opportunity to "leap-frog" over their technological gap in electronics. The process, it has been

suggested, should probably begin by incorporating microprocessors into existing products and processes. After this stage has been negotiated successfully, attempts should be made to expand the role of the microprocessor into new applications requiring significant changes in practice. In other words, a user ("pull") strategy seems preferable to a producer ("push") strategy. There are many application areas for microprocessors such as energy, transportation systems, food processing, and the delivery of health and medical services.

The Brazilian government has viewed some of these advances in the availability of computer-based information as both an opportunity and a concern. Transborder data flows via transnational computer-communication systems play a particular role because they contribute to a transfer of such information resources as computer hardware, software, data bases and information jobs. Information resources are considered to be crucial for decisionmaking and major sources of economic and political power; their location and use are of great importance. As transnational corporations are the principal users of transnational computer-communication systems, the Brazilian Government's policy focuses on them.

Domestic and foreign-based transnational corporations are indeed the primary users of transborder-data-flow links in Brazil. At present, they are responsible for 27 of the 29 links established in the country, all but one of which were installed since 1979. The expected growth rate is three links per month in the foreseeable future. These computer-communication systems are not only used for standard internal communication purposes, but also to assist in the performance of a variety of functions that should otherwise be undertaken by foreign companies operating in Brazil. These systems can potentially change, therefore, the manner in which foreign companies conduct their operations in any industry.

Most of the effects are based on the location of information resources and the impact this has on the autonomy of corporate systems. If recent transnational issues can be diffused, however, cooperative efforts to take advantage of the rapid transfer of computerized information have great potential. Acquisition of scientific and technical information marketing

surveys, joint data collection and monitoring of environmental conditions offer only a few areas of opportunity.

Trends in satellite communications and receivers is another high technology area to explore. It has been estimated that the entire value of the satellite communications business over the next 10 years will amount to over $30 billion. Another area of growth is in local area networks, since studies have indicated that many company communications are internal. With regard to the home, the development of technologies linking television sets with information bases is promising. Two types of these systems are available. The first, videotex, provides two-way interactive communication connecting the television set to the computer via the telephone. The second, teletext, broadcasts TV signals directly to home receivers but suppliers can make the system two-way by the addition of a telephone line or cable link. In 1982, Brazil began new trials in videotex technology. Other areas of growth in this field include cellular mobile radiotelephone service, full video teleconferencing, electronic mail, computerized utility meter reading systems via telephone lines, ultra cold switches (Josephson Junctions), and optoelectronic integrated circuits.

Office automation is attracting increasing attention as the price of computing declines while capabilities grow. Important areas of growth include semiconductors and magnetic recording, with their potential for faster and more complex integrated circuits; software products; and electronic typewriters and word processors. Because of the severe price competitiveness in this field, it has been speculated that the United States increasingly will move into the higher value sectors (indeed, some of this movement already has occurred), while other lower cost producers, such as Brazil, will emerge as suppliers of equipment at the lower value end of the spectrum.

A major innovation in telephone and telegraph equipment is the evolution from analog to digital communication. This development, along with the demand for local data networks, 'office of the future' systems, satellite communications, mobile radio networks, lightwave systems and sophisticated terminal equipment will provide a large and growing market

for manufacturers of telephone and telegraph equipment. Other potential growth areas include private branch exchanges (PBX), key systems, more sophisticated telephone sets, facsimile machines, telephone answering machines, and cordless telephones. With regard to Brazilian-U.S. trade relations in this area, however, it should be noted that in 1982 Brazilian imports of U.S. equipment dropped 33 percent to $4 million.

Finally, as another high technology area, diagnostic technology should be mentioned for its widespread applicability, its impact on traditional industries such as pharmaceuticals, and its relation to health and the conquering of disease.

Vaccines and antibiotics have virtually conquered the infectious diseases that were leading causes of death during the first part of this century. But our healthcare system, which by tradition is geared to treating disease after symptoms appear, is now grappling with a new dilemma: today's major killers--heart disease, cancer, certain defects of the newborn--generally strike with little or no early warning. By the time the disease is diagnosed, effective treatment may be impossible.

But new technology is increasingly able to spot these disorders in their early, presymptomatic stages. Economics have generally held up the widespread application of some of these methods; some have been used on an individualized basis, or only for research. But more efficient techniques, including automated test procedures, promise dramatic economic improvements in the near future. Furthermore, diagnostic costs are being trimmed by the growing use of lifestyle assessment programs that identify a person's propensity towards a particular disorder, narrowing the range of pertinent tests.

A sampling of significant recent developments:

- Dozens of highly accurate lab tests, based on the body's natural immunological system, zero in on specific disease markers that were undetectable a few years ago. We may soon be able to spot quickly any disease by examining a "fingerprint" of the human body's thousands of proteins.

- Simple, inexpensive devices for diagnosing and monitoring disease at home are already commonplace, and many more are in development.

- Complex clinical diagnostic tests are increasingly automated. Multisample, multi-reagent instruments offer fast, low-cost body fluid analyses, often in a matter of minutes.

Early diagnosis is seen as smart business in the U.S.. Investors are backing many new ventures, and companies like Du Point, Corning, and Allied are making substantial acquisitions in the field. Even companies in other, unrelated fields such as Faberge, Revlon, and Timex are entering the market.

Technologies alone, of course, will not necessarily make revolutions. In the case of diagnostic technology, there are several major roadblocks to the general adoption. Many doctors (and patients as well) sometimes resist new technology, and few insurance policies now cover presymptomatic tests. The public often regards preventive medicine as inconvenient, unglamorous, and ineffective.

GENETIC ENGINEERING

The combined use of biochemistry, microbiology and genetic engineering is opening the way to industrial microorganism production, and transforming entire economic sectors. The later include not only the chemistry and pharmaceutical sectors, but food and energy as well.

The food sector will derive great benefits from biological discoveries in the medium term. Their application will increase yields considerably, and will save on fertilizers, which are costly to produce in terms of energy. Thanks to these technologies, a new agrofood industry is in the making, which can revolutionize all facets of agricultural production New microbiological techniques will allow for protein savings in agriculture. This development, which will allow proteins to be used primarily for human consumption, furnishes hope for assured food supply.

Plant cell and tissue culture technologies currently available are enabling plant scientists to make major contributions to crop improvement, and an expanded role for these technologies is envisioned for the future. Areas that could make the most significant contributions, especially in industrializing countries, include clonal propagation, disease elimination, haploid production, germ plasm exchange, wide hybridization, and mutant selection.

One need is to develop a strategy for a total improvement program for a specific crop species. It will then be possible to establish plant cell and tissue culture as an adjunct tool for breeding and other production/management research programs for the crop. Such a program might initially follow these steps:

- Identify the crop to be improved.
- Identify and characterize the breeding and improvement objectives for the crop.
- Establish the specific problems encountered for which alternate methods such as one or more plant cell and tissue culture techniques can be applied.
- If an in vitro approach is feasible, determine the status of the specific tissue culture method.
- Develop the appropriate tissue culture methods if unavilable to include plant regeneration.

Research involving tissue culture must be pursued collaboratively with the plant breeder or other plant scientist who is seeking to establish the improved crop species in a production system. Other scientists may be brought into industrial collaboration such as physiologists, microbiologists, biochemists, and molecular biologists as specific expertise is required. Additional personnel, such as production agronomists and extension workers, may be required to help evaluate and test the crop plant materials.

Improved crop varieties and production systems are key to improved agricultural productivity in practically every agricultural system. In

industrializing countries, where equipment, fertilizer, technology, and research-extension capabil ties may be limiting, improved varieties and production practices proba ly represent the least expensive improvement within the shortest time in crop agriculture.

MANUFACTURING AND MATERIALS

A revolution in manufacturing seems to be completely transforming the economics of production. It is doing so by reducing the cost penalty of product diversity. Within companies, the traditional conflict between marketing, which wants to offer customers more models, and the factory, which has wanted to limit product line variety for the sake of production efficiency, is becoming a thing of the past.

Setups that used to take hours can now take minutes as a result of new, sophisticated machine tools and microprocessor control and sensory technologies. The faster setups are the key to collapsing the structure of downtime, inventory and overhead cost that plagues the conventional factory.

The marketing and competitive implications of these new plant economics are powerful. Because product variety costs less now, there will be more of it. Shorter setups increase effective plant capacity and reduce the cycle time it takes for the complete model mix to move through the factoy. This allows the manufacturers to increase their model range in finished goods stock and keep their delivery lead time constant without raising their inventory costs.

Full-line producers with smaller market shares may suffer less manufacturing disadvantage than before. The strategic payoff from the investment lies in marketing and in better control of competitors. Shorter setup times enable a company to serve distribution channels better and to capture, at acceptable cost, higher-price, low-volume products. Broad-line producers everywhere will have to deal with these new economics of diversity.

Although development trends in this area are not uniform, certain tendencies appear to be universal.

- The proliferation of computer-aided manufacturing methods of all levels has entered a new period of increase acceleration. Although, in Japan, this is manifested primarily in the adaption of very bold and far-reaching projects, in the U.S. and Europe, it is of a more evolutionary character with emphasis on the development of autonomous machining cells that can be integrated into larger systems.

- Electronic control hardware is no longer as central to CAM development projects as it was earlier. Mini- and micro-computers are readily available and adequately reliable. The emphasis has, therefore, shifted toward development of appropriate control software (distributed systems, improved worker-machine communications, etc.) and design and development of appropriate mechanical hardware. Machines of a robustness, versatility, and reliability hitherto unknown are having to be developed.

- The flexibility of manufacturing systems is being vastly increased by the appearance of freely routable transport carts and mobile robots for workpiece transfer and the emergency of multirole (ultimately metamorphic) machine tools. These developments permit virtually any workpeice to be machined anywhere at any time.

- Technological process planning--a field in which Europe and the U.S. have been traditionally strong--is assuming a vastly enhanced role, partly as providing automatic links between CAD and CAM, partly as a growing software component of machine-tool-control units. The intelligent controls now emerging need to be told only what to manufacture and from what blank. How they will machine it, they will determine for themselves. Generative and artificial-intelligence-based methods are playing an increasingly important role.

- Assembly automation using sophisticated robots with sensory inputs (for example, vision) is being actively pursued in each of the regions.

- Integration of hitherto separate CAD/CAM and quality-control modules into overall systems is today more easily feasible. Efficient computer-aided techniques are being evolved for orderly, well-designed, and efficient ways of achieving this goal.

- Operation monitoring, early-warning failed detection, localization techniques, and improved maintenance and servicing (diagnostic and repair) technology are all essential for untended nightshift or totally tended operation. They are being rapidly evolved in each of the regions.

Apart from these universally valid points, there are, of course, dissimilarities also. Japanese developments are generally considerably more advanced; the U.S. and Western Europe are paying painstaking attention to the expected financial repercussions of every single step. Nevertheless, the outlines of an industrial system incorporating untended factories with metamorphic machine tools is, for one reason or another, accepted by all. All countries are devoting considerable public resources to fund progress along this path.

When a country moves aggressively toward an export promotion mode, it competes in the international marketplace, and needs change. Costs need to decrease. Quality needs to improve. Product differentiation is needed. New materials need to be employed. In short, there would seem to be a strong demand and interest in Brazil for new manufacturing technologies. A wide cross-section of Brazilian industry, such as aircraft, automotive, petrochemicals, and livestock feeding, has reached a stage of development that requires computerized manufacturing techniques--such as numerically-controlled machinery in an automotive parts plant or an automated processing plant--if international competitiveness is to be attained.

OTHER TECHNOLOGY AREAS

Energy technologies such as bioenergy, geothermal and solar energy, will contribute substantially to resources already in use. Concerns with energy savings and conservation remain.

The present oil supply and demand situation has inspired two opposing views of the energy future: the belief that the energy savings and conservation, induced by rocketing prices, will endure, and the view that today's lower oil prices are a threat to tomorrow's energy users. Some are not optimistic about the future. Total primary energy consumption,

particularly oil and gas, is slated to remain at low levels only as long as industrial output is depressed and unemployment remains high. What is of concern is that lowered energy consumption and slightly dwindling oil prices are being taken as a signal that the energy crisis is over.

Pessimism stems from the fact that "a short-term oil glut and lack of investment funds in depression-ridden economies has stopped the admittedly costly development of nonconventional energy resources, including synfuels, tar sands, shale oils, etc. Efforts to improve technological efficiency (with some exceptions) are delayed for much the same reasons, since they now look economically unattractive."

When--if--the long-hoped-for recovery comes about, regardless of a new onslaught of current and inflation-adjusted energy prices, consumption is due to rise again. This new demand for energy, coupled with our neglected development of alternative energy sources and supplies and the neglected development of true energy conservation, may lead to a renewed, and possibly more acute, energy crisis, with obvious negative implications for the world's economies.

In other areas such as chemicals, technological progress will alter techniques of exploration, extraction, transport, storage and use of hydrocarbons. The pharmaceutical sector as well as the chemistry sector will continue to be affected by advances in biochemistry, microbiology and genetic engineering.

The design, optimization, and operation of a wide range of processes in the chemical, petroleum/petrochemical, food, biochemical/pharmaceutical, mineral and allied industries are some specific areas to explore. Such research is laying the foundation for technological innovation in chemical and process industries. These efforts include design and control strategies, mathematical models, and experimental techniques that cut across a large number of industries and processes. Included are catalysis; combustion; plasma chemical technology; biochemical; electrochemical and separation processes; particulate technology; thermodynamic and transport properties; renewable and nonrenewable materials processing; and mineral processing.

## SCIENCE AND ENGINEERING RESEARCH/EDUCATION

There is increasing concern in both the United States and Brazil today about the adequacy of engineering education to meet national needs. Problems that have been cited in the U.S. include shortages of new engineers in some fields to meet projected industry demand, a decline in the number of Ph.D.s granted annually, faculty shortages to teach and train future specialists in these areas, outdated and short supply of laboratory equipment at many colleges and universities, and a concern about the quality of engineering education in general.

Data from the Division of Science Resources Studies of the National Science Foundation show that in the U.S. production of new Ph.D.s in engineering has dropped from 3,430 in 1970 to 2,530 in 1981, a 26 percent decrease. At the same time, an increasing percentage of the new Ph.D.s that are being awarded are going to foreign nationals. In 1981, foreign students accounted for 51.5 percent of Ph.D.s conferred in the engineering fields.

At the bachelor's level, there has been a 48.0 percent increase in the number of new engineering graduates since 1975, reflecting increased industry demand and high starting salaries. Even so, only about one of every three qualified applicants to engineering schools is being admitted, due to limited resources and faculty shortages. Vacant faculty positions at U.S. engineering schools are now estimated to number about 1,600. disincentives to pursuing a faculty career include low academic salaries vis-a-vis industry, outdated instruments and facilities compared with those available in industry, and a decline in available research support. In addition, faculty shortages combined with increased undergraduate enrollment have contributed to overcrowded classes and heavy teaching loads.

Quantitative factors such as those noted above have given rise to concern about the effects they may have on the quality of U.S. engineering education. While market forces may in time correct problems due to

imbalance in supply and demand, qualitative effects on the level of engineering education may take considerably longer to resolve.

The status of foreign students in U.S. colleges and universities also can be said to be in somewhat a state of chaos. Concern over national security and foreign competition threaten to reduce U.S. willingness to admit foreign students, and conditions are made worse by conflicting Federal policies and parochialism in state legislatures. At the universities themselves, many administrators are concerned to acknowledge the presence of large numbers of foreign students, even though their graduate departments often depend heavily on those students. On the other side, there is recognition that today's students from abroad are tomorrow's policy makers and that international educational exchanges can offer enormous benefits to cooperating countries.

## BIBLIOGRAPHY


American Machinist. CAM: An International Comparison. American Machinist (November 1981) Special Report 740, pp. 207-226.

Board on Science and Technology for International Development (BOSTID). Priorities in Biotechnology Research for International Development. Proceedings of a Workshop, Washington, D.C. and Berkeley Springs, West Virginia, July 26-30, 1982. Washington, D.C., 1982.

Burbridge, Marc. "Roundup in Rio. Datamation Listens to Latin Leaders Discuss Their Informatics Hopes and Headaches." Datamation (March 1983) pp. 189-198.

DeYoung, Garret H. "Stalking the Silent Killers." High Technology (March 1983) pp. 31-39.

Garges, Larry and Barrowcliff, Stuart. Marketing in Brazil. Washington, D.C.: U.S. Department of Commerce, 1981.

Gellman, A. J. Profiting from Technology Transfer. Gellman Research Associates, 1981.

Mitterand, Francois. Technology Employment and Growth. Chateau de Versailles, June 5, 1982.

Panem, Sandra. The Interferon Dilemma: Secrecy vs. Open Exchange. The Brookings Review (Winter 1982) pp. 18-22.

Roper, Christopher and Silva, Jorge (eds.). Science and Technology in Latin America. London and New York: Longman, 1983.

Simon, Leonard. Literature Models of Science for Research Planning. Philadelphia: Center for Research Planning, March 1983.

"Transborder Data Flows and Brazil: The Role of Transnational Corporations, Impacts of Transborder Data Flows and Effects of National Policies." Brazilian Case Study (82-230190 1982).

Wad, Atul. The Implications of Micro-electronics for the Third World. Lund Letter on Technology and Culture (December 1982) pp. 2-6.

Yared, Roberta. Energy Savings and Conservation Options. (Autumn 1982) pp. 1-5.


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## SESSION 4: FUTURE COOPERATION: GOVERNMENT/INDUSTRY/UNIVERSITY ROLES

### INTRODUCTION

Domestically the U.S. government views its role in science and technology to be rather restricted. The Federal government sees basic research as the principal target for federal funding. This is justified on the grounds that basic research, conducted primarily at higher educational institutions, has social dividends and is a national resource from which all sectors can draw. Applied research also has some federal financial support, but is also associated with private sector funding. Development and design of market products is viewed as a function of the private sector because of its direct application to economic activities. This general statement of domestic scientific and technological government-private sector relationships provides a basis for U.S. international activities.

### FOR GOVERNMENT: WHAT'S POSSIBLE AND WHAT'S PRACTICAL

The United States government has:

- Encouraged a variety of scientific exchanges and research activities between the United States and other countries such as Brazil.
- Promoted free trade and unrestricted flow of technology between nations.

A changing environment suggests some new directions for these policies.

First, industrializing country governments have pressed for guidelines for technology exchange which would provide more favorable terms for them and better meet development objectives. The old modes of interaction between corporations of the U.S. and Brazil frequently followed the pattern of U.S. firms establishing production facilities in foreign countries, and producing for those domestic markets with majority ownership normally

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retained by the U.S. firm. U.S. manufacturers also have exported machinery and equipment, provided licenses, accepted management consultant contracts, and entered into limited joint ownership relationships. These forms of industrial interaction between U.S. firms and foreign countries were predicated upon open trade, free flow of capital, and established private property rights. The growth of industrializing country restrictions, regulations, and limitations on foreign investment has tended to question the traditional mode of U.S. government non-involvement in international technology transfer policies.

Some industries are pressing U.S. government agencies to discuss with industrializing countries such as Brazil, policies which tend to keep U.S. firms out of segments of foreign markets. At times, U.S. firms are refraining from technology transfers abroad to avoid future entry of industrializing country firms into U.S. and other markets with these transferred technologies. This contrasts with more traditional policies of U.S. firms which were likely to license their know—how to foreign firms which agreed to stay out of the licensor's primary market and were not viewed as competitors.

Industrializing country national development goals have other effects. These objectives are increasing awareness in the U.S. of important relationships among technology, trade, and development. New U.S. government initiatives, such as the Trade and Development Program, are attempting to play a special role in fostering the development of countries while also promoting trade opportunities for the U.S. These innovative programs have the potential to encourage new models and prototypes for future U.S.-Brazil industrial cooperation.

Second, the appropriate role of government in science and technology is currently being discussed in the United States. High technology companies in the United States, faced with steadily increasing foreign competition, are seeking an expanded role for the U.S. government. What high technology companies want of government might be summarized as follows:

- Greater emphasis on science and mathematics, in general, and improved university engineering programs in particular;
- Increased federal funding for university research;
- Increased tax incentives for R&D spending and new capital formation;
- Renewed efforts to keep foreign markets open and to halt protectionism;
- More relaxed and consistent regulations on high technology exports; and
- Relaxation of antitrust policies to allow companies to conduct R&D jointly.

These proposals of high technology industries tend to run counter to current lobbying by more traditional industries in the U.S. for protection from imports of foreign goods which are reducing their market shares and causing unemployment of people and capital. The high technology industries believe their future lies with trade barrier reductions, both in the U.S. and foreign nations, since these firms tend to be technology leaders.

These firms are also requesting that more attention be paid to science and engineering in the U.S. Greater resources for science and engineering in the U.S. are likely to have mixed effects on international cooperation in science and technology. While the pool of resources devoted to reseach and engineering may grow, these are more likely to be devoted to U.S. domestic rather than international priorities. Identifying areas with mutual benefits to the research communities of both countries will attract increased attention. Chemical and process engineering; microprocessor applications to health, transportation and environmental problems, and agrogenetics offer possibilities to explore.

A more flexible line between private and public sector responsibilities in research may be necessary in the U.S., especially for "sunrise" industries. Some argue strongly that currently the crucial importance of U.S. domestic science and technology policies to foreign affairs is not adequately appreciated. Commitments to liberal trade must be coupled with a strategy of reindustrialization in the U.S. if trade barriers are to be averted.

## ROLE OF SMALL BUSINESS

Some claim that only in organizations of large scale is it possible to couple technical advance and market demand. Important new technologies such as synthetic rubber or polluton control devices were called forth by economic or social needs. It is market demand which resulted in these new technologies.

But this picture of the large R&D organization driven by consumer demands is questionable, especially in today's "sunrise" industries. Megatrends, the recent best-seller on America's future, comments: "Instead of constantly bemoaning the loss of old industries, we must explore the adventurous new technologies; electronics, biotechnology, alternative energy sources, mining of seabeds, robotics, and more. Ten years from now, the electronics industry will be bigger than auto and steel are today. And in these areas, small firms such as those identified with the Route 128 and Santa Clara county phenomena tend to predominate as innovators."

Traditionally, the small firm made the important innovation which was then priced up and marketed by large firms. Today, it is these small firms which are picking up and applying the technologies developed in the university. For example, Stanford University recently offered to let any company use its fundamental genetic engineering patent to make new forms of life and new biological products for only $10,000 a year plus future royalties. The licensing and royalty terms are being kept reasonable to make sure "lots of players get into the game promptly" and to "increase the probablity of valuable new applications for human service."

One could characterize IBM as a situation in which underlying technologies were changing rapidly. IBM was making some contribution to those technologies but certainly had not in any sense pre-empted them. They were widely known; anybody could take a stab at using them. Some conclude, on this basis, the anti-trust case against IBM was highly unfair.

Some of this we knew already. A major factor stimulating innovation in an industrial sector is the entry of new, often small firms with radical innovations. Examples of entrants introducing innovations that established firms failed to develop are legend: the incandescent lamp (Edison), the electric typewriter (IBM), the transitor radio (Sony). Many new technologies created, rather than followed, the market. Radical innovations such as the computer, the laser, and nuclear power are examples.

The future of Brazilian-U.S. S&T private sector cooperation may find an increased participation by new and smaller high technology firms. Small firms are frequently the pioneers of new technology but sometimes do not have the production capabilities of either exporting to large foreign markets or establishing production facilities abroad to service those markets. Thus, an agreement with foreign private or state capital may provide these firms with the appropriate capital to realize returns on their technology—a technology which may become obsolete in a relatively short period of time. The development of joint relationships with foreign firms is also a potentially advantageous way to finance future research and development in advanced technologies.

ROLE OF VENTURE CAPITAL/ACQUISITIONS/TECHNOLOGY TRANSFER AGENTS

In addition, a growing number of "technology middlemen" in the United States are establishing businesses which bring together potential buyers and sellers of technology, particularly small and medium-sized firms. Along these lines, an interesting new marketing channel has been organized in Great Britain, with the establishment by 10 British companies of the non-profit British Technology Transfer Group which was successful in establishing useful contacts in developing countries when the individual companies were unable to do so.

However, perhaps the major factor inhibiting participation in international technology transfer by small-to-medium-sized firms in the U.S. is the lack of "insurance" to undertake the risks, uncertainties and time delays associated with international interactions. Several years time

may be required before a business venture abroad begins to break even or yield a return. Additional costs are frequently also required for technical support services, or modifications in product or process designs to make the technology operational in the particular market conditions. New financial mechanisms are going to be needed to encourage the transfer of technology to developing countries by small and medium sized firms. Venture capital may play a role.

UNIVERSITY SCIENCE AND ENGINEERING RESEARCH/EDUCATION

In recent years, in the U.S., a number of new relationships and agreements for industrial sponsorship of university research have been initiated. These relationships, which are aimed at stimulating U.S. innovation and productivity, are motivated by needs on the part of both the universities and industry. With past declines in Federal support to universities, these institutions have turned increasingly to other sources. Industry, on the other hand, seeing an erosion of its technological advantage in the face of intensifying foreign competition, has begun to look toward university research and engineering both as a source of current research and future talent.

An additional factor tending to promote university-industry research relationships is the mounting perception that the development of new and improved industrial products and processes is increasingly dependent on basic scientific knowledge. DNA technology, for example, an outgrowth of university-based research efforts, is now on the verge of wide commercial exploitation. Electronics, chemistry and computer machinery research represent other areas in which significant industry-university cooperative arrangements have been established. Government agencies, such as the National Science Foundation, have facilitated these relationships through matching interests of universities and companies, and providing seed funds.

With the expansion in U.S. industry-university cooperative research ventures, a number of issues emerge. These include the issue of whether the commercial relationship will require university faculty to sacrifice free inquiry and open transfer of knowledge; the problem of patent

application or review procedures to prevent the release of proprietary data delaying publication or other public disclosure of research findings; and conflicts over whether patents and license rights should be held by the university, individual researchers, or the corporation that sponsors the research.

Offices are being established, in addition to existing ones such as the Wisconsin Alumni Research Foundation, to deal with these issues and move univesity on-the-shelf technologies to the market in cooperation with an industrial firm. Recent changes in U.S. patent laws with respect to universities are accelerating this trend.

These university-industry programs provide one answer to how government-to-government programs which provide development of indigenous science and technology in universities and research laboratories can in turn be channeled into the productive sector. One view is that rarely have programs addressed themselves to designing and engineering of "operational technologies." Most of the efforts have gone toward a long-term buildup of basic research ability, most of which is not related to the applied and development research that feeds into operational technologies.

But the Stanford University basic patent for genetic engineering is rather unique, in that it has the potential of underlying a whole industry, and the determination of a royalty base for it, had no precedent. Licensing and royalty revenues could grow to $1 million a year within four to five years.

Foreign firms have also participated with U.S. universities. In May of 1981, West Germany's Hoechst made a $50 million grant to support basic genetic research at Massachusetts General Hospital in Boston. As a result, Hoechst will have the right to license exclusively any patents received by the hospital as a result of work Hoechst supports.

Many questions concerning the nature of industrial technology and how it is derived must be answered to deal realistically with current technological advance and development in both Brazil and the U.S., and the

related set of U.S.-Brazil technology transfer issues. Much has been learned from the experiences and relationships developed in scientific cooperation. Here, cooperation initiated by individual scientists and their universities has played a dominant role. Future activities will begin to better reflect the complex relationships between science and technology and the important role of these activities in trade and development.

## BIBLIOGRAPHY


Ailes, Catherine P., and Rushing, Francis W. The Science Race: Training and Utilization of Scientists and Engineers, U.S. and U.S.S.R., New York: Crane Russak, 1982.

Black, Ronald P., Todd, W. Murray, and Cain, Malinda. The International Transfer and Acquisition of Technology, draft report to U.S.-AID, Denver Research Institute, Denver, February 1983.

Fishlow, Albert. "The United States and Brazil: The Case of the Missing Relationship," in From Gunboats to Diplomacy: New Policies for Latin America, prepared for the U.S. Senate Democratic Policy Committee, June 1982.

Ganz, Carole. "An International Comparison of Government Information Policies for Industrial Innovation," paper presented at American Association for the Advancement of Science (AAAS) Annual Meeting, San Francisco, January, 1980.

Ganz, Carole. "United States Patent Policies for Government - Supported Research." in Science Policy Perspectives: USA-Japan, Arthur Gerslenfeld, editor, New York, Academic Press, 1982.

Gilpin, Robert. Technology, Economic Growth, and International Competitiveness, a report for the Joint Economic Committee, Congress of the United States, July 9, 1975.

Keyworth, George A. "A New Federal Policy for Aeronautics Research and Technology," proposed remarks of George A. Keyworth, Science Advisor to the President, Aero Club of Washington, November 9, 1982.

Landis, Fred, editor. Proceedings of a Conference on Engineering and Science Research for Industrial Development, Easton, Maryland, October 3-7, 1977, available from Division of Policy Research and Analysis, National Science Foundation, Washington, D.C.

Naisbitt, John. Megatrends, New York, N.Y.: Warner Books, 1982.

Pollack, Andrew. "The Birth of Silicon Statesmanship," The New York Times, Sunday, February 27, 1983.

Sagasti, Francisco. Science and Technology for Development, Ottawa, Canada: International Development Research Centre, 1978.

Senich, Donald and Kaatz, John R. "The Role of American College and University Faculty in the Industrial Innovation Process," in Science Policy Perspectives: USA-Japan, Arthur Gerslenfeld, editor, New York, Academic Press, 1982.

U.S. Department of State, "Role of the Private Sector in Developing Countries," U.S. Department of State, Bureau of Public Affairs, Washington, D.C., October 19, 1981.

## SESSION 5: SUMMARY OF PRECEDING SESSIONS

We want to take a few minutes at the start of this concluding session to briefly summarize some of what was accomplished in the last two days. This, with the objective of contributing to the scope and direction of future meetings with similar objectives, and to the considered extension of the scope of the U.S.-Brazil agreement to encourage industrial and technological, as well as scientific cooperation.

We focus on each of the four sessions:

First, let us consider Session 1: Case Studies in Cooperation: Lessons to be Learned for the Future. Our objective here was to consider both new and more traditional models for industrial research cooperation between U.S. and Brazilian firms,and the kinds of scientific cooperation that have taken place. These examples were to serve one objective of this conference: to become clearer about exactly what is and can be meant by cooperation between U.S. and Brazilian firms.

The possibilities for expansion of the case studies, we considered, as input into future cooperation, are of course extensive. The Brazilian-American Chamber of Commerce lists about two thousand U.S. and Brazilian firms doing business or having interest in doing business between the U.S. and Brazil. We only present one example of scientific cooperation, while over 100 projects have been funded by NSF and CNPq over the last ten years, of which some have important industrial application. Some of these have been identified at this conference. Other participants have spoken about a rich stock of case studies resulting from research on industrial cooperation between the two countries.

These case studies also serve another purpose. Some business leaders in the U.S. who are seeing structural changes in their industry are saying, "If you can't beat them, join them." The "join" strategy involves diversifying production to industrializing countries, and joint ventures



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with private and government-controlled foreign enterprises. Several of the case studies considered reflected this "join" strategy.

Third, these case studies show the various and very different roles government may play in industrial cooperation. Government regulations and incentives influence in some way all private sector cooperation. But identifying the specific impact of the government on the industry or on the firm is often not simple. Further, policy makers within governments sometimes view industrial sectors as organized stuctures that act and react as single entities; this is not substantiated by this conference. On the contrary, the industries and firms represented show a significant diversity of views regarding the role of governments--and this does not split U.S. and Brazil.

A major gap in both the science and industrial areas, are the perspectives of Brazilian participants in these endeavors, and their views as to the impacts. What has worked from the Brazilian perspective, at the firm and at the national level? In science, for example, we have available an assessment of U.S. participants' views of the benefits derived, from cooperative research but without the companion piece. We have added to a joint perspective in these sessions, but much more could be done to accomplish joint versions of the past as examples of opportunities which can work in the future.

This brings up a related point. What is the audience for what has been done and what could be done? Certainly better and wider dissemination of accomplishments of the joint program and models for joint efforts is possible. There is at the least an education function that a government-to-government agreement can serve--to industry, to government, to universities.

The U.S. Department of State and Brazilian Foreign Ministry will be the executive agencies under the renewed agreement. How to improve awareness of this Agreement, the cooperation it encourages, and its accomplishments, could be one focus of the renewed agreement. Cooperative agreements between the U.S. and other countries have included dissemination

and program development activities. Encouraging attendance by both the U.S. and Brazilian private sector in such seminars as the one offered this week in Strategic Technology Management for International Competitiveness at Northwestern Univesity also offers possibilities.

Let us say a few words on Session 2: Private Sector Views on Issues Affecting Future Cooperation. This session focused on policies, primarily trade and development in both countries which are affecting and can affect future cooperation. An improved Brazilian balance of payments is important to the future of this country. Improved U.S. economic competitiveness through export of technology and technology-intensive products is important to the U.S.

We know, and knew before this conference that these policies sometimes conflict. Some industry leaders in the U.S. are opting for "fight" strategies such as increased diplomatic pressure to reduce what are viewed as unfair trade practices and subsidies by foreign governments. We know that these evolving issues are not going to be solved in two days. For one, these issues affect more countries than our two. The international competitiveness of the U.S. is affected by trade with countries other than Brazil, there are external markets for Brazilian products other than those in which the U.S. competes significantly, and sources of technology and capital for Brazil other than the U.S.

There is little doubt though that, considering the human and natural resources of both countries, bilateral technology-related trade relations between the U.S. and Brazil can contribute to advancing and developing both countries, and that this trade has been declining in recent years.

Several participants have mentioned the need for increased appreciation in the U.S. that industrializing countries are not solely natural resource sources. Brazil consitutes a significant market for U.S. technology, and increased awareness of this potential within a broader U.S. business community should be encouraged, for example, by U.S. Commercial Attaches. Cases in which wholly or partially owned Brazilian firms constitute profitable markets for U.S. technology should be explored. New

kinds of licensing arrangements between U.S. and Brazilian firms which offer one alternative to protectionism should be considered.

Second, the domestic policies of both countries often dance to different drummers than international relations. International efforts to exchange science and technology can be effective only when some basic domestic policies in both the U.S. and Brazil are in place. We have examples of countries which have developed indigenous scientific and technological capabilities while importing technology. We have examples of U.S. state-of-the-art technology which firms have traded without undue concerns for competitive re-entry into U.S. domestic and other markets.

Industrialization and re-industrialization policies in both countries can perhaps better complement international relationships more adequately in the future than in the past. The explicit science and technology policy measures in both countries conducive to international cooperation are one subject for future discussion.

Third, the relations between trade and development are complex; innovative government policy alternatives to import and export restrictions as a means to increase exports and decrease imports need to be developed. Capital markets and interest rates in both countries play a role.

Future meetings and a renewed agreement can continue the private sector dialogue which has been begun in the past few days. There is another point. While the U.S. Department of State and the Brazilian Foreign Ministry will be executive agencies under the new agreement, its implementation and outcomes depend significantly on the participation and roles of other agencies of both governments.

Some agencies like NSF, and other technical agencies, participate primarily as funding agencies. But these agencies participate only indirectly in the setting of trade and development policies. The participation of the Department of Commerce and other "policy" agencies in a future agreement is a question to consider. Private sector views on the role and participation of these agencies in an renewed agreement should be sought.

In Session 3, we looked at new directions for future cooperation in science and technology. An important point is that "high technology" however it is defined, in today's changing world, has a broad scope, and has great potential for productivity increases. It also of course has its negatives in terms of even short-term job losses and other dislocations. We do know that "high technology" is likely to be more science-based than other areas, and that the rapidity of change calls for new modes of market and property protection than for example patents accomplish. The participation of small firms in these areas in the U.S. is widespread.

There is room for cooperation in many industrial sectors and science and engineering disciplines. What is important to consider is that there be a balance of benefits to the individuals and firms in both countries in these areas. There must be future and more in-depth consideration of the kinds of benefits to individual firms and industries, as distinct from the important ways in which governments and society benefits.

The view was expressed several times that private sector cooperation is the "engine" for the future of U.S. Brazil relations. Government policies on both sides should be responsive to that engine and the productivity increases which result.

Session 4 considered the roles of government/industry/and universities in future cooperation. First, cooperation between large U.S. and Brazilian firms is taking some new directions, about which there can be more awareness in both industrial communities. There are new modes in which U.S. firms are participating in Brazil's economy. Large firms, it was generally concluded in both countries have the resources and information to buy and sell technologies, and make good business decisions.

The increased participation of small and medium sized business in both the U.S. and Brazil in technology cooperation and development offers opportunities. There was some consensus that new institutions were probably not necessary. Rather a new focus for existing organizations such as the Federation of Industries of the State of Sao Paulo to match the

interests of U.S. and Brazilian firms, and for other private sector enterprises, may be considered. Private sector technology transfer agents also can be encourage to engage in this work, and the role of venture capital may play a role. The Trade and Development Program could in the future explore some of these new directions. There was some agreement that although government funds can play a role; programs driven by private sector initiatives were likely to be more successful.

The further issue remains of government policies on both sides which affect this cooperation. How and whether the new agreement deals with such trade and development issues remains a question. A continued private sector perspective, as was encouraged in this meeting, is one approach. The renewed agreement, perhaps though private sector representation on the Joint Commission, can take this into account. There are arrangements between the U.S. and other countries in which this is the mode. Joint Commissions of other agreements frequently often sponsor seminars on science and technology policy issues of interest (and of controversy) to both countries. This is the case in the long-standing US Japan Agreement.

There are also, of course, other ways in which governments play a role in private sector cooperation. We considered science and engineering areas in which there is industrial application. The history of the development of the aircraft industry in Brazil through aeronatical engineering is testimony to this.

The whole area of industry-university cooperation, NSF Innovation Centers, and other mechanisms which encourage the utilization by industry of university-based technology requires further exploration.

We want to close on the following note: Some of the U.S. participants in these discussions know Brazil very well, sao quasi-Brazileiros. Other who have attended have added their experiences and expertise in science and technology policy, technological innovation, and technology trade and transfer to the stock of knowledge available to continue and to improve U.S. Brazil cooperation. We hope they can be encouraged to continue to take a special interest in Brazil. It is the diversity of perspectives,

and the depth of knowledge of the participants in this conference that have made it so productive.

Finally, we ca· be very satisfied with our work; we believe, it has added considerable substance to symbolism in the future of U.S. Brazil science and technology relations. We have set examples in diversity and in substance which we hope future conferences can be encouraged to continue.

# NATIONAL SCIENCE FOUNDATION
## U.S.- Brazil Private Sector Cooperation For The 1980's

**WEDNESDAY, MARCH 23, 1983**

*OPENING SESSION* 6:00-8:00

**THURSDAY, MARCH 24, 1983**

*SESSION ONE* 9:00-12:00

Case Studies in Cooperation: Lessons to be Learned for the Future

- Technology Transfer
- Consulting Engineering
- Raw Materials: Rubber/Minerals & Mining
- Transportation: Aircraft
- Science & Engineering Research/Education

**LUNCH**

*SESSION TWO* 2:00-5:00

Private Sector Views on Issues Affecting Future Cooperation

- U.S. Technology Export Controls
- U.S. Domestic Market Concerns
- Encouraging Domestic Industry in Brazil
- Import of Technology/Outflow of Returns in Brazil
- Other Issues

**DINNER**

**CATLANDS PLANTATION**
**LEESBURG, VIRGINIA**

**FRIDAY, MARCH 25, 1983**

*SESSION THREE* 9:00-12:00

New Directions for Future Cooperation in Science & Technology

- Planning Future Cooperation—New Tools
- High Technology Areas
- Genetic Engineering
- Manufacturing & Materials
- Energy Conversion & Conservation/Alternative Energy Sources
- Chemicals & Pharmaceuticals
- Science & Engineering Research/Education

**LUNCH**

*SESSION FOUR* 2:00-5:00

Future Cooperation: Government/Industry/University Roles

- For Government: What's Possible and What's Practical?
- Role of Small Business
- Role of Venture Capital/Acquisitions/Technology Transfer Agents
- University Science & Engineering Research/Education

**RECEPTION**

**SATURDAY, MARCH 26, 1983**

*CONCLUDING SESSION* 9:00-12:00

U.S.-BRAZIL PRIVATE SECTOR COOPERATION IN
SCIENCE AND TECHNOLOGY FOR THE 1980'S

March 23-26, 1983

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