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USAID/India
**Program for the Advancement of
Commercial Technology**

Project No. 386-0496

Midterm Evaluation
Second Phase Report

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EXECUTIVE SUMMARY

1. Purpose of the Program for Advancement of Commercial Technology Project

The purpose of the PACT Project is to encourage sustainable increases in market-oriented R&D in India by (i) demonstrating that investment in R&D in India can be profitable; (ii) demonstrating a model for financing commercial R&D; and (iii) building R&D capacity by supporting the equivalent of \$20 million in R&D.

The project established a \$10 million fund managed by the Industrial Credit and Investment Corporation of India (ICICI). ICICI provides conditional grants to Indo-U.S. joint venture R&D projects aimed at producing commercially viable products or processes. Grants can fund up to 50% of a project, with a size limit per grant of \$500,000. If a product or process is commercialized, then joint venture partners must repay 200% of the grant through royalty fees based on gross product sales.

USAID/India provided a total of \$11.4 million to PACT, while ICICI has contributed the equivalent of \$300,000. USAID's contribution is meant for the Technology Development Fund (\$10.0 million); promotion in India (\$400,000); PACT Council meeting expenses (\$200,000); contracts/grants to other institutions (\$730,000) and evaluations (\$70,000). The A.I.D. Private Enterprise Bureau provided \$1.0 million for the U.S. Program Advisor's contract. The PACT Project Agreement was signed in August 1985.

2. Purpose of the Evaluation and Methodology Used

USAID/India's two part midterm evaluation of PACT examines project management and implementation, PACT's relationship to other initiatives encouraging market-oriented R&D, and the progress of joint ventures funded by PACT. The first two issues were evaluated by Industrial Development Services Ltd. in February and March 1989 and are presented in a separate report.

This second evaluation report assesses the progress of funded joint ventures. The study was carried out by a team from Management Systems International in August and September 1989. The team included one representative of the U.S. Department of Commerce.

The goal of this evaluation was to assess the profitability of sub-projects. These findings will help USAID/India test the assumption that joint venture technology development projects can be profitable for both parties. This assumption is critical to PACT's ability to promote sustainable increases in market-oriented R&D. In addition, this second evaluation also sought to identify management issues facing the project and to assist the Mission in understanding the technology commercialization process in India.

The evaluation used a formal multiple case study design, including eight in-depth and ten brief studies of PACT sub-projects. These case studies are the basis of our assessment of sub-project progress and description of constraints to commercialization. The cases relied on semi-structured interviews and site visits with U.S. companies, semi-structured interviews and site visits with Indian companies, and review of ICICI project files. A standardized data collection guide was used in all cases. Site visits were made to the Indian companies involved in all eight cases, and to the American companies in three of the eight in-depth cases.

3. Findings and Conclusions

As of September 20, 1989 ICICI had approved 18 projects and two prefeasibility studies, involving financing of \$6.8 million in PACT funds. Approximately \$2.0 million of this \$6.8 million has been disbursed to 13 PACT sub-projects. Approved projects involve total funds from PACT and private sector sponsors totaling \$16.35 million.

USAID/India estimates that project disbursements will increase to \$8.0 million by December 1991, assuming completion of current sub-projects and partial disbursements for sub-projects approved between September 20, 1989 and August 31, 1991. Assuming that an additional \$1.5 million is committed to new projects during FY 1990, then by August 31, 1990 it is likely that commitments will total \$8.3 million. Most projects are running a minimum of six months behind schedule, and several larger approved proposals have had no disbursements and therefore may be further delayed. Since the start of PACT two approved projects have been cancelled.

Characteristics of the Projects Reviewed

Overall, the sub-projects were well selected, involving companies that appear productive, committed to commercial technology development, and well managed. All grantees visited were currently carrying out R&D on the problem for which they had received the PACT grant.

The eight projects reviewed in depth represented four distinct models of technical collaboration between Indian and U.S. companies. These were:

- a. Indian and U.S. companies each performing about half of the technical work on the project, with both sharing relatively equally in the expected benefits of commercialization. Examples are Ponds India/Giorgio Foods and Globe Auto/Scott Motors.
- b. U.S. companies providing assistance in research, marketing, and on specific technical issues, with the Indian company carrying on the R&D program largely on its own. Examples are Pennwalt India/Pennwalt Sharples-Stokes, Cipla/Byron Chemical.

- c. The U.S. company transferring key intellectual property to the Indian company, with the Indian company developing applications for the technology. Examples are Pest Control India/Fermone Chemicals, SPIC Science Foundation/DNA Plant Technology and ATL India/Advanced Technology Labs.
- d. The Indian company doing the majority of technical work, the American company designing a single high tech component, with the Indian company deriving most benefits from commercialization. Example: Indchem Electronics/Modular Semiconductor.

In all cases companies were committed to the idea of investing in R&D before they received the PACT grant; it is likely that even without PACT funds, most projects would have been carried out. However, company representatives said that PACT support allowed them to achieve their objectives sooner.

Most sub-projects looked sound in terms of business plans and technical progress. Business plans indicated that sponsors had projected significant net income from their products, generally in the 30% to 40% range. In several cases companies had reached the

point of test marketing products resulting from the R&D. Several companies said that they could sell their new products now if they had buyers; these included Globe Auto, Pennwalt and Cipla. Ponds India is able to sell mushrooms to Giorgio from its test facility, but its large scale facility is still 9 to 12 months from beginning commercial production.

Several projects are also facing significant difficulties in attaining commercialization. Constraints include:

- Slow progress due to communications problems and difficulties in obtaining necessary research equipment and supplies;
- Unwillingness of a partner to transfer key intellectual property;
- Sale of one partner to a new company or change of management of a partner;
- Inability to attain originally planned technical specifications;
- Inability to attain expected production costs;
- Difficulties in obtaining contracts or approval from buyers;
- Inadequate arrangements for protection and transfer of intellectual property.

At this early stage in the project no grantee has sold a good or technology developed under a PACT grant, although several can now begin to market a product. In all cases reviewed, costs of production and wholesale prices for products developed under sub-projects have not been established. Whether the products can be sold for prices that will cover costs and provide profits to sponsors remains to be seen. Therefore it is too early to determine the profitability of any of the sub-projects.

Payback to the PACT Fund

It is too early to determine what the rate of payback to the PACT fund will be, but it is the team's impression that PACT managers should expect 25% of the projects to end without successful commercialization. Repayments to PACT are not expected to be large enough to fund new sub-projects until late FY 1992. These findings, however, are indicative and need to be revised once the first set of sub-projects begins to pay royalties.

Other Effects of PACT

Several sub-projects have given private companies opportunities to build R&D management skills through collaboration with foreign partners. There is little doubt that the opportunity to conduct commercially-oriented R&D has given private companies in India valuable experience in bringing new technologies to market. There is also no doubt that PACT has increased the business activity of U.S. firms in India. Three of eight sub-projects examined in depth indicated that the U.S. company had done little or no business with India before the PACT Project. For two companies previously doing business in India (Scott Motors and Modular Semiconductors), involvement in PACT increased market-oriented joint R&D significantly. In addition, officers of all U.S. companies stated that participation in joint R&D has helped them to understand how to do business in India.

No companies reported that they will carry out additional R&D because of their experience under PACT. Most Indian company representatives interviewed stated that they would wait until they had begun commercial production of products developed under PACT before they would conclude plans for additional collaborative R&D. It is clear that the most important factor causing increases in R&D capacity in Indian firms will be demonstration of the profitability of commercially-oriented R&D.

4. Principal Recommendations

A. Improve Legal Agreements Between Partners for Profits and Intellectual Property. ICICI should encourage partners to conclude adequate legal arrangements for distribution of benefits derived from commercialization at the outset of a sub-project.

B. Improve ICICI Legal Agreements. Several terms in ICICI sub-project agreements need to be clarified. These include definition of "innovation" produced by a sub-project, specification of the revenues that will be subject to PACT royalty fees, and clarification of royalty fees that will be charged in the event of transfer of intellectual property by license agreement.

C. Improve ICICI's Sub-project Filing System in the Following Areas:

- Consistency of project data and preparation of summary account records.
- Documentation of expenditures and revenues to verify expenditures and sales.
- Monitoring the financial condition of grant recipients and sales of PACT-funded products or processes.

D. The Need for Additional PACT Funds. If additional funds are available, USAID should provide the minimum amount needed to allow new project approvals from late FY 1990 until early FY 1992. If \$1.6 million more is provided, then the PACT fund can approve of four new projects during that year, with an average grant per project of \$400,000. This would provide sufficient funds to continue sub-project reviews and approvals, while minimizing additional losses if it appears that sub-projects are not leading to commercial sales.

E. Improve Communication. Steps should be taken to improve communication between ICICI and PACT partners. ICICI should also consider assisting grantees in improving communication between the partners.

F. Clarify Battelle's role in the PACT Project. There is a need to establish the limitations of Battelle's role in technical oversight of projects, and to establish a formal protocol for technical progress reviews.

G. Policy Dialogue on Foreign Investment and Import Regulations. Because of the equity ownership limitations in current GOI foreign investment regulations, some "high tech" companies will not be willing to collaborate on R&D for products involving hazardous materials. It may be worthwhile to include this issue in policy dialogue between the GOI and private sector interest groups.

Several companies also mentioned that customs delays and import duties on research supplies and equipment have added significant costs to conducting commercial R&D in India. It may be worthwhile to encourage ICICI and local business associations to engage the GOI in dialogue concerning regulations on research related supplies and equipment.

PROGRAM FOR ADVANCEMENT OF COMMERCIAL TECHNOLOGY PROJECT
INTERIM EVALUATION PHASE II FINAL REPORT

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PROGRAM FOR THE ADVANCEMENT OF COMMERCIAL TECHNOLOGY

PART II EVALUATION REPORT

1. OBJECTIVE AND METHOD

USAID/India planned a two-part midterm evaluation of PACT to examine three issues:

1. Project management and implementation;
2. The relationship of PACT to the recent emergence of similar initiatives encouraging market-oriented R&D;
3. The progress to date of the joint ventures funded by the project.

The first two were evaluated under a separate contract carried out by Industrial Development Services Ltd. in February and March 1989, and are presented as a separate report.

Progress of the joint ventures was the focus of this second evaluation. The evaluation was conducted by a three person team from Management Systems International between August 21 and September 29, 1989. The team included one representative of the U.S. Department of Commerce.

The larger objective of the evaluation was to assess the profitability of sub-projects funded by PACT. These findings help USAID/India to test the assumption that joint venture technology development projects can be profitable for both parties. This assumption is critical to the ability of PACT to demonstrate to private companies that investment of commercially oriented R&D is a worthwhile use of scarce resources.

The evaluation also sought to identify current management issues facing the project, and to assist the Mission in understanding the technology commercialization process in India.

The evaluation used a formal multiple case study design, consisting of eight in-depth cases and ten brief studies of sub-projects funded by PACT. The case studies are based on three sources of data: semi-structured interviews and site visits with U.S. companies; semi-structured interviews and site visits with Indian companies; and review of ICICI project files.

A standardized data collection guide (Annex 1) was used in all cases to assure that similar information was collected on each case. This guide covered the following topics:

- Project Background and Progress
- Project Profitability for Both Partners
- Expected Returns to PACT
- Technical Transfer Mechanism
- Intellectual Property Protection
- Change in R&D Capability and Other Benefits to the Indian Company
- Benefits to the U.S. Company

Site visits were made to eight Indian companies and to the American companies in three in-depth cases. Site visits included interviews with the staff of the PACT-supported project and with senior corporate officers, and examination of the research facilities.

II. Background of the PACT Project

The Program for Advancement of Commercial Technology (PACT) project is an experimental project designed to accelerate the pace and quality of technological innovations in products and production processes relevant to the economic development of India. The project's purpose, to contribute to building market-oriented R&D capacity in the Indian private sector, is being pursued by demonstrating that investment in market-oriented R&D in the private/joint sector is profitable.

The focus of PACT is on the "development end" of R&D and on promoting Indo-U.S. business and research linkages. It is expected that Indo-U.S. joint ventures will not only transfer new technologies and processes from the U.S. but also provide the Indian partner an opportunity to acquire the U.S. R&D management techniques.

The project is administered by the Industrial Credit and Investment Corporation of India (ICICI). For this purpose, ICICI has established a separate PACT division. Two PACT councils - Indian and American - were created to provide advice and guidance for PACT operations and to oversee management of the program. Besides the periodic joint meetings of the PACT councils, the Indian and American Councils meet at least once every six months in their respective countries. The PACT councils have met jointly five times. For approval of sub-projects under PACT, ICICI has established a PACT Screening Committee. To assist ICICI in implementing the PACT promotional efforts and financing programs in India and the U.S., the provision was made for two PACT Program Advisers - Indian and American. While Battelle Memorial Institute (Battelle) of Columbus, Ohio was appointed as U.S. Program Advisor, the position of Indian Program Advisor was eliminated at the request of ICICI.

USAID/India has planned commitments of \$11.4 million and ICICI has made an in-kind contribution equivalent to \$300,000 to the project. The USAID contribution is meant for the Technology Development Fund (\$10.0 million); promotional efforts in India (\$400,000); council meeting expenses (\$200,000); contracts/grants to other institutions (\$730,000) and evaluations (\$70,000). The A.I.D. Private Enterprise Bureau has provided \$1.0 million for the U.S. Program Advisor's contract. The current PACD of the project is July 31, 1990.

PACT has received widespread, positive publicity within India, particularly in the financial and business communities. The project's evident value to India has encouraged the establishment of six capital funds in India that provide loans or equity investments for market-oriented R&D. In addition, to promote technology development the ICICI has established a new company, the Technology Development and Information Company of India (TDICI) in Bangalore.

III. CASES OF PACT GRANTS

Case Study A

1. Company Names

Indian: Ponds India Limited

American: Giorgio Foods, Inc.

2. Project Title: Development of a process package for high yielding prime button mushrooms.

3. Date Sanctioned: June 1987

Project Start Date: January 1988

Original Completion Date:

Estimated Completion Date:

4. Total Budget: \$718,000, increased to \$944,000

PACT Grant: \$359,000, increased to \$472,000

5. Disbursements to August 31, 1989: Rs. 6,500,000

Disbursements to date equal 91% of PACT funds.

6. Project Background

Giorgio Mushroom Company was started by Pietro Giorgi in 1929 and currently grows 5,000 tons of mushrooms per year in the U.S. Its sister company, Giorgio Foods was started by Pietro Giorgi and associates in 1960 and is now a leading mushroom processor in the U.S.

In the 1960s Giorgio Foods began to face serious competition from mushroom processors in Far East. First Taiwanese and Korean producers began selling processed mushrooms at highly competitive prices. In the mid-1970s, Giorgio Foods also faced a flood of competition from producers in the Peoples Republic of China after China was granted U.S. Most Favored Nation status. By the late 1970s Giorgio found it difficult to buy sufficient low cost supplies of mushrooms to keep up with canners in the Far East and canners in the U.S. that had production arrangements in developing countries. (For example, Jolly Green Giant has a major share of the market and produces most of its mushrooms in Indonesia.) Facing this fierce competition, Giorgio began searching for low cost mushroom supplies in the developing world.

After identifying India as a potential source of supply, Fred Giorgi approached Ponds India through Cheeseborough Ponds. At this time, in the early 1980s, India produced just over 1000 metric tons of mushrooms per year, most of this coming from the unorganized sector. Modern commercial mushroom cultivation was almost unknown. Initial investigations by Giorgi technicians indicated that conditions in certain elevated, cool weather areas of India were perfect for mushroom cultivation.

In 1986, Ponds India and Giorgi Foods agreed to undertake a project to develop a production package suitable for large-scale button mushroom production in the Nilgiri Hills just outside of Ooty in South India. They prepared a proposal for a \$359,000 conditional grant in late 1986 and submitted it to PACT. The total proposed project budget was \$718,000. This proposal was approved by PACT in June 1987, and the project was started in January 1988.

The project's objectives included setting up an experimental farm at Ooty for growing an important edible species of mushroom, *Agaricus Bisporus*, using local raw materials under local conditions, aiming at bioefficiency of not less than 60% and developing processing techniques that reduce shrinkage loss during blanching and canning.

Mushroom growing science and technology is well established world wide. The challenge facing this PACT project was to develop a package of materials and processes that adapt existing mushroom growing techniques to materials and conditions available in India. In practice this required several tasks:

- (A) Development of a growth medium from locally available materials;
- (B) Selection of optimal strains of button mushrooms;
- (C) Development of production processes that use relatively little capital, fuel and electricity while being productive and efficient enough to make the project profitable.

For the project to be a success, the operation needed to match or exceed the quality of mushrooms available from the Far East, and have production costs that are low enough to make the wholesale price as cheap as or cheaper than other developing country suppliers and to make an acceptable return available to Ponds' investment.

It was not possible to transfer existing Western methods to India because of several factors, including: the characteristics of Indian soil and climate; the fixed capital expenditure required for air conditioning and concrete growing rooms used in the U.S. and Europe were so high that a project employing these would not be viable in India; and the mechanization of mushroom growing used in the West is not necessary in India because of cheaper labor costs.

The R&D was expected to cover a two year period at a total cost of \$1 million. The phases of work originally planned were development of biowaste

materials, growth processes, and pasteurization; and optimizing soil and growing conditions. A pilot plant was to be set up which, if successful, would be scaled up during the subsequent commercialization phase.

According to the division of labor originally proposed, PIL would set up the pilot plant, provide the personnel, formulate the experiments together with GF, obtain the source materials, and carry out processing. GF would provide technical assistance to PIL in evaluating soil, raw materials and production processes, in developing the mushroom strains, and evaluating the quality of mushrooms grown at the pilot stage, and carry out market tests in the U.S. According to Ponds, PACI's role was critical to the companies' undertaking the project.

Results as of September 18, 1989

As of September 1989, Ponds India has invested over \$1 million in the project, 7,000 person days of technical labor, and 70,000 person days of unskilled and semiskilled labor. Ponds India staff have been trained in short courses at the Horst Institute in Holland, an institute that specializes in mushroom related sciences and technologies. Several Ponds staff have also completed practical training at Giorgio Foods in Pennsylvania. Technical staff from Giorgio have spent a total of 11 person months working in India with Ponds.

A local casing material using, among other components, rice straw and chicken manure has been developed. The material is mixed and prepared on the factory site, fermented, and pasteurized using heat generated by the fermentation. The project staff has identified a good quality spawn and has reproduced it with less than 1% contamination.

The pilot plant, consisting of seven mushroom growing rooms, a small analytics lab and facilities for producing casing materials, have been built and equipped. The plant produces 120 tons of mushrooms per year. Most technical targets concerning productivity of the operation and quality of mushrooms have been met or exceeded in the pilot process.

According to project participants, a high level of success has been achieved. Two test consignments have been shipped to the U.S. and have passed Giorgio's quality testing and gained FDA approval.

According to the manager of PIL's mushroom project, they are confident that this will be a profitable project and they will now carry out expansion in parallel with continuing pilot plant operations. The project has been extended for six months through the end of 1989 to train personnel for the commercialization phase and develop the canning process. However, the ICICI September 1989 report states that project completion has been delayed because desired bioefficiency levels have not yet been reached. Ponds India staff state that they are close to achieving all technical objectives including this one.

Based on the acceptable results of the pilot operation, Ponds has decided to go ahead with a three-phase expansion program. The first phase will build facilities in the same small valley as the pilot operation to produce 2000 to 2500 tons per year. Plant and engineering designs for the first phase of commercial operations have been completed. The plans have been reviewed by one of Giorgio's plant managers, who is spending three weeks helping Ponds finalize their expansion plans. A Dutch consultant on mushroom technologies employed by Giorgio also visited the facility for three days and reviewed the plant, equipment and materials designs. It was reported that the two consultants' advice resulted in significant reductions in capital requirements and improvements in processes.

Ground preparations for the 2000 ton facility have been completed, and building sites are being prepared for construction. Procurement of equipment will begin during the last quarter of 1989, and it is anticipated that the facility will begin producing on a commercial basis during the second quarter of 1990.

In 1992 Ponds intends to expand its production by another 2,000 tons at another site near Ooty. This second facility will be producing commercially by 1994. As long as this first 4,000 ton operation is successful, they intend a third capital expansion to raise total capacity to 10,000 tons per year by the year 2000.

Ponds anticipates a return on investment of between 22% and 24% if operations go as planned. Ponds has estimated that the project will save Giorgio Foods \$10 million in mushroom costs over the next ten years, and that the project will result in \$75 million in net foreign exchange earnings for India by 2000.

7. Project Profitability for Ponds/Giorgio

Both Giorgio and Ponds view this as a successful project, although it is still in its preliminary stages. For Giorgio it has been a test effort in establishing long-term supply arrangements with a firm in a country with low labor costs. Giorgio Foods would like to replicate this experience in other countries to increase their mushroom supply and to diversify sources. Ponds India views the project as an initial effort in agribusiness production, and is interested in identifying similar opportunities in India. Ponds staff also report that the PACT project again confirms their commitment to R&D in new production areas.

Successful commercialization of the program will provide GF with substantial savings in the cost of mushrooms, enabling increased sales and market share. PIL will become competitive in the export market by introducing a new appropriate technology to India. PIL also has established facilities that can be used in growing other horticultural products.

Royalties to PACT

Ponds has agreed to pay PACT a royalty fee of 2% of gross sales for the first two years, and 3% of gross after year two.

It is now expected that royalties to PACT will begin to be paid during the second half of 1990. Once the first phase facility reaches full capacity in 1991, Ponds will be able to pay approximately the following royalty:

<u>Year</u>	<u>PACT Royalty</u>	<u>Assumptions¹</u>	<u>Cumulative</u>
1989	0		
1990	\$ 21,000	(620 tons x \$1700 x 2%)	\$ 21,000
1991	\$ 41,000	(1,120 x \$1,870 x 2%)	\$ 62,000
1992	\$130,825	(2,120 x \$2,057 x 3%)	\$192,825
1993	\$211,817	(3,120 x \$2,263 x 3%)	\$404,642
1994	\$307,640	(4,120 x \$2,489 x 3%)	\$712,282
1995	\$231,718	(payments total 200%)	\$880,000

Assuming that the plans are followed, repayment of the PACT grant will be completed by mid-1995. Ponds estimates that payback will be completed at the end of 1994 based on their production projections.

8. Intellectual Property

Transfer Mechanism

To date, GF has trained four PIL employees in the U.S. for periods of three to six months, and has sent its own personnel to India for extended periods to review the project. Outside technical advice has been sought from Swiss and Dutch consultants and from Pennsylvania State University which has the largest mushroom research center in the world.

Means of Protection

The mushroom growing supplement (spawning formula) used by Giorgio is under a patent developed by Pennsylvania State University. However, there are no plans to transfer this formula to Ponds India at this time, and the patent expires in three years. Some of the machinery used is covered by European patents. Giorgio and Ponds India do not have a technical cooperation agreement covering disposition of intellectual property which may be developed under the project. Any new processes developed will be protected through trade secrets. Ponds India claims it would be difficult to reproduce the exact technology elsewhere.

¹ We assume that the wholesale price of mushrooms paid by Giorgio to Ponds increases by 10% per year.

There apparently is a memorandum of understanding between the two companies under which they agree not to share the technology with other companies. This MOU also contains a buyback provision in which Giorgio has first option to purchase Ponds India's production for twenty years. The reviewers did not see the actual MOU.

9. Problems with Government of India

Imports: Duties on capital goods and equipment used for R&D are a disincentive to R&D expenditures.

10. The Role of Battelle and ICICI

Battelle has never sent a mushroom expert to review technical progress of the project. This has not been a concern or problem for either of the partners, but it does contrast with the extensive technical involvement that Battelle has had with the Pennwalt project.

11. Planned Business Operations in India and Changes in R&D Plans

Ponds India would like to continue to invest in R&D to develop new commercial products. Giorgio Foods has no plans to expand their operations in India.

12. Summary of Constraints to Commercialization

This project has encountered few serious constraints to commercialization so far. The most important challenge facing the project now is to meet bioefficiency and cost efficiency targets in the commercial-scale mushroom growing facilities now being constructed. There are still many unknown variables that will determine the cost efficiency of the new facilities.

13. Suggestions

There is nothing further that the PACT Project can contribute to resolving the bioefficiency and production cost issues facing Ponds India. Determination of the final output capacities, bioefficiency and input costs will have to be determined by Giorgio and Ponds staff.

Management of Ponds India made the following general suggestions based on their experience with the PACT project:

- a. Pay careful attention to partner selection in R&D joint ventures. Both partners should gain substantial benefits from the arrangement. In addition, both partners should have a long term interest in the success

of the project.

- b. Invest in products that have established markets

Case Study B

1. Company Names

Indian: Pennwalt India Ltd.

American: Pennwalt, Sharples-Stokes (now called Sharples Inc.)

2. Project Title: Dewaxing Rice Bran Oil

3. Date Sanctioned: February 1987

Commitment: October 30, 1987

Project Start Date:

Estimated Completion Date: October 1989

4. Budget:

Total Project Budget: \$335,000

PACT Grant: \$146,000

5. Disbursements to August 31, 1989: Pennwalt: Rs.800,000 (\$62,000)
Sharples: 0

Disbursements to date = 42% of the total PACT grant.

6. Project Background

Pennwalt Sharples-Stokes (Sharples) is a leader in the applications of centrifuge technology for producing pure solids, while Battelle is considered a leader in certain applications of acoustic wave technologies. Battelle's data suggested that the combination of acoustic wave and centrifuge technologies would enhance the quality of solids. In the beginning of this PACT sub-project, Battelle approached Pennwalt USA to encourage it to undertake the rice bran dewaxing project.

Pennwalt USA approached Pennwalt India to determine if there were possible applications of this combination of technologies in India. Pennwalt manufactures chemicals, pharmaceutical and industrial equipment such as centrifuges for use

in separation. Pennwalt India's interest in applying this new hybrid technology to the recovery of edible rice bran oil was sufficient incentive for Pennwalt USA to get involved in this PACT sub-project. Pennwalt USA owned 100% of Pennwalt Sharples-Stokes, and also owned 40% of Pennwalt India.

Pennwalt India had been approached before the PACT Project by Castrol England to develop a process for clarifying used mineral oils. Their aim was to obtain a mechanical process to replace the chemical routes that they were using at that time. The mechanical process offered the advantage of preserving the quality of motor oils and not leaving corrosive acids in the oil.

After unsuccessful initial attempts to develop the mechanical process, Pennwalt India discovered a process to remove up to 90% of the colloidal carbon in spent oil, filed for provisional patents, and was sent a large shipment of spent motor oil to develop the process on a larger scale. This pilot effort, based on locally developed ultrasonic devices, worked and Pennwalt India is now ready to sell the first plant based on the technology.

At that point (early 1987) the application of acoustic wave and centrifuge technologies to edible oil refining seemed promising. Pennwalt India had already obtained promising results from using the hybrid process on safflower oil. If the two technologies could be successfully combined for rice bran oil, then there was a strong possibility that this new technology could be applied to other oil seed by-products. Despite its promise, however, Pennwalt USA had so much demand for its products from domestic customers that it gave relatively low priority to this PACT sub-project. In practical terms, this meant that Pennwalt USA gave approval to the project, but did not commit its own domestic R&D resources to the effort. Only after the effort by Pennwalt India showed positive results did the U.S. company plan to commit its own R&D resources.

The technological objective of the project was to develop a process design for continuous dewaxing of rice bran oil. India has a shortage of edible oils and, although it is the world's largest producer of rice, little edible oil is produced because crude rice bran oil contains a high level of fatty acids and waxes. Existing processes for dewaxing are not cost effective. Because of a general shortfall of edible oils production, the Government of India has attached a high priority to oils, and offers exemptions on excise duties for edible oils made from "minor" oils. Upon successful development of the technology, Pennwalt India plans to sell turnkey plants for rice bran oil purification.

The key elements of the innovative R&D were:

1. Addition of chemical additives (inorganic salts) to the wax crystallization process
2. Crystallization of the waxes
3. Use of ultrasound technology to form finer, more uniform crystals
4. Use of centrifuge technology to remove the wax.

Progress to Date

The Cooperation and Project Finance Agreement was signed on March 24, 1988. After the sub-project was approved, Sharples allowed the Indian company to carry on the research program largely unassisted. In the words of a Pennwalt India representative, "Sharples said they would give technical assistance to the project, but 100% of the R&D would be done by Pennwalt India."

Battelle took an active interest in the project and informed Sharples that they felt that Sharples should bring their latest centrifuge technology to India to aid the project. Sharples took the position that their "latest" technology was unnecessary to accomplish the objectives of this commercialization effort. According to a Sharples representative, Battelle began "pushing" Sharples to take a role in the project that the U.S. company never intended to take. Sharples maintained that the Indian subsidiary should carry out this commercially oriented research on their own, and if they were successful in this first effort to apply centrifuge and acoustic wave technologies to rice bran oil, then the U.S. company would get involved in later applications.

The initial agreements for sharing technologies between Sharples, Pennwalt India and Battelle were all informal. Sharples assumed that they were serving primarily as the intermediary for communication between Battelle and Pennwalt India. In the view of Sharples representatives, Battelle took an active technical partner position in the project, and the role of Sharples was to transfer the latest in centrifuge technologies to the project. Battelle representatives, however, stated that they were not told that they were supposed to provide acoustic wave technology to the project. Battelle staff assumed that Sharples would supply the centrifuge technology to the Indian company.

Beginning in November and December 1988, Sharples began to have concerns about their ability to control their centrifuge technology provided on license to Pennwalt India. No technical cooperation agreement was signed by Battelle and the two Pennwalt companies to protect Sharples' intellectual property.

Battelle was concerned that Sharples was not sufficiently involved with technical aspects of the project. At this time, representatives of Battelle began insisting that Pennwalt India "open their research records" to Battelle. Pennwalt USA became concerned about the possibility of infringements on their proprietary technologies and they were reluctant to provide information to Battelle. Sharples took the position they needed to know how any information they provided would be used before they gave research data to Battelle. Battelle responded that they wanted to publish a list of technology applications under the PACT Project.

However, it had been established at the beginning of the project that there would be no need for Sharples to provide Battelle or ICICI with technical information on Sharples' operations. In a letter dated Dec. 15, 1987, Pennwalt Sharples-Stokes stated to ICICI that because the project is being implemented in India and Pennwalt USA would be providing only technical and managerial

assistance, inspection of Pennwalt USA facilities was unnecessary. This position was accepted by ICICI.

In a cable dated into ICICI 17/11/88, Dr. Peter Taussig says that a representative of Battelle would be coming to India, that he is an expert in acoustically enhanced separations and "it appears to us that his presence in India would provide an excellent opportunity for you to take advantage of this expertise in support of your pact project, dewaxing of rice bran oil." The next paragraph said: "The cost to you would be the extra travel expenses associated with his travel from Bangalore to Bombay."

In December 1988, the Battelle technical representative met with Pennwalt India staff responsible for conducting the project. The purpose of the visit was to review progress to date and to assist the Pennwalt team in their development efforts. The Battelle officer concluded that even though 20% of the budget (US \$70,000) had been expended, very little if any progress had been made. Battelle staff concluded from the technical representative's report that the value of ultrasonics in this separation of wax from rice bran oil had not yet been demonstrated and that the project team had little experience with ultrasonic systems and their applications to separation. Battelle recommended to ICICI that there be no additional payments under the grant until the following was accomplished:

- An assessment of the state of the art and progress being made by others in improving the separation of wax from rice bran oil.
- Design, purchase and installation of ultrasonic test apparatus followed by a laboratory demonstration that ultrasonics will enhance the separation of wax from rice bran oil.
- A list and description of major milestones required to meet the program's overall development objectives.
- A statement of the role and responsibility of Sharples Stokes in assisting Pennwalt India to meet the program's objectives.

The Battelle technical representative also recommended that PACT obtain information on Pennwalt's test apparatus and how they performed lab tests.

When Battelle's technical officer visited Pennwalt India, Pennwalt's consultant on application of ultrasonics did not show up for the meeting² and many questions concerning the ultrasonic system remained unresolved. The team that did meet with the Battelle representative was not sure what power levels

² It was reported by Pennwalt India representatives that the acoustics consultant was unable to attend because he works at Pennwalt only one day per week and was unavailable to meet the Battelle representative on such short notice.

were needed to initiate nucleation of wax crystals or how they would couple the ultrasonic energy to the reaction vessel. They were not set up to give a lab demonstration of the process. They were just then constructing a lab facility and said it would be ready during mid-1989.

At about this same time, Sharples became aware that Battelle had sent a technical officer to visit the laboratories of Pennwalt India and that this Battelle officer was carrying on advanced development research for application of acoustic wave and centrifuge technologies for other Battelle clients. A research scientist at Battelle told a Sharples representative that Battelle was working on the same technologies for applications to sewage treatment.

In 1988, Pennwalt, Sharples-Stokes was sold to the Swedish company, Alfa Laval, and Alfa Laval also expressed an interest in buying Pennwalt India. This takeover of Sharples caused an almost eight month delay in the project because many of the Sharples staff originally associated with the rice bran oil project were transferred or joined other companies, and Pennwalt India became reluctant to share any of its findings with a company now owned by one of its main competitors in India.

In June 1988, Pennwalt wrote a letter to Battelle asking for information on crystallization and kinetics of crystal growth in an ultrasonic field, circuit designs of ultrasonic generators and patent information on these, and impressions and experience of Battelle on the utility of measuring zeta potentials with MATEC-ESA instrument.

As of September 15, 1989, Pennwalt has set up the lab facilities needed for the dewaxing processes, in many cases fabricating its own equipment because of the cost and delays of importing equipment. The process has not been successful in achieving improved wax crystallization expected from use of ultrasonics, and so Pennwalt has relied instead on wax removal through chemical additives, followed by crystallization and centrifuging. Ninety percent removal of waxes has been achieved, despite the delays resulting from the unsuccessful ultrasound research. Scale-up from the pilot plant production to commercialization is only 2.5 times the size of the pilot plant, and Pennwalt expects to achieve equivalent separation efficiencies at this larger scale.

Pennwalt hopes that they will be able to incorporate ultrasonics into the dewaxing process in the next several months, and they intend to continue research on this problem. In the meanwhile, Pennwalt is ready to sell dewaxing plants that use conventional mechanical methods. They intend to sell the first plant to a customer who would accept the plant as a pilot, offering 90% wax removal from conventional methods and including continuing experiments with ultrasonics. Pennwalt has already received inquiries from vegetable oil refineries interested in the process, including one serious inquiry from Colgate Palmolive.

Marketing of dewaxing plants will eventually be carried out around the world by various Pennwalt USA subsidiaries. It is not clear how this sales arrangement will be altered by Pennwalt USA's sale of Sharples Stokes. Despite

these successes, Pennwalt India has been handicapped by the restructuring of Sharples, which no longer is available to provide the technical assistance needed to complete pilot plant testing on schedule. Pennwalt India's management has expressed an interest in locating either another U.S. partner or an outside source of technical advice.

7. Profitability

It is impossible to tell now if this project will be profitable for Pennwalt India. Pennwalt India's evaluation of the rice bran oil process still indicates that this will be a profitable investment for the company. The fact that Pennwalt India has decided to continue its development program and claims that they are now ready to sell a plant indicates that the project still appears profitable to Pennwalt India. Pennwalt India is a highly profitable company, paying 35% dividends on stock over the last several years, and they seem to have no reason to believe that this project will have a lower rate of return on investment than their usual investments.

Two additional unknown factors that will affect the profitability of the project are whether the technology will receive any special support from the Government, and what price buyers will be willing to pay for the plants. These factors remain to be determined in the future.

There is some question about how PACT will recover its royalties from the project. There are two potential threats to PACT's repayment associated with this agreement. First, Pennwalt is obligated to pay a royalty fee as a proportion of gross sales of the "innovation", but the term "innovation" is never explicitly defined either in the agreement or in the Project Proposal. Pennwalt India staff stated that their understanding was that they were obligated to pay a royalty fee to PACT of 10% of gross sales of the rice bran oil dewaxing plants. It is also conceivable that Pennwalt would decide to pay royalties only on certain components that were developed by the PACT project, as Indchem has decided to do. If this were the case, the payback period would be significantly longer.

Second, it is unclear whether Pennwalt is obligated to repay the grant if it is able to develop a rice bran oil dewaxing process that does not use ultrasonically enhanced separation. If they begin to sell plants that do not use ultrasonics, then they maintain that the objectives of the PACT project were not met, and therefore they do not have to pay the royalty. This is an issue that is not addressed in the existing ICICI/Pennwalt agreement.

Third, the company is also carrying out research on several other possible applications of the oil purification technology being developed under the PACT project. According to the terms of the PACT agreement, it is not clear whether PACT would have a right to royalties on sales of technology developed by the PACT funded project but applied to oils other than rice bran oil.

8. Technical Transfer and Protection

Transfer Mechanism

Pennwalt USA's technology is provided to Pennwalt India on a license basis. There was no formal technical agreement between Battelle and either Pennwalt company.

All rights arising from the development of the dewaxing process would be solely with Pennwalt India Ltd., and Pennwalt USA has no rights or interest therein. Pennwalt India pays 10% of gross revenues as royalty to PACT.

Pennwalt India was to carry out development on its own, with Pennwalt USA providing technical assistance. Pennwalt USA has regularly provided technical support to its subsidiary, including updates on separation technology developments, evaluating its technical reports, and exchange of technical and management personnel. Pennwalt USA did not request any PACT funding, and did not plan to commercialize the innovation. Apparently, Pennwalt USA's benefits were to derive from its forty percent ownership of Pennwalt India.

Pennwalt India receives assistance in both separation processes and pilot plant studies from a University of Bombay consultant specializing in oils, fats and waxes.

Means of Protection

Pennwalt USA's technology was protected against infringement by Pennwalt India by license agreement. Pennwalt USA's and Pennwalt India's technology was protected from infringements by Battelle and ICICI by a verbal agreement with ICICI that exempts the companies from being required to provide proprietary information.

No technical cooperation agreement was signed between the two companies because there was to be no substantial contribution from Sharples other than technical assistance to the project. Under the original arrangement, Sharples was to pay a fee for use of separation processes developed by Pennwalt India. Pennwalt India has already filed for a provisional Indian patent for the rice bran oil technology process, and plans to file in other rice producing countries including the U.S. According to the Managing Director of Pennwalt India, if they receive orders to build plants before the patent is issued, they would require the purchaser to sign a trade secrecy agreement.

9. Change in R&D Capability & Other Benefits to Indian Partner

The PACT funded R&D project comes at a time when Pennwalt India is expanding its R&D facilities. PACT funds have helped Pennwalt to improve their R&D facilities, and have given the firm's R&D personnel an opportunity to conduct original development work on oil purifying technology. The project also

encouraged Pennwalt to seek technical assistance from Sharples on an ad hoc basis as specific technical questions and problems arose.

This project offered Pennwalt India a chance to develop a technology that could be sold in most countries that produce substantial amounts of rice. Pennwalt would have owned the rights to the technology, and could sell the technology world-wide.

10. Benefits to the U.S. Partner

Under the original project plan, the U.S. partner was to provide a small amount of technical assistance and advice, but most of the work was to be carried out by Pennwalt India. When the technology was demonstrated to be successful, Pennwalt Sharples-Stokes intended to develop applications for the technology to other edible oils. This would have given the U.S. company an opportunity to market the technology world-wide for oils other than rice bran.

After the sale of Sharples-Stokes to Alfa Laval, Pennwalt USA has not expressed any substantial interest in the project, and there is no immediate benefit to Pennwalt USA that will result from the project other than additional earnings from its ownership of 40% of Pennwalt India.

11. Problems with Government of India: The only problem reported is the high import tariffs that Pennwalt India must pay on imported research equipment.

12. Problems with ICICI and Battelle: Pennwalt India officers said that they feel that they should have been given a notice of the findings and outcome of the Battelle technical progress review by ICICI. Other problems with Battelle are outlined above.

13. R & D Plans: Pennwalt India plans to continue R&D for the rice bran project. The company is seeking another U.S. partner to assist on the ultrasound applications.

14. Summary of Constraints to Commercialization

- A. Perceived threats to intellectual property from Battelle technical staff.
- B. Identification of a suitable U.S. technical partner in the area of ultrasonics to replace Sharples-Stokes.
- C. Continuing uncertainty about the technical feasibility of acoustic wave technologies in edible oil separation processes.

- D. A minor constraint to commercialization has been the high import tariffs that Pennwalt India must pay on imported research equipment.

15. Suggestions

- A. Clarify the role of Battelle in the PACT Project. There is a need to establish the limitations of Battelle in technical oversight of projects, and to establish a formal protocol for technical progress reviews that includes an opportunity for the participant companies to respond to review findings.
- B. Clarify PACT's royalty rights from sales of plants that do not incorporate ultrasonic techniques.
- C. Assist Pennwalt India in identifying a new American partner to work on the ultrasonics problem.

be approved. The proposal was in the names of Globe and Scott respectively, and not their joint venture, Globe Scott Motors. The total project budget was \$800,000, and the PACT grant portion was \$400,000. Estimated completion date for the project was April 1989.

The project is governed by a formal joint development agreement between the two companies. The two partners decided not to undertake the project through Globe Scott Motors because they expected that the investment required to commercialize the permanent magnet alternators developed by the PACT program would be too large to be carried out by Globe Scott, and because Globe Scott was not financially sound enough to receive a PACT grant.

The Globe Auto Scott Motors project is an excellent example of the PACT program's objective of combining the strengths of two small, innovative companies. Globe and Scott now are carrying out joint R&D to create a permanent magnet alternator (PMA) that will produce two to three times the output of conventional alternators. Scott's main contributions to the PACT R&D are knowhow in permanent magnet technology and development of electronic controls for the alternator using computer modelling. (The drop in prices of electronic components is a key element which makes the new PMA design competitive.) Globe has R&D capabilities in design, drafting and testing and has a tooling facility. Globe supplied mechanical designs and tooling for the project as well as qualified engineering personnel, at costs considerably lower than would be possible in the U.S.

According to Globe management, besides increased efficiency, a PMA also has lower costs, higher reliability and lower maintenance than a conventional alternator. The alternators will have automotive, railway and refrigeration applications. The project aims at filling the technology gap between PMAs currently used in motorcycles, which have too low output and lack the controls needed for larger vehicles, and those used in aircraft, which have higher output than needed and cost more than conventional alternators.

The three R&D objectives were:

1. Develop advanced PMA with increased output and the associated controls
2. Create software to model the alternator for the various applications
3. Develop production techniques to minimize tooling costs

Commercialization is planned using "flexible manufacturing"; the same components will be used in different sized alternators. Globe Auto initially planned to increase its share of the automotive market and to gain access to the railway market. More than fifty percent of the product would be used by Scott in its own air conditioning systems.

Progress of the Project

Scott Air, a sister company of Scott Motors which makes compressors for the air conditioning of buses, was sold to Jordan Enterprises, a holding company

of Imperial Electric. According to Albert Burck of Scott Motors, Scott Motors was not adequately financed and therefore the PACT grant was welcomed as a source of needed working capital.

After approval it took until December 1987, almost 10 months after signing the agreement, to receive the first disbursement of \$98,000. This was because ICICI was delayed in initial PACT Project disbursements while it entered into an agreement with the Ministry of Finance. As of June 30, 1989, the following has been spent on the project:

<u>Company</u>	<u>Own Resources</u>	<u>PACT Funds</u>	<u>Total</u>
Globe	Rs. 1,800,000	Rs. 1,800,000	Rs. 3,600,000
Scott	\$ 250,000	\$ 253,000	\$ 503,000

Globe has completed development of prototype PM alternators suitable for automotive, light industrial and railway applications. After initial difficulties with heat build-up, Globe is confident that they have solved the problem for automotive alternators, and they hope that the larger sized alternators will not have the same heat problems. This heat problem was solved with the help of a team of scientists from the Indian Institute of Technology.

Permanent magnet automotive alternators up to 150 amps have been produced and tested, with good results. The major components of the alternator have been developed and the electronic voltage regulator has been successfully tested. Cost analyses of smaller automotive PM alternators indicated that Globe will not be able to make a profit on the sale of these smaller alternators. Therefore attention in marketing and development has shifted to railway and special vehicle alternators, such as air conditioned buses and refrigerated trucks.

The electrical and mechanical design for railway alternators has been completed and a prototype has been made. In addition, Globe engineers have gone to Scott Motors to work on development of alternators for refrigerated vehicles.

Mr. Zatakia claims that Globe is ready to produce heavy duty alternators, and they have prototypes for the railway alternators. The first sale may be heavy duty alternators for Government of India earth moving equipment, a market requiring 300 units. Globe has sent drawings to the government's railway testing laboratories, and has demonstrated the performance of their heavy duty alternator to the Railway Research Organization Director during a recent visit that he made to Globe. If the railcar alternators are acceptable to the railways, Globe may be able to sell several thousand units to them. Globe officers said that at this time, Globe's sales to the state railways are essential to the repayment of PACT.

Mr. Zatakia also points out that they do not have the production capacity now to meet demand if their optimistic sales scenario proves correct. If they receive a lot of orders in the near future, they will need to license production

of the alternators to other companies. They also hope to license the designs to companies in Europe.

7. Profitability

It is very difficult to predict the profitability of the project now before any alternators have been sold. It is clear however that the royalty to be paid to PACT will be a significant drain on profits over the near term. Globe's rate of profit on gross revenues has been about 3.5% over the past two years. This is slightly less than the 4% royalty payment due to PACT. Nevertheless, Mr. Zatakia thinks that there will be substantially larger profits available from PM alternator sales because there is no competition in this market. In addition, he has been informed that ICICI will be flexible about the percentage of gross revenues that will be required under the PACT agreement. He believes that ICICI will reduce their royalty fee if Globe is not making sufficient profits on PM alternator sales over the next few years.

It is clear that this project has the potential to be a profitable investment for both Globe Auto and Scott Motors. Since they have not sold a single alternator yet, and they do not have any confirmed purchase orders, it is difficult to project the eventual sales of their new PM alternators. Initial sales to the Indian Government for use in the railways and heavy equipment will be critical to the profitability of the project for PACT.

Estimated PACT Repayments

<u>Year</u>	<u>Repayment</u>
1989	- 0 -
1990	\$21,900
1991	\$33,100
1992	\$204,700
1993	\$204,700
1994	\$204,700
1995	\$21,900

8. Technical Transfer and Protection

The two companies have a licensing agreement under which Scott agreed to supply full technical information, material, and manufacturing and testing equipment. Globe received an exclusive license for manufacture, assembly and sale of Scott's components in India and a non-exclusive license for other countries. Scott also agreed to supply knowhow during the eight year duration of the agreement. After expiration of the agreement, Globe can manufacture the components with no additional payments.

The agreement also provides for training of Globe personnel in Scott

plants. Scott also committed itself to sending an engineer to India to assist with start-up operations. Globe has the right to sub-license the technology to other Indian companies subject to approval by Scott. Scott has also reserved the right to perform quality testing.

According to Globe management, the intention is to jointly patent the PM alternator design in India, the U.S. and third countries. Globe and Scott plan to license the alternator in the U.K. and other European Community countries. Scott will market the controller independently. Globe did not exclude the possibility of selling alternators in Eastern Europe, where they currently sell other products. The end use would be buses and heavy electric devices. (It should be pointed out that PACT does not fund development of technology for military purposes.)

9. Change in R&D Capability & Other Benefits to Indian Partner

The project has helped Globe to expand its development operations, and has demonstrated to Globe the value of investing in new products as a means of diversifying out of products with declining profit margins. The project has also continued to build the collaborative business relationship between Globe and Scott.

10. Benefits to the U.S. Partner

The project promises several major benefits to Scott. These include:

- Infusion of PACT funds as working capital;
- Providing additional access to the Indian and possibly East European market;
- Opportunity to cheapen tooling costs by purchasing tools and dies from India;
- A prospect for earning profits from the sale of PM alternators in India and abroad.

11. Summary of Constraints to Commercialization

- A. Receiving a contract to supply PM alternators to the GOI for heavy construction equipment.
- B. Receiving approval from Indian Railways for the design and performance of the PM alternator, and receiving contracts for railway alternators.

develop this CRTC.

After hearing about the PACT Project, Indchem made an inquiry into the types of project that could be funded by PACT, and was invited to submit suggestions for possible projects. In the second quarter of 1987, Indchem presented six R&D ideas to a PACT screening panel. The panel suggested that the most appropriate one for PACT would be the Indian language CRT controller. Through personal contacts, Indchem staff got in touch with Modular and suggested that they submit a joint proposal. Modular is well known in the area of chip applications design, and this complemented Indchem's strength in marketing and hardware development. The division of responsibility in the project is the following: Indchem develops the CRTC design and other hardware, while Modular designs and produces the CRTC video interface chip.

The proposal was submitted to PACT in November 1987, and was sanctioned in February 1988. Documentation for the grant was completed by March 1988, and Indchem was given two disbursements of Rs. 400,000 each under the grant, one in July 1988 and the second at the end of 1988.

Progress to Date

The two companies have had a total of five technical staff working on the project since July 1988. Of the eight major technical milestones set for the project, Indchem and Modular have completed four. In September 1988 they completed the study of CRTCs for Indian languages and preliminary specifications for the controller. In December 1988 they completed design of the PC board, and in May 1989 they completed testing and validation of the PC board. Indchem and Modular have indicated that they may not be able to fit the video interface (VSLI) and CPU interface functions on a single chip. Modular is now finalizing the design of the VSLI chip and the partners have tentatively decided to use an off-the-shelf CPU chip in place of the second chip that was originally planned. Indchem has also designed PC add-on boards incorporating the chip, and expects to be able to sell these by the end of 1989. Modular reports that they have almost finished designs for the prototype VSLI chip and plan to contract for production in April 1990.

As of September 20, 1989 the project was about one month behind schedule. Once the chips have been manufactured on a trial basis, Indchem will distribute them to potential buyers for evaluation. When the design of the chips is completed they will be produced in U.S. foundries under contract to Modular, and then will be shipped and sold to Indchem. Modular will pay a royalty to Indchem for each chip sold to buyers other than Indchem.

Modular reports that they sent an invoice to Indchem on July 17, 1989 for payment under the PACT grant and that they have not received any payment yet. They claim that they have completed over 60% of the work by this date, but had not received their first payment. Within three weeks they expect to begin producing prototype chips. They require the money for this production and claim that they may have cash flow problems if the payment takes much longer to arrive.

ICICI reported that they had received the invoice in August, but that it has taken a long time to receive GOI approval to release the dollars to Modular.

7. Profitability

Profitability of the R&D Investment

Indchem's original profitability projections for the Indian language CRT controller project were for a 40% return on investment. The project has met its original technical targets, and the company still expects to make approximately 30% to 40% per year on its investment. Indchem has continued to invest in the project and has undertaken preliminary marketing efforts. Therefore, this project still shows strong indications of becoming profitable.

Given the arrangement that Indchem has with Modular, it is likely that Indchem will receive the majority of benefits from sales of Indian language chips, boards and terminals. Modular will earn approximately \$ 1 margin on every chip sold, while Indchem will earn up to \$ 3 on every chip sold, plus a margin on other components and royalties on chips sold by Modular to other companies.

Profitability for PACT

This R&D effort is aimed at producing three products, each one of which can be sold by Indchem:

- A. The technical designs to produce phonetic CRTC's. These can produce licensing fees and royalties for Indchem. At this time, there is no arrangement for Modular to share in these fees and royalties, but PACT would presumably earn a royalty on Indchem's royalties and licensing fees.
- B. Terminals incorporating the CRTC chip. Indchem will purchase the chips from Modular and incorporate these into a board to be designed and assembled in India. Indchem will sell the terminals, and Modular will sell only the chips used in the terminals. For terminal sales, Modular earns revenues only from chip sales, while PACT earns a royalty on either the entire terminal price or just the CRTC chip.
- C. Circuit board sales that incorporate CRTC chips. For these sales, Modular earns revenues from the chips, while Indchem gets the remainder. PACT receives a royalty on either the chip revenue or the whole board's revenue, depending upon how the ICICI agreement is interpreted.

Indchem officers report that they have agreed with ICICI to pay royalties only on chip sales. For example, if they buy the chips from Modular at \$7 per piece and sell it as a board or terminal component for \$15, then PACT will be paid \$15 x the royalty fee. The finance Manager of Indchem said that he does not know what the exact royalty fees is in the agreement, while the Chairman of the company said that they had agreed with Indchem that the royalty fee would

be flexible, and would depend on the profitability of the project. He suggested that the fee would start out small and would increase as Indchem's margins improved on this product line.

This lack of clarity as to what the royalty fee is based on and even how much it will be may cause future problems for PACT reflows. First, it is possible that PACT is entitled to royalties on more than just chip sales. PACT resources have also been used to develop several components of the CRTC controller, including the PC board. As in most PACT agreements, the term "innovation" is not defined in the agreement, and therefore the issue of which revenues should be subject to royalty fees is unclear. If royalties are only to be charged on chip sales it will take significantly longer to pay back the conditional grant than if the fee is charged on boards and terminals.

Second, in most agreements, the amount of royalty fee is fixed in the agreement. No record was found indicating that the royalty had been fixed in this case, but there were no other projects that allowed repayments to PACT to be based on the profitability of the project. The PACT grant may take considerably longer to pay back if the fee is allowed to be contingent on profits.

It is also a serious concern that the Finance Manager and Chairman of the company both did not know how much the royalty fee was. This indicates a lack of understanding of the terms of the PACT conditional grant.

8. Technical Transfer and Protection

This project is a joint venture with no formal legal agreement governing the distribution of rights to intellectual property resulting from the project. Indchem and Modular do have a nondisclosure agreement that prevents either party from sharing technical information on the CRTC design with other individuals or firms.

Once the chip has been developed, Modular and Indchem will draw up a licensing agreement to govern rights to the chip design. Until then there is no formal agreement governing ownership of intellectual property developed under the project.

Modular has the right to produce and sell chips to customers other than Indchem. Indchem reports that Modular will have to pay a royalty fee for every chip that they sell to other buyers. There is no copy of a formal agreement in the ICICI or USAID files that establishes this royalty arrangement, and it is not clear why Modular does not earn a royalty on sales made by Indchem of equipment using the VSLI chip.

9. Change in R&D Capability & Other Benefits to Indian Partner

The electronics industry has become highly competitive in India, with many new entrants during the 1980s. Firms like Indchem have found that their profit margins in older, established product lines have been falling quickly, and they are under pressure to develop new products with higher profit margins. Indchem expects this project to result in a product for which they are the only producer in India. This will allow them to earn higher than average profit margins on CRT sales.

It is clear that Indchem recognizes the value of R&D investment, and that this investment has become particularly important as the GOI has liberalized industrial investment and output to a limited extent. Indchem officers are aware that R&D investments lead to "technical monopolies", i.e., products in which there is limited competition and higher profit margins available.

10. Benefits to the U.S. Partner

The main benefit to the U.S. partner is the opportunity for selling chips. Modular will earn a margin on every chip sold. Other than this, Modular obtains few benefits from the arrangement.

11. Summary of Constraints to Commercialization

- A. Indchem equipment receiving GOI approval of their hardware for purchase by government agencies.
- B. Another competing computer hardware manufacturer not coming out with a superior VLSI CRT controller acceptable to the GOI before Indchem.

Case Study E

1. Company Names

Indian: Pest Control India

American: Fermone Chemicals, Inc.

2. Project Title: Development of Pheromones and Controlled Release Formulations for Control of Certain Cotton Pests in India.

3. Date Sanctioned: June 1987

 Project Start Date: July 1987

 Original Completion Date:

 Estimated Completion Date:

4. Total Budget: \$604,000

 PACT Grant: \$302,000

5. Disbursements to August 31, 1989: Fermone: \$32,000
 Pest Control: Rs. 1,000,000

6. Background and Progress

Cotton is a major crop cultivated over an area of more than 8 million hectares and accounting for over 50% of pesticide use in India. The use of broad spectrum pesticides and synthetic pyrethroids in cotton cultivation has resulted in several problems, including resistance by pests requiring repeated applications, destruction of parasites and predators that are natural enemies of cotton pests leading to increased pest problems, and inferior quality cotton. The project proposes to attack these problems by (i) developing new routes for synthesizing pheromones through use of cheaper raw materials and (ii) development of new controlled-release formulations suitable for conventional pesticide application methods.

This PACT sub-project was intended to produce pheromones from locally available raw materials such as castor oil rather than petrochemicals. It was a joint venture between Pest Control India (PCI) and Fermone Chemicals Inc. (FCI), with FCI transferring its existing pheromone and controlled-release technologies to PCI.

PCI, incorporated in 1954, is now the largest pest control company in India. FCI is a manufacturer of synthetic pheromones and controlled-release

formulations for application of pheromones. In 1974, PCI decided that they needed to modernize their pest control methods and to become more environmentally concerned. They initially formed a working relationship with Conrel Corporation to conduct experiments on integrated pest management. Conrel came to India in 1979 and arranged tests of pheromones on cotton pests over a six month period in the North. The results were promising and the GOI was impressed. After this one of the key staff in Conrel left the company and started FCI. FCI then got in touch with PCI to discuss a joint venture in pest control using pheromones, but at this time FCI did not have the cash to undertake the project.

The project had three main phases: (A) Field trials by PCI in India to identify effective pheromones and integrated pest management practices using pheromones; (B) Synthesis of pheromones from Indian raw materials; and (C) development of new controlled-release formulations suitable for application of conventional pesticides.

After receiving the first PACT disbursement of Rs. 1 million, PCI purchased land in Karnataka and lab equipment to set up a lab. Initial field trials demonstrated that the application techniques can be adapted to Indian conditions, but the sulfur content in the air in Bangalore made it necessary to move the lab to Vapi, Gujarat. There additional trials were conducted with increases in cotton yields of about 20%. Based on these results PCI expects to receive GOI approval for use of pheromones for cotton within a year.

For the trials FCI provided PCI with both the pheromones and the controlled-release chemicals. During this initial period, PCI insisted that FCI transfer chemicals to PCI at cost, thereby subsidizing this phase of the project. FCI objected to providing chemicals at prices that did not cover overhead costs for PCI's marketing efforts. PCI refused to pay more than direct costs for the chemicals, maintaining that they were only purchasing trial quantities, and that they were paying duties of up to 240% on imported chemicals.

During 1988 while field trials were being carried out, FCI seriously needed additional capital and began searching for investors. In 1988, after an unsuccessful bid by another company, Troy Chemical Company bought FCI. This change in ownership caused FCI to stop work on the PACT project for over six months, and caused a postponement of plans to begin synthesizing pheromones.

As of mid-September 1989, PCI was anxious to go ahead with plans for production of pheromones in India and was waiting for FCI to provide the information to build a pheromone laboratory. The designs for the pheromone plant were supposed to be delivered to PCI in December 1988. FCI, however, seems to have changed its plans to transfer both controlled-release formulations and pheromone technologies to PCI under the PACT project. As a result of FCI's change of ownership and concerns for the safety of their patents and trade secrets, the contact person at FCI informed the evaluation team that they would not transfer these technologies to the Indian company and that they hoped to continue selling the chemicals to PCI for the next few years.

Representatives of Pest Control said that as of September 1989 Fermone had sent neither the controlled-release formulations nor the pheromone formulas. Pest Control said that they were flexible about the kind of agreement that they would enter into to share these intellectual properties with Fermone, and that they would like to enter into a joint venture with Fermone. This joint venture could control all of the intellectual properties in India, and benefits would be shared proportionally to ownership of the joint venture. They stressed that they are willing to be very flexible in the arrangements that they form with Fermone to share the technologies.

The evaluation team reviewed the Pest Control/Fermone files and could not find any legally binding agreements between the two companies governing the intellectual properties to be transferred under the PACT grant. Fermone and Pest Control both confirmed that they don't have any legally binding agreements to govern the transfer properties from Fermone to Pest Control.

This change in plans for transferring Fermone's production technologies will present a serious problem for PCI's efforts to sell pheromone-based integrated pest management in India. First, PCI claims that the chemicals are too expensive to import on a commercial basis, and that production in India is necessary to make these technologies affordable to Indian farmers. Second, GOI approval may be dependent on production of both the pheromones and controlled-release formulations in India. Third, PCI expects acquisition of FCI's technologies to be very profitable for PCI, and will be seriously disappointed if they feel that they will only be allowed to market the chemicals.

It is possible that FCI does not understand that production of these chemicals in India may be the only way for them to continue selling in this market. Whatever may be the case, there is a strong chance that this project will not result in the production of pheromones and controlled-release chemicals in India.

On returning to Washington, the evaluation team leader called a senior officer of Fermone Chemical Company to check the facts of the case study. This officer confirmed that Fermone has not transferred any intellectual property yet, and that they had not reached any new agreements with Pest Control during the August 1989 PACT meeting in San Francisco (representatives of both companies attended). He added that Fermone is willing to transfer their pheromone formulas and plant designs to Pest Control if they sign a secrecy agreement with Fermone, but Fermone is not willing to transfer the technology needed to produce the controlled-release formulations in India. The Fermone officer said that this transfer would be giving the company's "crown jewels" to Pest Control without adequate protection of the property.

Fermone has taken the position that there are several problems involved in transferring their controlled-release formulations:

1. There is a risk that the patent protection available in India will not be sufficient to protect Fermone's valuable intellectual properties.

2. The 7 year duration of patent protection in India is insufficient time to recoup the initial R&D investment.
3. Because Fermone would only own up to 40% of the joint venture company, Fermone would not have sufficient technical control over the use of dangerous chemicals. Therefore they fear the liability associated with accidents involving those chemicals.
4. Fermone management also says that 40% of the equity is not sufficient compensation for transfer of their key intellectual properties.

Fermone staff said that during an open session of all participants in a PACT council meeting, a member of the PACT Board pressured Fermone in public to enter into the joint venture with Pest Control, and suggested that Fermone has an obligation to form this joint venture. Fermone's management did not raise their concerns about the board member's comments because he did not want to discuss this important business matter in public. Instead a Fermone representative went to the cocktail party after the meeting hoping to meet with members of the board to discuss the problem. Fermone management had been told that board members would be attending the party and that this would be an opportunity to discuss sub-projects. However, according to a senior officer of Fermone, no board members attended the dinner and cocktail party. The officer was concerned that "they (the PACT Board) had tried to rope (Fermone) into a joint venture in public," with pressure being put on him to enter into an arrangement that he feels would not be in the interests of his company, and then he was not given a chance to respond to the board in private.

7. Profitability

The profitability of this project depends heavily upon two factors: (i) the project not being scuttled by FCI's refusal to provide PCI its proprietary technologies; and (ii) GOI approval of this pest management system for cotton, and provision of support and subsidies for its use.

Given the lack of proper agreements governing the transfer of FCI's technology, it is possible that this would not result in a fair return to the American company. This seems to be the reason that FCI has become reluctant to continue with the project as planned.

This case illustrates the importance of proper intellectual property arrangements in R&D projects. R&D projects produce, share or transfer intellectual property. Well-constructed agreements are needed to ensure that the benefits resulting from exploitation of intellectual property are shared fairly.

8. Technical Transfer and Protection

FCI's proprietary controlled-release formulations and plant designs for pheromone production were to be transferred to PCI under a loose joint venture agreement. The technology development activity planned was identification of new routes for producing pheromones and new controlled-release formulations. PCI would have used technical advice and laboratory and plant designs from FCI to carry out this work.

The most serious weakness of this project seems to be that FCI considers the risks associated with providing its intellectual property to PCI to be greater than the expected profits from production in India. FCI and PCI have a joint venture agreement, but it does not clearly define rights to benefits coming from use of the technology.

9. Change in R&D Capability & Other Benefits to Indian Partner

If this project proceeds as planned, it is highly probable that the Indian partner will gain substantial benefits. These include direct profits from sale of the chemicals, capturing a large share of the integrated pest management market in India, and improved laboratory facilities. PCI has clearly used this project as an opportunity to conduct R&D on integrated pest management.

10. Benefits to the U.S. Partner

None so far. Given the shortcomings of the instruments governing transfer of intellectual property, there is a significant chance that the U.S. partner will not receive fair benefits from the project.

11. Summary of Constraints to Commercialization

- A. Lack of a mutually acceptable agreements between Pest Control India and Fermone Chemical Company governing production and sales of pheromones and controlled-release formulations. There is a possibility that the two partners will not reach a mutually acceptable agreement governing these intellectual properties.
- B. Obtaining GOI Ministry of Agriculture approval for pheromone technologies in GOI supported agriculture extension programs. GOI support is essential to the ability of farmers to buy and apply these technologies.
- C. Imported pheromones and controlled-release formulations will be too expensive for the Indian market. Fermone Chemical Company currently refuses to transfer the controlled-release formulations to Pest Control India and intends to export the formulations to India.

- D. Fermone Chemical Company officers believe that Indian investment laws do not provide sufficient control of their technical processes to protect the U.S. company from industrial accidents.

12. Recommendations for Action on the Constraints

- A. One response by PACT Project management might be to encourage Fermone Chemical Company to transfer its controlled-release technologies to Pest Control India. This is what a member of the PACT Board intended to do during the PACT meeting in San Francisco. It is, however, a mistake to encourage the U.S. company to transfer its technologies to Pest Control India because U.S. companies can and should look out for their own interests in technology agreements. If Fermone Company wants to enter into the agreement, they should be allowed to do so without intervention by PACT.
- B. India's foreign investment laws may result in equity positions that are insufficient to ensure technical control of dangerous technical processes and substances. It may be worthwhile to include this issue in policy dialogue between the GOI and private sector interest groups.
- C. In future PACT sub-projects, partners should be encouraged to complete agreements governing the transfer of valuable intellectual property and commercialization of related technology at the beginning of a PACT sub-project.

Case Study F

1. Company Names

Indian: SPIC Science Foundation

American: DNA Plant Technology Corporation

2. Project Title: Improved varieties of coffee and rose by tissue culture.

3. Date Sanctioned: December 1988

4. Total Budget: \$1,380,000

PACT Grant: \$500,000

5. Disbursements to August 31, 1989: Rs. 1,500,000

6. Background and Progress

SPIC Science Foundation (SSF) is a non-profit research foundation established in 1987 by SPIC Ltd. SPIC Ltd. is a diversified holding company owned 26% by the Government of Tamil Nadu, and 74% by the public through public shares. SSF carries out research and development in petrochemicals, fertilizer, biotechnology and plant sciences. DNA Plant Technology (DNAP) is a major agribusiness biotechnology company in the U.S.

The PACT sub-project carried out by SSF and DNAP seeks to develop improved varieties of coffee and roses through somatic embryogenesis, and to apply existing spin-filter bioreactor technology developed by DNAP for mass production of mature embryos. This process will allow the two companies to produce seedlings of improved varieties of coffee and roses for sale to rose and coffee growers in India and abroad. In case processes can not be developed for roses and coffee, bananas and orchids were selected as back up plants.

The technique outlined in the project proposal involves identification of elite coffee and rose plants, selecting individual embryo cells and culturing them in a fermentor with plant growth regulators. The cultured embryos are then sorted by a video scanner-sorter that separates the embryos from the other cells. The sorted embryos are then grown into seedlings. This process has been accomplished on a laboratory scale with carrots and alfalfa, but the process has never been applied on a commercial basis. The project therefore consists of adaptation and application of an existing technology on a commercial scale.

In the case of coffee, the goals of applying the tissue culture R&D were to produce a variety which is disease resistant, has lower caffeine content, and better liquor quality. The phases of the R&D are:

- o Procure elite germplasm
- o Develop protocols and procedures to produce plant varieties with the desired characteristics
- o Develop bioreactor technology for selection of embryos
- o Testing and evaluation

SSF contacted DNAP to investigate licencing of the spin-filter bioreactor technology that DNAP had developed and patented. SSF suggested that the two organizations carry out a joint development program under PACT using DNAP's bioreactor technology. DNAP saw this project as an opportunity to license its technology in India, and viewed development of the micropropagation process as a low risk investment, one involving application of existing technologies.

Although the Project was sanctioned by PACT in December 1988, delays in signing the agreement between ICICI, DNAP and SSF moved the actual project start date to July 1, 1989. After the project was approved, ICICI sent a copy of the agreement to SSF for signature, SSF signed it and sent it onto DNAP for signature. After DNAP signed and sent it to ICICI there was delay of several months before ICICI sent a copy of the agreement to DNAP. Both companies began work on the project in July 1989, but because DNAP had not received either the signed agreement or its first disbursement under the agreement, the company had to stop work on the project in September 1989. Neither DNAP nor SSF was informed why the PACT agreement or first disbursement had not been sent to DNAP.

DNAP staff commented that the time spent waiting for a signed agreement and the first disbursement is costly, and that a project like this may work for a university research organization which has part of its overhead costs covered by non-project sources, but it does not work well for a private company involved in R&D. According to them, the PACT grant barely covers their direct costs.

7. Profitability

SSF expects that this will be a profitable investment, but because they are a research foundation, they have not made projections of their royalty income, licensing fees, or eventual return on investment. DNAP is not certain whether the project will be profitable or not, and says that they will have to wait until the commercialization arrangements are worked out to determine the earnings they will receive from the project.

When SSF completes development of the technology, they intend to provide it on a license basis to a company that will commercialize the technology. In exchange for the right to use SSF's technology, the licensee would pay a license fee to SSF. SPIC Ltd., SSF's parent company, will be given the first right to buy the technology, and if they refuse then it will be offered to other companies.

SSF representatives report that they understand the agreement with ICICI requires that they pay a royalty fee of 5% of gross sales from seedling sales. They think that the royalty obligation to PACT is passed on to any entity that

commercializes the technology and that they have no obligation to reimburse PACT directly from their licensing fees. In other words, SSF thinks that the right to use their technology to produce and sell seedlings using techniques developed under the PACT project is encumbered with the 5% royalty fee on total seedling sales.

USAID and ICICI representatives maintain that the obligation for repayment is joint and several and that the company commercializing the project would assume responsibility for payment of the entire PACT grant. Given this interpretation, it is still not entirely clear who bears what responsibility to pay royalties to PACT. The following example illustrates this:

Repayment Obligation Example

1. SSF and DNAP successfully complete their R&D and produce intellectual property (IP). This IP incorporates DNAP's spin filter bioreactor and video scanning technologies.
2. SSF transfers this IP to SPIC Company for commercialization. SPIC produces seedlings commercially, and will pay a royalty fee to SSF based on gross seedling sales. SSF will in turn pay a royalty fee to DNAP for its technologies.
3. The mandatory royalty fee under the PACT agreement is 5% of annual sales of the "innovation". In addition, if the intellectual property rights are sold or licensed, then SSF must repay the grant from its royalty fees.
4. Problem: In this case would:
 - SSF pay a royalty fee to PACT from the licensing fee that it receives from SPIC? How much would it pay: 5% or 100% of its licensing fee?
 - SPIC Company pay 5% of gross sales as a royalty to PACT?
 - DNAP pay a royalty fee to PACT from the licensing fee that it receives from SSF? How much: 5% or 100% of the licensing fee? Would DNAP pay this fee until it had paid back all of the PACT funds provided to DNAP, or would SPIC assume part of DNAP's repayment obligation?

DNAP is to receive \$240,000 under the PACT grant. However, other than the licensing fees that they receive from providing SSF their spin-filter technology, they have little immediate prospect for earning income from this project. As mentioned above, DNAP's profits from the project are not stipulated by any of the existing agreements. Thus, there is some question how DNAP would be required to pay back its portion of the PACT grant. If all of DNAP's repayments are to come from the licensing fees sent by SSF, then it is likely to take decades to pay its share back.

This sub-project's PACT agreement does not say whether DNAP's repayment obligations under PACT will be shifted to SSF or to SPIC Company if these two companies received the main benefits of technology commercialization. In cases where one partner is unable to pay the PACT royalty because commercialization benefits go to the other partner, it may be necessary for PACT to require the partner receiving most benefits to pay the entire PACT grant. This issue may need clarification.

From this example we can see that although the PACT agreement explicitly addresses the issue of transfer of rights to the innovation, there is still considerable uncertainty as to who will repay PACT, and at what rates.

8. Technical Transfer and Protection

Under the Memorandum of Understanding between the two companies, SSF's role was to: 1) identify plant varieties; 2) set up facilities; 3) standardize regeneration procedures and hybridization methods; 4) send scientists to DNAP for joint R&D to develop protocols for cell cultures and become familiar with bioreactor technology; and 5) set up field trials.

Prior to the PACT project, DNAP had developed tissue culture processes for production of plant embryos and created the patented spin filter bioreactor in collaboration with Arthur D. Little. DNAP was interested in adapting the technology to different plants, and India was selected as a site because it has one of the world's largest collections of coffee germplasm. Under the PACT project, DNAP was to: 1) advise SSF researchers; 2) work with SSF to develop protocols and procedures; 3) adapt the bioreactor technology for use with the specific plants chosen; 4) assist with evaluations; and 5) provide bioreactors and processing equipment to SSF.

DNAP has also developed the computer software for programming needed to carry out embryo sorting. Through computer imaging, the reactor picks out the embryos for separation. This new process is expected to shorten the time of normal seed growth dramatically.

The companies have a licensing agreement under which coffee and rose germplasm was to be provided by SSF. The agreement also stated that DNAP would train Indian personnel in the U.S. and this has already taken place. The venture was expected to take three years to complete and is on target. SSF expects to be able to sell licenses for commercial use of their technology beginning in 1992. In India, the new coffee plants would have to be marketed through the Indian Coffee Board, and SSF has already signed an agreement with the Board for field testing and evaluation of the plants.

The SSF project director described DNAP's participation as "contract research." Besides the sum it receives from PACT, DNAP also receives royalties from use of the bioreactor technology. Under the Memorandum of Understanding signed by the two companies, both parties have equal rights to exploit the new

technology. SSF claims that they and SPIC Ltd. will commercialize the products in India together, or license or sell it to other companies. Because SSF is a non-profit research foundation, SSF can not use the process to produce seedlings for sale on its own. Therefore, DNAP will license use of the bioreactor technology to SPIC.

However, if SSF and SPIC do commercialize the technology, it is unclear what specific benefits DNAP will receive other than their current license fees for the spin-filter bioreactor and the computer software for sorting cultured cells. There has been no agreement on how the process and technology will be commercialized, and both parties take the position that they will deal with that problem once there is a process to commercialize. Both companies will have equal rights in commercialization, according to SPIC, and will work out an agreement on sharing profits once feasibility is established.

Apparently, DNAP also has an agreement with General Foods which will affect the markets they can enter. SSF plans to market the coffee in India and possibly Europe and the Middle East. Eastern Europe was also mentioned as a potential market. DNAP is interested in South American markets. For roses, the venture hopes to build a market in Europe, Southeast and South Asia. SPIC Ltd. has a large marketing network, and will involve a Dutch flower company in the process.

9. Change in R&D Capability & Other Benefits to Indian Partner

SSF scientists will spend a total of two person years working in DNAP's laboratories in the U.S. SSF will also receive DNAP's spin-filter bioreactor technology and computer sorting software on a license basis. In addition, SSF has acquired equipment under this project that it will be able to use for other research projects.

10. Benefits to the U.S. Partner

According to representatives of SSF, DNAP's role in commercialization of the technology developed from the project is unclear, but they do receive two benefits from the project. research money and an opportunity to evaluate the commercial applications of their existing technologies. Both SSF and DNAP representatives report that they do not have any agreement that specifically governs the division of profits resulting from their collaboration.

11. Summary of Constraints to Commercialization

- A. DNAP staff stated that at the time the evaluation was conducted, they did not foresee receiving substantial benefits from the commercialization of their technology. There is a chance that DNAP will not continue to carry out its responsibilities as a partner if they do not expect substantial benefits from their involvement.

12. Suggestions to Overcome Constraints

- A. Encourage DNAP and SSF to enter into an agreement that will allocate expected benefits among the partners.

Case Study G

1. Company Names

Indian: Cipla Ltd.

American: Byron Chemical Company

2. Project Title: Development of new processes for synthesis of anti-cancer agents (Vinblastine and Vincristine and Etoposide) and other drugs (Nadolol, Salmeterol, and Ciprofloxacin).

3. Date Sanctioned: October 1988

Project Start Date: November 1988

Original Completion Date:

Estimated Completion Date:

4. Total Budget: \$1,050,000

PACT Grant: \$497,000

5. Disbursements to August 31, 1989: Cipla: Rs. 3,000,000
Byron: - 0 -

Disbursement to date = 42% of PACT grant.

6. Background and Progress

Cipla Ltd. makes bulk drugs and formulations, producing all of their drugs in India. In 1988, it had gross revenues of Rs. 600 million. Byron Chemical Company is a small U.S. based drug importer and distributor with gross revenues of \$10 million in 1988. Byron acts as Cipla's agent in the U.S. and assists Cipla in obtaining FDA registration and approval of specific drugs.

Cipla regularly reviews the status of drugs in the U.S. to identify those that are going off patent. It takes about six years to formulate a drug and obtain FDA approval for it, and so Cipla has chosen selected patented drugs that

will go off patent in 1993, 1994, and 1995 and is attempting to formulate these in their laboratory. Once they are successful in making the drug, Byron takes care of the requirements of obtaining U.S. FDA approval for the drug. Meanwhile, if Cipla has successfully produced a drug for which there is a U.S. patent outstanding, Cipla will produce the drug for the Indian market as long as it is profitable.

The project funded by PACT involves two anticancer drugs developed by Ely Lilly 20 years ago, and three other drugs. One anticancer drug is based on alkaloids derived from certain plants common in South India. The PACT project involves developing new processes to extract alkaloids from the plants so that the yields are higher than under existing methods. A second drug is made from a plant that comes from North India.

The innovative elements of the project are in the use of indigenous plant materials and improvements in extraction and production processes. Three of the drugs, Vinblastine, Vincristine, and Etoposide, are plant alkaloids which are difficult to extract. To date, the anticancer agents Vinblastine and Vincristine have been successful in laboratory trials and have been produced in small quantities. Cipla also sought to develop new processes for manufacturing Salmeterol and Nadolol. This work is still in its early stages and is not seen as being as promising as the anticancer drugs.

Byron, which will market the drugs in the U.S., has arranged bioequivalency studies and testing in the U.S. to ensure the drugs met U.S. regulatory requirements, including FDA approval. Byron also carried out the initial search to determine which U.S. drugs would have patents expiring in the next several years and market research on the bulk drug industry.

7. Profitability

It is highly likely that one or more of these drugs will be successful on the market. Cipla has a good record in selecting and producing drugs, and choose the drugs to be developed under the PACT project because of their potential for profits. Cipla has stated their intent to produce several of the drugs being developed on a commercial scale if lab trials are successful.

Payment of Royalties to PACT

<u>Year</u>	<u>Royalty</u>
1989	- 0 -
1990	- 0 -
1991	\$71,000
1992	\$142,000
1993	\$142,000
1994	\$142,000
1995	\$142,000

8. Technical Transfer and Protection

This project involves almost no technical transfer other than the advice provided by Byron to Cipla on which drugs to select and how to comply with FDA regulations. Byron does not provide any proprietary technology to Cipla, and does not train any Cipla staff.

Cipla some time ago obtained FDA approval of its laboratory. Cipla management says they do not plan to seek patents in the U.S. for any of the products or processes marketed there because "it is too costly a procedure." (And Cipla is not a small company, with estimated sales in 1989 of over \$60 million.)

9. Change in R&D Capability & Other Benefits to Indian Partner

According to Cipla management, to make sales, it is critical for generic drug manufacturers to be first on the market when drug patents expire. All testing and approvals must be completed before that time, and an average of only one out of five of the drugs under development ever reaches the market. Cipla's managing director stated that the company would have undertaken these projects even without the PACT grant. He also made the point that Indian labor costs are not cheaper than those of other developing country drug manufacturers, but Cipla's comparative advantage is in its materials and "superior" production processes.

This PACT sub-project builds Cipla's R&D capability by giving the company more opportunities to develop new drugs and drug production routes. The project does not transfer any R&D skills from the U.S. partner to the Indian company.

10. Benefits to the U.S. Partner

This project gives Byron an opportunity to earn profits from sales of Cipla's bulk drugs in the U.S.

11. Summary of Constraints to Commercialization

- A. Cipla is not certain now which of the five drugs will become commercially viable. There is still uncertainty concerning production costs, USFDA approval, and technical success in synthesizing from local material. Cipla and its partner, Byron Chemical, should be allowed to work these problems out on their own.

Case Study H

1. Company Names

Indian: ATL India Ltd.

American: Advanced Technology Labs

2. Project Title: Moderately Priced Ultrasound Scanner Systems.

3. Date Sanctioned: The PACT Status of Sanctioned Projects Report dated August 3, 1989 states that the ATL sub-project was sanctioned in February 1988. ICICI reports that the project was not approved by the PACT Screening Committee. The sub-project was decommitted in August 1989.

4. Total Budget: \$584,000

PACT Grant: \$292,000 (Decommitted in August 1989)

5. Disbursements to August 31, 1989: - 0 -

6. Background and Progress

Advanced Technology Labs (ATL US) has had a partnership with Indchem for eleven years. Under the venture, ATL US supplies raw materials and parts for electronic components, Indchem assembles the components into circuit boards and other electronic parts, and ATL US does final assembly, testing and sale. This venture is not particularly profitable for ATL US, but it does give the American company an opportunity to sell its top of the line medical equipment in India.

ATL India proposed that ATL US produce its lower cost ultrasound equipment in India, redesign the equipment to reduce costs, use local materials and improve equipment performance by making minor design changes. The result of this effort would be a better diagnostic machine adapted to India's large market.

ATL India approached PACT to request assistance in developing this improved ultrasound equipment and submitted a PACT application. The project was sanctioned in February 1989. Neither ATL US or ATL India were ever formally notified that they had received a PACT grant. ATL India, however, was told during a phone call with ICICI staff that their proposal had been "approved in principle."

After being informed of "approval", ATL India selected the specifications and features that were desirable for the machines. For the next phase of the project ATL US would have to send several of its more experienced engineers to develop the hardware in India. ATL India encouraged ATL US to commit technical staff to the project, but after considering the large amount of business available in the U.S., ATL US decided that they could not spare their engineers.

After sanction the project made no progress and was decommitted in August 1989.

Once it was clear that ATL US would not provide technical personnel needed for the project, ATL India decided to continue the project on their own. After over six months of work, ATL India has developed a low cost ultrasound machine, and they will sign an agreement to license some components from ATL US.

7. Profitability

ATL India/Indchem officers are certain that developing a low cost, locally produced ultrasound machine based on ATL US's designs will be a profitable. When assistance from ATL US was not provided, ATL India decided to continue the project without PACT funding. This is an example where the Indian company would have conducted the technology development effort with or without PACT support. This is also a case where the American company felt that their returns from the project would be too small to merit sending experienced engineers to India.

8. Technical Transfer and Protection

All proprietary technology to be provided by ATL US was to be licensed to ATL India. The project did not involve any training of Indian engineers in the U.S., but it was planned that ATL US engineers would to India to assist in development of the hardware.

9. Change in R&D Capability & Other Benefits to Indian Partner

This project involves transfer of existing technology from the U.S. to India, not development of new technology.

10. Benefits to the U.S. Partner

License fees and profits to be earned by ATL US through its ownership of part of ATL India were not sufficient to induce ATL US to undertake this project, even after the PACT grant was sanctioned.

The General Sales Manager of ATL US said that he thought the PACT Project is a good idea. He thought that Battelle's role was to assure repatriation of profits should they occur. He had heard that Scott Motors had to wait 10 months for their first draw, and this made him apprehensive about the project.

11. Summary of Constraints to Implementation

- A. ATL US did not foresee sufficient profits from their involvement in the project to justify committing their scarce technical staff to the project.

IV. Short Case Studies

The following case studies are based on structured telephone interviews with only the U.S. partners. Because of time limitations, site visits were not made to either the Indian or U.S. companies.

I. RESEARCH ENGINEERS LTD./RESEARCH ENGINEERS INC.

Project Title: Development of software for structural engineering drafting.

Date Sanctioned: December 1988

Project Budget: \$770,000

PACT Grant: \$385,000

Interview Summary:

Research Engineers Inc. was started in 1978, with its principal product being structural analysis software used on mainframe computers by architects and engineers. The program sold very well, with over 1200 current users of their software in the U.S. In 1983, as PCs became widely available, REI officers decided that they should design a structural analysis and design (STAAD) package for PCs. In 1986 they established an office in England and they have set up two others in Europe and one in India.

Having decided to develop a PC-based STAAD program, they assessed the labor market for engineers and computer scientists in India. They decided that India has abundant skilled labor available at cheap prices, and therefore they could develop the product through their subsidiary in India. At that time they heard about the PACT Project, talked to Battelle and submitted a proposal to PACT.

The package that they proposed would combine elements of STAAD packages never assembled in a single program before. This new program would allow engineers and architects to use one integrated package to manage all of their information involved in a design project. The system would be open, allowing its software to run on any IBM compatible equipment and able to accept files from other STAAD packages.

Representatives of REI say that their PACT sub-project gave them an incentive to tap the cheap, highly skilled labor available

in India. This will drastically cut REI's labor costs in developing new software products, but will require solving the problem of managing technical labor in India, where technical management skills are comparatively weak.

So far they have not found the development costs to be as low as initially planned because of substantial time contributed to the project by U.S. managers. They are now learning how to manage a project in India, and expect that it will be cheaper for future projects after they have developed a pool of technical management expertise in India.

They received their first payment under the PACT grant in March 1989, using this to buy equipment and for start up expenses.

The product, once completed, will be sold in the U.S. They will begin test distribution of the package in the U.S. in the summer of 1990. If it is successful in there, REI will also market it in Europe and the U.K. The Indian subsidiary will sell the product on license within India. In order to protect their intellectual property in India, they will sell it initially only to large firms.

So far they have had several minor difficulties. First, as mentioned above, the project has cost more while they are developing a pool of technical management expertise. Second, it has been difficult to communicate with India. Finally, import duties on computer peripherals in India significantly raise the cost of doing computer-related R&D in India.

J. FOUR EYES RESEARCH PVT. LTD./ALCOA CORPORATION

Project Title: Spent wash treatment by membrane technology.

Date Sanctioned: October 1987

Project Budget: \$450,000

PACT Grant: \$160,000

Interview Summary:

Four Eyes Research has been approached by several companies in India to produce spent wash waste treatment facilities. Four Eyes found that this process would require a new combination of technologies, so they proposed to Alcoa U.S. that they jointly

develop a process using ceramic membranes from Alcoa. Alcoa said this sounded promising but at that point they had not evaluated the technology in the U.S. They agreed to a development project and applied successfully to PACT in 1987.

Under their project agreement, Alcoa would provide the membranes and modules for the membranes, Four Eyes would do the laboratory work in India, and Alcoa would provide technical advice in the U.S. but do no laboratory work.

Four Eyes buys the membranes from a wholly owned French subsidiary of Alcoa. Four Eyes does not pay any fees to Alcoa for technical assistance received, and the Indian company is charged the same prices for membranes and modules that Alcoa charges to universities. Alcoa representatives say that they do not want to make any profit from their contribution to the project, and that they do not consider this an R&D investment in the sense of expected profits. In addition, any intellectual property resulting from the project would be owned by Four Eyes.

Alcoa officers said that this project will provide Alcoa with information on possible applications of their membrane technologies. This is useful because they do not know much about applications and this will allow Alcoa to expand business through new applications. Alcoa also found this PACT project useful because the project was accompanied by a commercialization plan that promised sales in the near future.

Field work has been proceeding well, but Four Eyes has encountered technical difficulties resulting from sedimentation in the process. They have also had difficulties clearing the membranes and other equipment through Indian customs, and have had to pay full duties on materials that they import. Four Eyes also found that ICICI took too long to review initial legal agreements. Alcoa suggested that the PACT Project should provide funds for Alcoa technicians to travel to India to work with their partner.

As a result of this effort Alcoa is seriously considering establishing a representative office for Alcoa in India through their subsidiary Lancy International.

K. SUDARSHAN CHEMICALS LTD./AMVAC CHEMICAL CORPORATION

Project Title: Development of an alternative process (cynate route) for manufacture of isoproturon.

Date Sanctioned: June 1987

Project Budget: \$250,000

PACT Grant: \$125,000

Interview Summary:

Isoproturon is a weedicide used in wheat cultivation. It is usually produced through a process employing phosgene, a highly hazardous and corrosive chemical. This project intends to develop a manufacturing process that will produce isoproturon without phosgene.

This is a corporate joint venture in which Amvac reviews plant drawings and process chemistry, provides off-the-shelf technologies to Sudarshan and consults on technical process, while Sudarshan is responsible for most lab work.

To date they have been able to complete pilot production runs of isoproturon using a new route, but they need to conduct further analysis of the process. They have also discovered that production costs of their process are too high for their isoproturon to be viable in the Indian market.

Amvac's representative says that they are not sure how they will recoup their investment once the process becomes commercial. They do not have any firm plans for marketing isoproturon produced by the process outside of India, and it remains to be determined how they will commercialize the process.

Amvac reports that Sudarshan had difficulties funding the R&D effort during the first year of the project because of slow payments from ICICI. Amvac staff also found it very difficult communicating with Sudarshan in India; this communication difficulty has resulted in Amvac staff's feeling that they have little control over the project.

L. SIEFLEX AUTOMATION & ROBOTICS/CIMFLEX TECHNOLOGY

Project Title: Development of diagnostic products to reduce downtime in manufacturing operations.

Date Sanctioned: June 1989

Project Budget: \$1,200,000

PACT Grant: \$ 500,000

Interview Summary:

We spoke with Charles Buenzli who replaced Ravi Ghai as vice president and general manager. Cimflex and its Indian partner are developing an intelligent system for diagnosis and repair of machine tools. They were recently informed that their project was approved by PACT, after which ICICI sent them a sub-project agreement to sign. They returned this agreement with revisions of terms concerning technology ownership. They were told on September 7, 1989, that ICICI had approved the revisions.

Cimflex has already carried out most of the R&D and has a prototype installed. The PACT grant will allow them to begin commercial production of the system. Cimflex has worked with Sieflex in the past when Sieflex licensed a robotics product line from Cimflex. At this time, Sieflex engineers carried out work for Cimflex under contract. Buenzli says that Sieflex has a good track record and therefore he does not anticipate any problems.

Cimflex's software is in a sophisticated language that Sieflex will rewrite for use with less costly, low-end hardware. Cimflex has invested \$5 million to date in this R&D effort. The new language, called "C", is expected to give Cimflex access to new markets. Sieflex will have rights to C in India and some countries of the Pacific Rim; Cimflex will market the product in the U.S., Japan and Europe. To transfer the technology the Indians will be given software, and training will be done through exchange of engineers and electronic data exchange.

The original software was developed through a Cimflex/Paine-Webber project. It is protected by a combination of patents, copyrights and trade secrets. Cimflex has just filed patents that will reserve rights for Cimflex worldwide. Software developed under the PACT project will be licensed to Sieflex, which originally wanted ownership rights.

Cimflex has already begun exporting software to India. They have had no problems except slow paperwork. They do not expect profits from India from this project. They have had a good relationship with ICICI and have found Battelle very supportive. Business operations in India have been smooth due to the competence of the Indian partner. From Cimflex's perspective, it is a win-win venture. They are optimistic that both companies will profit sooner than they would have by financing the project internally. Cimflex needs to carry out this project to compete in the U.S. market, and the PACT financing lets them complete their effort sooner.

M. SOUTHERN ELECTRONICS/LASER ENGINEERING, INC

Project Title: Development of flexible waveguide for CO2 laser for endoscopy.

Date Sanctioned: June 1989

Project Budget: \$1,100,000

PACT Grant: \$ 500,000

Interview Summary:

We spoke with Frank J. Martin concerning the venture's CO2 laser surgery device. Laser Engineering is a developer, manufacturer and marketer of CO2 surgical lasers now used worldwide. The company wants to develop a fiber for CO2 lasers. Southern Electronics has manufacturing and marketing capabilities and wants to manufacture lasers in India. The two companies formed a joint venture, Southern Laser Engineering, 60% owned by Citadel Pharmaceutical.

Mr. Martin reports that the PACT-funded project is on track and they have completed the prefeasibility study. However, he added that they have not found the Indian partner to be very supportive and that they have had to push their partner at each stage. He added that if the research depended on a rigid timetable it would have to be abandoned, and that deadlines have consistently been missed. The governments of both countries have been a hinderance and there has been much duplication of effort by the two companies. Program success in the future will depend on getting a competent manager in India and on the Indian partner's pushing things forward.

Fibers for CO2 lasers would have worldwide applications. The Indians have the necessary technical expertise but no domestic production of CO2 lasers. They will need to learn manufacturing processes. The two companies will market the end product throughout South Asia. Laser Engineering will retain U.S. and world rights.

R&D will begin as soon as the PACT funding is received. Laser Engineering will provide one or two lasers to Southern Electronics and the companies will exchange technical personnel for training. They anticipate two years before commercialization. Clearly the low Indian labor costs are an advantage to Laser Engineering, which will profit from the sale of lasers and export of parts.

No proprietary intellectual property will be transferred to Southern Electronics. The laser tube, which is proprietary, is export-controlled in the U.S. The Indians will be trained in developing power supplies, microprocessor controls and the optical system. Laser tubes will have to be purchased from the U.S., and this creates a new market for Laser Engineering. There have been no serious problems with either government yet, because Southern Electronics has not tried to export lasers. The agreement between the two companies will have a requirement concerning repatriation of profits and Laser Engineering does not intend to invest any additional capital in the venture.

Laser Engineering has found Indian laws attractive. Once they begin commercial sales, the government will lock out other laser manufacturers and will give them an exclusive market. (Martin found this to be very short-sighted on the Indian Government's part.)

The cooperation and financing agreements are on the way from ICICI, which has been slow in processing paper. Communications have also been very poor. Battelle was involved in the project at one stage, but has not been asked to do much.

N. PONNI SUGARS AND CHEMICALS/OSMONICS INC.

Project Title: Purification and concentration of sugarcane juice employing membrane technology.

Date Sanctioned: February 1989

Project Budget: \$50,000

PACT Grant: \$25,000

Interview Summary:

Osmonics has received sixty percent of their share of the PACT prefeasibility study grant. There were serious delays in receiving payment from ICICI and they expect the other 40% of the grant when the report is issued. Osmonics agreed to participate in the prefeasibility study at the end of March. Five days of testing took place in May with the Indians participating. The next step is a full feasibility study. They have no agreement with Ponni yet regarding how the two partners will carry out the project.

Ponni is part of the Esvin holding company and Osmonics is really working with Esvin. Esvin is anxious to push Osmonics to the next step and to get A.I.D. funds.

The research evaluates the use of cross-flow membrane technology in sugar refining. The purpose of the project is to increase sugar yields and reduce processing costs in cane processing. This technology is already in use in the U.S. sugar industry, although on a limited basis. India is a major sugar cane producer and it is clearly better to process the sugar in situ. India has a large internal sugar market, and Europe is also a potential market. Before going ahead with an agreement, Osmonics wants to study application of the process to the Indian sugar market.

It has not yet been decided who would build the equipment. The Indians would like to minimize import tariffs by assembling components there but for now they will buy components and application technology from the U.S. The hardware would be built in India. Osmonics will provide the membrane and fluid engineering technologies.

India has no capability in membrane science. This will have to be developed and extensive field testing carried out. The economics do not look attractive at this point in time. Osmonics may just sell components and provide the know-how for running tests

to determine if it will be economically viable in the long run. It may require four to eight years to pay back the equipment investment.

The project is attractive to Esvin because Esvin is not the end customer for the refining equipment. Esvin will sell the equipment to other companies in India. Osmonics is not convinced that they will be able to sell enough to make the investment worthwhile. Esvin, on the other hand, has a lot to gain and little to lose. The opposite is true for Osmonics.

Osmonics is also concerned about taxes in India. In addition, there was a delay in receiving funds from ICICI. Osmonics was not told of Battelle's existence in the program until after they signed the contract with ICICI. Battelle has no direct involvement now. Osmonics officers are concerned that none of this conversation be referred to Esvin until they have finished their negotiations.

O. AMERICAN HYTECH CORPORATION

Project Title: Development of a document management system.

Date Sanctioned: July 1988 (Cancelled August 1989)

Project Budget: \$1,600,000

PACT Grant: \$500,000 (Cancelled)

Interview Summary:

American Hytech is a software developer. It has had a successful joint venture project to develop software with Vipro Systems, an Indian computer software company. This project resulted in Instaplan, a package that now has over 20,000 licensed users. This project was carried out with the backing of local venture capitalists.

They are now trying to have their new product development work done in India because of cheaper skilled labor costs there. An Indian partner approached American Hytech to submit a PACT proposal, and Hytech subsequently submitted one in early 1988. After submitting the proposal, American Hytech has heard nothing from ICICI or PACT representatives as of September 1989.

During this waiting period, the Indian partner lost some of its key technical personnel. American Hytech asked ICICI to refer

a new Indian partner and began contacts with BHEL and Sunray Computers in India as possible partners. Communication with ICICI has generally been very poor and it has taken a long time to get responses to inquiries.

On August 11, 1989 ICICI cancelled the PACT sub-project, and then asked Battelle to inform American Hytech of the cancellation.

P. BIOCON INDIA LTD/BIOCON U.S.

Project Title: Fermentation Process for the Enzyme Rennet.

Date Sanctioned: July 1988

Project Budget: \$460,000

PACT Grant: \$230,000

Interview Summary:

The project was initiated by Biocon India Ltd., a subsidiary of Biocon (U.S.) Inc. Both companies are subsidiaries of an Irish company. Biocon (U.S.) is a sales and marketing company, not a manufacturer. Biocon India proposed a project to develop a solid state fermentation process for rennet that (i) requires low initial capital investment, (ii) achieves higher yields than existing processes, (iii) achieves viability at low capacities, and (iv) allows easy scale-up of production. In this project Biocon (U.S.) was to provide technical advice to the Indian company and would market the rennet.

Up to September 1989, Biocon India had developed a solid state process and was producing enzyme rennet on a laboratory scale. Initial yields are as good as was originally expected. The two companies will have no difficulty collaborating on commercialization because they are part of the same group of companies.

So far Biocon (U.S.) representatives feel that the PACT sub-project has been very successful. They felt that the assistance that they have received from Battelle and ICICI has been very helpful.

Q. GUJARAT STATE FERTILIZERS/ECOGEN INC.

Project Title: Development of Bacillus Thuringiensis based on biopesticides for control of certain pests.

Date Sanctioned: December 1988

Project Budget: \$2,240,000

PACT Grant: \$ 500,000

Interview Summary:

Ecogen Inc. possesses the technology to identify the genes in *Bacillus thuringiensis* (BT) that produce particular biological toxins, and to breed varieties of BT that produce more toxins. These toxins are effective pesticides that have several advantages over conventional broad spectrum pesticides and synthetic pyrethroids.

Gujarat State Fertilizer Corporation (GSFC) asked Ecogen if they would help GSFC to set up a production facility for BT toxins on a commercial scale. This would involve setting up a laboratory that would screen strains for genetic characteristics affecting toxin production, breed the highest yielding BT strains in the U.S. and develop proprietary strains that can be grown commercially by GSFC in India.

Ecogen found this an attractive project and agreed to apply for a PACT grant with GSFC. In the project GSFC would be given the rights to produce BT toxin-based pesticides in India and would pay royalties to Ecogen, while Ecogen would have worldwide production and sales rights to the new strains. The BT strains developed under the project would also be patentable by Ecogen.

Although the project has been slow to start, Ecogen and GSFC have signed the agreement with ICICI, Ecogen has developed BT toxins in the U.S., and these are ready for field trials in India.

R. THERMAX PRIVATE LTD./BABCOCK AND WILCOX COMPANY

Project Title: Development of internally circulating fluidized bed boilers.

Date Sanctioned: December 1988

Project Budget: \$1,177,000

PACT Grant: \$ 500,000

Interview Summary:

Thermax Private Ltd. approached Babcock and Wilcox to request technical assistance in adapting and commercializing circulating fluidized bed boiler technology available from an Austrian firm, Simmering Graz Pauker AG. This technology would be available on license from the Austrian firm. Babcock and Wilcox's role in this project was to review and comment on the test plan for the equipment, and to evaluate results obtained in Thermax's tests.

As of September 1989, Babcock & Wilcox had not provided any technical assistance to Thermax. If tests prove successful, Thermax Babcock and Wilcox, the Indian joint venture between the two companies, will arrange a license agreement to produce the boilers in India.

V. MAJOR ISSUES FROM THE CASES

A. Progress

As of September 20, 1989, ICICI had approved 18 projects and two prefeasibility studies, involving financing of \$6.8 million in PACT funds. Approximately \$2.0 million of this \$6.8 million has been disbursed to 13 PACT sub-projects. Approved projects involve total funds from PACT and private sector sponsors totaling \$16.35 million.

USAID/India estimates that project disbursements will increase to \$8.0 million by December 1991, assuming completion of sub-projects so far approved and partial disbursement of sub-projects approved between September 20, 1989, and August 31, 1991. Assuming that an additional \$1.5 million is committed to new projects during FY 1990, then by August 31, 1990, it is likely that commitments will total \$8.3 million.

Since the project's beginning ICICI has examined 337 proposals, of which 244 were inquiries received by ICICI and 60 were received by Battelle. As of September 1989, 17 inquiries were being profiled, 12 additional profiles had been completed, 4 new proposals are under formulation, 18 proposals had been approved, 2 prefeasibility studies approved, 15 proposals had been committed and 13 had some funds disbursed.

It is difficult to estimate how far behind schedule PACT is in using its funds. Most projects are running at least six months behind schedule, and several of the larger approved proposals have had no disbursements and therefore may be further delayed.

Characteristics of the Projects Reviewed

The eight projects reviewed in-depth represented four distinct models of technical collaboration between Indian and U.S. companies. These were:

- i. Indian and U.S. companies each performing about half of the technical work on a project, with both sharing relatively equally in the expected benefits of commercialization. Examples are Ponds India/Giorgio Foods and Globe Auto/Scott Motors.
- ii. U.S. companies providing advice on research, marketing, and on specific technical issues, with the Indian company carrying on the R&D program largely on its own. Examples are Pennwalt India/Pennwalt Sharples-Stokes, Cipla/Byron Chemical.

- iii. The U.S. company transferring key intellectual property to the Indian company, with the Indian company developing applications and modifications for the technology. Examples are Pest Control India/Fermone Chemicals, SPIC Science Foundation/DNA Plant Technology and ATL India/Advanced Technology Labs.
- iv. An Indian company doing most technical work, an American company designing a single high tech component, with the Indian company deriving most benefits from commercialization. Example: Indchem Electronics/Modular Semiconductor.

The PACT Project is restricted to funding R&D activities to the point of production for sale. Since the commercial viability of a product or process can be proven only by actual production and sale, the commercial viability of each sub-project is difficult to determine now. Nevertheless, several factors seem to be associated with continued progress toward commercialization. These include:

- i. Fair distribution of expected benefits from commercialization. Projects seemed to work better when both partners felt that they would receive substantial benefits from the project.
- ii. Fair compensation for the transfer of intellectual property needed for the project. Companies providing important patents, trade secrets or proprietary technology must feel fairly compensated and adequately protected if they are to be willing to contribute intellectual property to a project.
- iii. Each partner contributing technical expertise that the other party lacks.

Importance of Market-Oriented Products

The importance of the market orientation for the success of the PACT experiment cannot be overstated. One Indian company made the observation that it is essential that a substantial market already exist before collaborators begin product development. Companies reviewed here have taken this into account. It was noted, however, that U.S. participants in PACT were, for the most part, not investing or marketing in India; the majority were providing technical assistance or intellectual property to Indian companies.

It is evident from Ponds' and Globe's experience that their success to date is due to a close working relationships between the two partners and their complementary business interests. Because of the mutual respect between the two parties, minor problems that could have been insurmountable hurdles have been

overcome. This desire to collaborate is difficult to evaluate before a project starts but it appears to be essential for a project to proceed on schedule.

Companies Were Not New to Commercially-Oriented R&D

In all cases both American and Indian companies were committed to investing in R&D before they received a PACT grant. It is likely that even without PACT funds, most of these sub-projects would have been carried out, and, in fact, several companies stated that they would have carried out the R&D on their own without PACT funds. Nevertheless, company representatives stated that PACT allowed them to achieve their objectives more quickly.

Most PACT proposals presume that the Indian partner will carry out production and commercialization. In some cases loans for commercialization will be made by ICICI. ICICI's important role among Indian financial institutions is an advantage to PACT. Similarly, a conflict of interest may arise if ICICI provides loans for product commercialization to PACT grantees. To avoid this potential problem, it will be necessary to exercise great care in future lending decisions to PACT clients.

B. Profitability

At this point, most sub-projects look sound in terms of business plans and technical progress. This assessment is based on the team's review of business plans, examination of eight sub-projects approved as of September 1989, and a cursory review of 10 additional sub-projects.

All sub-projects sponsors submitted business plans for their projects, and these plans projected cost of production, total units sold, gross revenues, royalty fees to PACT and total net income from the product over periods from 5 to 10 years. In all cases the business plans projected significant net income from the products, generally in the 30% to 40% range.

Most sub-projects were progressing in their R&D efforts, and in several cases have begun test marketing new products. Several companies said that they could sell their new products now if they had buyers; these companies included Globe Auto, Pennwalt, and with limitations, Cipla. Ponds India is now able to sell mushrooms to Giorgio from its test facility, but its large scale facility is still 9 to 12 months from beginning commercial production.

Several projects are also facing serious hurdles in attaining their commercialization objectives:

- Pennwalt India has not been successful in applying ultrasonic technology to their oil separation process. Pennwalt also depends on the willingness of an initial buyer to risk investing in a technology that is not well established;
- Pest Control India depends on approval of their integrated pest control technology by state agriculture departments and on the willingness of Fermone Chemical Company to supply them with proprietary technologies;
- Globe has found that production costs for automotive alternators are too high for the market; the company now depends on the sale of PM alternators to the GOI for heavy construction vehicles and to the Indian Railways;
- Indchem depends upon GOI acceptance of their new hardware; profits will depend on the absence of serious competition from other manufacturers;
- Ponds India depends upon production costs of their new facility reaching levels anticipated in the original proposal.

Some of these conditions will be met, while others will not. This sounds simple, but means in practice that it is impossible to predict which sub-projects will be highly profitable and which will never pay a single Rupee back to the PACT fund.

We can say that as of September 1989 not a single sub-project has sold a good or technology developed under a PACT grant, although several can begin to market new products. In all cases reviewed, costs of production and wholesale prices for products developed under sub-projects were not determined. Whether new products can be sold for prices that will cover costs and provide profits to sponsors remains to be seen. Therefore it is too early to determine the profitability of any of the sub-projects.

PROJECTED CASH FLOW FROM DISBURSED PROJECTS

(\$000 @ 16:1)

<u>PROJECT</u>	<u>GRANT</u>	<u>REPAYMENT</u>	<u>1990</u>	<u>1991</u>	<u>1992</u>	<u>1993</u>	<u>1994</u>	<u>1995</u>
Globe/Scott	\$365.5	\$731.0	\$21.9	\$73.1	\$204.7	\$204.7	\$204.7	\$ 21.9
Pennwalt/Pennwalt	120.6	241.3		60.3	60.3	60.3	60.3	
Pest Control/Fermone	216.4	432.8			43.3	77.9	77.9	77.9
Ponds/Giorgi	406.3	812.5	3.2	65.0	105.6	130.0	260.0	248.7
Indchem/Modular	176.0	352.0	56.3	63.4	70.4	77.4	84.5	57.0
CIPLA/Byron	443.8	887.5		71.0	142.0	142.0	142.0	142.0
SPIC/DNA	<u>483.8</u>	<u>967.5</u>	<u> </u>	<u> </u>	<u>188.7</u>	<u>188.7</u>	<u>188.7</u>	<u>188.7</u>
	\$2,212.3	\$4,424.6	\$8.4	\$332.8	\$815.0	\$881.0	\$1,018.1	\$736.0
Less a factor of 25% expected fallout			<u>19.5</u>	<u>83.2</u>	<u>204.0</u>	<u>220.0</u>	<u>254.0</u>	<u>184.0</u>
			<u>\$61.9</u>	<u>\$249.6</u>	<u>\$611.0</u>	<u>\$661.0</u>	<u>\$764.0</u>	<u>\$552.0</u>

C. The Portfolio

1. Funds Disbursement and Royalty Reflows

A basic consideration in the evaluation of a company's cash flow is the total of funds coming in and the total of funds going out. In the case of PACT, ICICI has a known income of \$10 million from USAID. In addition, ICICI has potential income from repayments of conditional grants already extended.

Since most sub-projects involve extended periods of research and development, commercialization (and PACT royalty repayments) is expected to come several years in the future. The team estimates that significant reflows will not be available before 1992. This suggests that ICICI is running out of funds, and, lacking reflows, will not be able to fund future proposals. An analysis of cash outflow reveals that this is somewhat correct, with considerable uncertainty as to rate of disbursement and reflow of royalty payments.

There have been disbursements on 13 sub-projects, varying from 33% to 100% of the committed amounts. Average time from project start until final disbursement is 27 months. Thus the \$2 million in disbursements on approvals of \$6.8 million as of September 20, 1989 are projected to rise to disbursements of \$6.8 million by December 1991. If the same projection is applied to the six new proposals approved but not yet committed as of August 31, 1989, the total disbursed from the PACT fund by December 1991 will be approximately \$7.6 million.

This forecast assumes all sub-projects that have been approved but not committed will come to fruition even though past experience implies there will be drop outs. It is quite likely that because of project cancellations, the total disbursed by 1991 will be less than \$7.0 million unless the rate of project approvals increases dramatically.

Concerning sub-project commitments, as mentioned above, \$6.8 million has been committed as of September 1989, and project managers plan another \$1.5 million in commitments during FY 1990, bringing the total committed to \$8.3 million. The PACT Councils have mandated that approximately \$1.5 million should be held in reserve for project cost overruns, thus the PACT fund will have only \$0.2 million to commit during FY 1991.

Therefore this evaluation projects that PACT funds will be fully committed by early 1991, but at that time there may be \$3.0 million in PACT funds committed but undisbursed. The team's analysis of cash reflows from seven of the most advanced projects

suggests that royalty reflows to the PACT fund will be negligible until the end of FY 1990 (\$62,000 during 1990) and will not reach levels large enough to fund new sub-projects until the end of 1992, when cumulative royalties will be approximately \$920,000. (See Table 1) It is likely that the PACT fund will run out of funds for commitment by the end of FY 1990, and will not have sufficient reflows for reinvestment until mid 1992.

2. Quality

Overall, sub-projects were well selected, involving companies that appear productive, committed to commercial technology development and well-managed. All companies visited (with the exception of ATL) were carrying out research and development on the problem for which they had received the PACT grant.

3. Management

ICICI officers appeared to be very well informed about the status and progress of each sub-project. The three areas where there appeared to be noticeable deficiencies in management of the PACT portfolio were (i) clear definition of the terms of repayment in tripartite agreements, (ii) the completeness and consistency of information in sub-project files, and (iii) the time taken to correspond with companies. (For examples of communications difficulties, see Chapter V., Section D. Prompt Communication.)

After the evaluation team reviewed PACT files, ICICI staff reported that some files were incomplete because records had been removed from files during the evaluation visit to be copied for the August 1989 PACT Council meeting. This may explain the incompleteness of some sub-project files.

4. Payback

It is too early to tell what the rate of payback to the PACT fund will be. Three points are in order here. First, it is the team's impression that PACT fund managers should expect 25% of sub-projects to end without commercialization of technology developed by the project. In some cases the sub-project will not complete the R&D program because of changes in corporate ownership, disagreements among partners, and indications that technical objectives will not be achieved. In other cases it may be determined that a product will not be profitable.

Second, repayments are not expected to be sufficient to fund new sub-projects until the end of FY 1992. This suggests that there will generally be a four- to five-year gap between commitment of funds to a sub-project and royalty reflows from the sub-project.

These findings, however, are only indicative and will need to be revised once the first set of sub-projects begins to pay royalties.

Third, an item that needs clarification is grantees' payback arrangements with ICICI. In several Indian companies, both managing directors and heads of financial operations were unsure of the details of payback arrangements. It was often difficult to determine which revenues are subject to PACT royalty fees, and in a few cases it was difficult to determine what the percentage of royalty fee would be. ICICI personnel had mentioned that many PACT grant recipients were regular bank clients. This does not change the need to have clear agreements on royalties.

5. Project Control

In general, there appeared to be a lack of clear financial records in ICICI files on disbursements, foreign exchange rates governing disbursements, financial status of participants, uses of PACT funds, and arrangements concerning distribution of rights and benefits from intellectual property in sub-projects. It was very difficult to reconstruct case histories of approved grants from the information contained in ICICI's files. (Typical bank audit standards require that loan files be complete and consistent enough for an auditor to construct an accurate history of a banking relationship with a client.)

In addition, there appeared to be no formal arrangements for monitoring product sales associated with a PACT grant. Monitoring sales, with independent verification, will be a key challenge for management of the PACT fund in the near future.

Monitoring efforts by ICICI staff of the progress of each sub-project appeared to be good but systematic monitoring efforts could not be verified from the files. Summary position statements on technical progress, expenditures and disbursements under the grant were not supported by regular ledger or visit reports of technical experts. Nevertheless in interviews, ICICI officers were very well informed.

To illustrate the looseness of disbursement monitoring by ICICI a specific example is taken from the Globe Auto/Scott Motors file. On 7/15/89 a report from Scott showed that Scott had expended \$260,000 to date and expected to spend an additional \$258,000 to complete the project. As of that date Scott had received \$153,000 from PACT of their previously spent \$260,000. A 7/26/89 report in the file shows Scott had spent \$400,000 to 6/30/89 and expected to spend an additional \$120,000 by 9/30/89, therefore they were due \$260,000 in total from PACT. Based upon the letter of expected expenditures, Scott was authorized \$100,000.

(As of 8/31/89 Scott had not received the funds.)

That transaction represented prepayment of funds based only on a letter of request from Scott; no additional documentation was required by ICICI to verify expenditures to date. The file contained no explanation of the differing amounts reportedly spent by Scott. Examples like this suggest that more careful documentation of expenditures by ICICI may be necessary.

D. Technical Transfer and Intellectual Property

1. Technical Collaboration

PACT was modelled after the BIRD (Binational R&D) Foundation in Israel, as was the FACET program (French-American Cooperation for Entrepreneurship and Technology). A number of general conclusions came to light that bear comparison of PACT with BIRD and FACET. First, partner selection is a critical element in the technology development process. BIRD participants observed that the synergy of the two companies can make or break the relationship. This was also true for PACT. In several instances, one of the partner companies was sold or changed management, with the result that support for the PACT project was weakened. Concerning compatibility for technical collaboration, the project screening process seems to be working because there was no evidence that projects have been or will be abandoned because of technical failure.

One Indian executive mentioned, and this has been said for BIRD and FACET as well, that collaboration must be of mutual benefit to both partners. If one partner stands to profit considerably less than, or at the expense of the other, project success is threatened. Partners must be prepared for long-term collaboration; in cases where the project leads to joint commercialization, the process might take as long as five to ten years from conception to completion.

Technical Support for Sub-Projects

An important reason for success of the BIRD Foundation, which has close to 200 joint projects, was that partners received continuous technical support. It was observed that representatives of only a few PACT companies requested technical support from PACT in their R&D effort. However, many partners seriously need advice and assistance in the development of sound agreements concerning intellectual property. In the cases examined, support could come from outside consultants, Battelle, or ICICI, but the need for ongoing assistance was expressed in several interviews. (ANVAR, the national R&D agency which manages the FACET program in France,

deals with this need by paying for one-half of the consultant costs for companies involved in the program.)

In both the BIRD and FACET programs, there is a wide range of relationships among partners. This is also true for PACT:

- One company may play the major R&D role while the partner focuses on marketing or commercialization.
- In several cases the U.S. partner plays an advisory role, or that of a contract researcher.
- Several projects have formed joint venture corporations;
- In one case the Indian firm was a subsidiary of the U.S. firm.

Such flexibility in the portfolio is true in the Israeli and French programs, and is an important requirement for success.

2. Intellectual Property Agreements

Several PACT sub-projects were based on the transfer of valuable intellectual property from the American to the Indian company. Arrangements for transfer included licensing, establishment of joint venture companies that would own rights to the property, training of Indian scientists in the U.S., and transfer of designs and formulations without any formal legal agreements.

Legal arrangements between partners for ownership and disposition of intellectual property in many sub-projects did not exist. In others, vague references to the issue in cooperation agreements did not cover issues normally arising from joint R&D. Several companies had legally binding technical cooperation agreements or MOUs; most did not.

There were several examples where the American partner considered the benefits of participating in the project to be too small to warrant active involvement in the sub-project. In the Pest Control India/Fermone Chemicals case, Fermone was required to transfer two of their most valuable corporate assets to PCI, pheromone production techniques and controlled release formulations. However, Fermone had neither adequate legal protection of their properties nor clear agreement on how they would obtain benefits from the transfer of technology.

In the SPIC Science Foundation/DNA Plant Technology case, DNA

Plant Technology was expected to provide two critical intellectual properties to SPIC, their spin-filter bioreactor and video sorting software, and they did not have a firm agreement on how they would share benefits derived by SSF from the transfer. Representatives of DNA Plant Technologies stated that they were not certain what financial benefits they would derive from the project.

Existing U.S. and Indian laws in no way prevent PACT joint ventures from reaching mutually beneficial agreements concerning intellectual property and commercialization of products. PACT grantees entered into their agreements with the opportunity to divide benefits any way that was acceptable, and partners do have the power to modify their agreements under existing U.S. and Indian laws. Nevertheless, it was also true that in some cases decisions made by individual companies may have resulted in inadequate agreements governing future benefits arising from the sub-projects. This weakness should be noted as a possible constraint to the success of sub-projects in the future.

The team suggested to several companies that distribution of rights should be clarified before commercialization. ICICI or Battelle should address this issue at the beginning of each sub-project. Agreement on how proprietary technology will be transferred or shared should be part of a proposal and an annex to the ICICI agreement. In several cases (e.g., Fermone Chemicals, CIMFLEX), sub-projects were delayed because this had not been resolved.

Battelle and ICICI should also take steps to ensure that PACT-funded companies have adequate intellectual property protection. This is especially true in a program with the imprimatur of the U.S. Government, in which smaller companies may think such contingencies are taken care of by the program. It is particularly true given the differences in coverage of intellectual property under U.S. and Indian law.

Should a dispute over intellectual property rights arise between a U.S. and Indian partner, this situation may be aggravated by the fact that, in the ICICI agreement, the Indian bank reserves for itself the right to commercialize products or processes which the partner companies do not elect to commercialize. The U.S. side has no such provision.

Difficulties affecting returns to PACT could also arise from the export of technologies subject to U.S. Government export controls. U.S. companies are responsible for adhering to U.S. export control laws. Under the ICICI agreement, each company must comply with the applicable laws of its own country. However, several Indian companies mentioned their intention to market

technologies developed through PACT to Eastern European countries (e.g., Globe, INDCHEM, Cipla). It was not clear whether the U.S. partner was aware of this intent or whether it was a cause for concern.

The evaluators heard conflicting reports from companies on the issue of intellectual property protection, depending on the companies' self-interests. One Indian firm whose R&D ratio to sales was ten percent wanted better protection for its innovations. A pharmaceutical company whose products are based on drugs under U.S. patents did not agree that extensive intellectual property protection is a sine qua non for development of privately-funded R&D. Overall, intellectual property laws were not viewed generally as a constraint to implementation of PACT sub-projects.

3. Role of the Indian Government in Commercialization

The key role played by the Indian Government was apparent in most cases. If not part owner of a PACT-funded company, the GOI required product approval, testing or trials, imposed regulations on import of necessary equipment, or was a potential purchaser of the products. For example, the Indian national railway is projected to be the main market for Globe-Scott alternators. In several cases (INDCHEM, Globe, SPIC and Pest Control India) company representatives stated that government actions (approval, subsidies, or purchases) will be the key determining factor in the projects profitability.

VI. BENEFITS TO INDIAN AND U.S. COMPANIES

Because PACT sub-projects have not yet commercialized new technologies, PACT has not yet demonstrated that commercial R&D is profitable, and R&D capacity in India has grown only marginally. Nevertheless, future benefits of PACT may include access to new technologies by Indian companies, sourcing of cheaper components and raw materials by both U.S. and Indian companies, and access to new markets and skilled technical labor that is either scarce or expensive locally.

Regarding improved R&D capabilities, several sub-projects have helped private companies to build R&D management skills through collaboration with foreign partners. There is little doubt that the opportunity to conduct commercially-oriented R&D with PACT support has provided private companies in India with valuable experience in bringing new technologies to market.

In many cases the lion's share of potential profits from commercialization will accrue to the Indian partner. In several cases, the American partner stated that they did not expect significant returns from the project or that they did not know how they would benefit from their investment. In contrast, in several cases (SPIC Science Foundation and Pest Control India) the Indian firm was in a position to obtain valuable intellectual properties from an American company with no accompanying rights to benefits from the property going to the American partner. It is unlikely that American companies will continue to contribute substantially to PACT-funded sub-projects if they do not derive fair benefits from their participation.

Improved Understanding of the Indian Business Environment

There is no doubt that PACT has increased the business activity of U.S. firms in India. Three out of eight sub-projects examined in depth indicated that the U.S. company had done little or no business with India before the PACT Project. Two companies previously doing business in India (Scott Motors and Modular Semiconductors), increased their level of market-oriented joint R&D significantly because of participation in PACT.

All U.S. company representatives interviewed stated that participation in joint R&D has helped them understand how to do business in India. Specific comments on their experiences include:

- Access to engineers, computer software designers and laboratory technicians who work for cheaper rates is a major incentive to Indo-U.S. collaboration;

- U.S. company officers mentioned that the quality of highly skilled technical labor has been excellent in the Giorgio/Ponds and Globe/Scott sub-projects;
- Unskilled labor is cheaper than in most other Asian countries;
- Communication with India remains an impediment to business (several U.S. companies mentioned this);
- Management of Indian technical labor has required more time and resources than was originally anticipated and has raised the costs of joint R&D;
- The import of R&D related equipment has been slow and more costly than expected in several projects, including SPIC Science/DNA Plant Technology, Biocon India/Biocon U.S. Pest Control/Fermone Chemicals and Indchem Electronics/Modular Semiconductors.

Changes in R&D Plans by Indian Companies as a result of PACT

No companies stated that they had decided to carry out additional R&D because of their experience under PACT. Most Indian company representatives interviewed stated that they would wait until they were making products developed under PACT before they would conclude plans for additional collaborative R&D.

The most important factor causing increases in R&D capacity in Indian firms will be demonstration of the profitability of commercially-oriented R&D. Companies that obtain substantial profits as a result of R&D investments will no doubt continue to build their R&D capacity.

In several cases participation in PACT has strengthened the Indian partner's capacity to conduct market-oriented R&D. For example, Pennwalt India was building a new R&D facility at the same time they were completing work on their PACT-supported rice bran dewaxing process. Pennwalt staff mentioned that they would have conducted commercially-oriented R&D without the PACT grant, but that PACT allowed them to expand the scale and sophistication of their R&D division. The Ponds/Giorgio sub-project allowed Ponds India to set up a completely new R&D program for mushroom growing that employs over six scientists and technicians.

VII. MANAGEMENT ISSUES AND CONSTRAINTS

A. Terms of ICICI Agreements

There is a pressing need to define the terms of project agreements more clearly. Improvements are required in four areas:

- i. Definition of the term "innovation";
- ii. Specification of what revenues will be subject to royalties;
- iii. Clarification of the royalty charges in the event of transfer of lease or license transfers of intellectual property produced by PACT-supported R&D;
- iv. Clarification of the distribution of grant repayment obligations when both partners receive grant funds but one receives disproportional benefits from commercialization (see the SPIC Science Foundation case).

All royalty repayments are based on the term "innovation." Sales of products that incorporate the "innovation" are subject to royalties, but in no case was the innovation specifically defined. In all cases, "innovation" was defined by reference to the entire PACT sub-project proposal which never explicitly defined the term.

For example, Indchem claims that they will pay royalties only on the chip developed by the project. They do not intend to pay royalties on sales of boards or terminals that use the chip even though it appears that PACT funds were used to produce more than just the chip. (In fact the chip was designed by Modular Semiconductors in the U.S.)

In the Pennwalt case, it is unclear now if Pennwalt will be required to pay royalties on sales of dewaxing plants if the plants do not incorporate ultrasound technologies, or if a dewaxing plant is used to dewax another type of edible oil (with or without using ultrasonics).

There are numerous other possible problems associated with the unclear definition of innovation in ICICI agreements. Given these potential threats to PACT repayments, the fund will depend heavily on the goodwill and honest behavior of grant recipients.

In many cases it was unclear which revenues will be subject to PACT royalties. In the SPIC Science Foundation (SSF) case, the foundation maintains that the company that licenses technology produced by sub-project must pay a royalty on sales of seedlings, but that SSF does not need to pay a royalty on its licensing fees.

DNA Plant Technology Corp. transferred its bioreactor technology and video sorting software to the sub-project to be incorporated into the new seedling production process. SSF will license the new process to a third company that will produce seedlings for commercial sale. DNA Corp has received \$240,000 of the \$500,000 PACT grant. It is unclear whether DNA Corp. will be required to pay PACT royalty fees on their licencing fees, and if they are, then what proportion of their licencing fee must be paid to the PACT fund. DNA Corp.'s repayment obligations are not defined in the agreement. It should be noted that if DNA Corp. is responsible for repayment of the entire \$240,000, and if repayment is based on DNA Corp.'s licencing fees, then it will take many years, if not decades, to repay the PACT fund.

Cases like these show that it is essential for PACT management to develop a clear policy on royalty obligations when intellectual property is transferred as part of the commercialization process.

Finally, in several cases senior management of PACT companies did not know what the specific royalty fees were. In other cases, the understanding of management concerning PACT fees was different from requirements in the ICICI agreement. In several cases, the evaluation team was told that royalty fees were negotiable, and would be fixed depending on the profitability of the project. In one ICICI agreement the royalty fee is to be based on "net sales" rather than the usual "gross sales", but the term net sales was not defined in the agreement. There is a pressing need to clarify the repayment obligations of PACT fund recipients.

B. Need for Additional Funds

Under terms of the agreements a proposer may draw up to 50% of a conditional grant upon signing the ICICI agreement and commitment of PACT funds. The following cash flow forecast therefore assumes that a minimum of 50% of commitments have been disbursed. Thus commitments will never be more than twice the amount of disbursements. Viewed this way, by the end of FY 1991 the PACT fund will be fully disbursed.

Repayments will be nominal until the end of FY 1992. Therefore near the end of FY 1991 would be the proper time to evaluate whether the program is on track in reaching the PACT's payback objectives. At that time the disbursed projects will have matured to the point of commercialization or failure, and a better analysis will be possible.

If PACT sub-projects have not begun to repay substantial royalties by 1991, then there will be serious reason to reconsider the assumption that R&D expenditures are a sound investment. PACT

royalty repayments are in this sense an excellent proxy variable to test this critical project assumption, because royalty payments indicate sales, and sales in turn indicate (in a rough way) profits.

C. Intellectual Property Protection and Distribution of Benefits

As mentioned above, there is a pressing need to improve the agreements in the area of intellectual property rights. In cases where substantial intellectual properties are transferred from one partner to another under the PACT project, there should be sound, legally binding agreements drawn up to govern these transfers.

The basis of corporate participation in PACT is the opportunity to earn profits. Nevertheless, in several instances the American partners said that they did not know how they would receive the benefits from their participation. It should be made clear to all participants that the PACT Project seeks to help businesses in their pursuit of profits.

D. Prompt Communication

Most company representatives interviewed stated that ICICI's assistance has been helpful. Nevertheless, most respondents also said that they have had difficulties in communicating, both with ICICI and with their foreign partner.¹ In the case of ICICI, the

¹ Examples of Communication Problems with ICICI

1. American Hytech submitted a proposal to the PACT Board, the project was approved in July 1988 and it was cancelled on August 11, 1989. Representatives of American Hytech report that they were never informed that their project had been approved, and that they have waited for six months and have received no notice of their project status from ICICI. ICICI reported in September 1989 that they had asked Battelle to inform American Hytech that their project had been cancelled.
2. Modular Semiconductors sent an invoice to ICICI on July 17th, 1989, and had not received a response from ICICI as of mid-September 1989. They claim that they have completed 60% to 70% of the work under the project but received no funds from ICICI.
3. The ATL India project was approved in February 1988 and decommitted in August 1989. Representatives of ATL India

problem seems to be delays in informing participants about payments, the status of the sub-projects and other administrative matters. Numerous examples were given in which a company had to wait six months or more to hear about the status of their sub-project or about a particular payment. In one instance, a

stated that ATL was never informed by PACT that their project had been formally approved, but they had heard from ICICI's Mr. Shedde over the phone that they had been "approved in principle." As of mid-September 1989, ATL U.S. had not been informed that their project had been cancelled.

4. The project proposal submitted by SPIC Science Foundation (SSF) and DNA Plant Technologies Corp. (DNAP) was sanctioned by PACT in December 1988. As of mid September 1989 SSF had received a disbursement under the project of Rs. 1,500,000, but they had not been sent a copy of the agreement that they had signed and submitted to ICICI. As of the same time, DNAP reported that they had not received a dispersal under the project.

On September 13, 1989, SSF sent a letter to ICICI stating that DNAP had not received their disbursement under the project, and that neither company had received a copy of the agreement signed by ICICI. DNAP's Robert Whittaker reported that DNAP had begun implementation of the project in early 1989 after they were informed of the project's approval and that as of late August 1989 they had completed a substantial portion of their work under the project. At that time they had not received any payment under the project, and that they had not been sent a copy of the signed agreement.

5. Frank Martin of Laser Engineering reported that communication with ICICI has been slow. ICICI has been slow in processing documents, and Laser Engineering has had difficulties in reaching ICICI by phone and fax.
6. Representatives of Pennwalt India reported that they were never given an opportunity to read the results of their technical progress review, or to respond to the findings of that review.
7. David Paulson of Osmonics, Inc. reported that they had a delay of over one month in receiving funds from ICICI.
8. Research Engineers representatives reported that communication with both ICICI and with their Indian partner has been slow.

technical review visit was made to a company without the company being informed that the purpose of the PACT representative's visit was technical review. After the visit the representative wrote a strongly critical report, but the company, Pennwalt India, was never informed of the results of the review.

In so far as PACT seeks to serve businesses, there needs to be more attention to prompt responses to client problems. It is often very costly for a company to have staff assigned to a project and have delayed payments or approvals. For private businesses, every moment spent waiting is costly.

Another common complaint of American companies was that it was difficult to communicate with companies in India. There may be something that ICICI or Battelle can do to improve the speed of communication, for example, set up a facsimile service that has a line to India that is more reliable than the existing systems.

E. Progress Review

ICICI now relies on reports coming directly from the companies for information on technical progress and sales. As companies begin to sell PACT-funded products, it will be necessary to obtain more objective information on sales. Sales data should be independently verified to ensure that PACT companies properly report their revenues.

VIII. KEY RECOMMENDATIONS

A. Improve Legal Agreements Between Partners for Profits and Intellectual Property

Agencies implementing the PACT Project should encourage partners to conclude legal arrangements for fair distribution of benefits derived from commercialization of new products or processes at the outset of a sub-project. This recommendation has implications for several aspects of the joint ventures. First, joint venture partners should be encouraged to establish legally binding agreements governing distribution of revenues and/or profits derived from sales of the new product or process. Second, partners should also be encouraged to establish legally binding agreements concerning intellectual property resulting from the R&D projects. Third, legally binding agreements should be reached concerning intellectual property provided to the project by either partner.

These legal agreements are the basis for fair treatment of both joint venture partners and the PACT fund, and should be established as a precondition to a PACT sub-project agreement. Failure to establish appropriate legal agreements for these three aspects of the sub-projects may lead to future legal disputes and reduction in the royalty reflows to PACT.

B. Improve Terms in ICICI Agreements Concerning Innovation, Revenues Subject to PACT Royalty Fees and Royalty Fees in Cases of Intellectual Property Transfer.

Several terms in the ICICI sub-project agreements need to be more clearly and fully specified. These include definition of "innovation" produced by a sub-project; clearer specification of the revenues that will be subject to PACT royalty fees; and clarification of the percentage of royalty fees that will be charged in the event of transfer of intellectual property by license agreement. (See the SPIC Science Foundation for an example of the problem.)

Reflows to the PACT fund may become subject to serious reductions and legal disputes if these terms are not more carefully specified.

C. File Management

The current ICICI sub-project filing system needs to be improved in the following areas:

- Information on grant disbursement, technical progress, revenues and royalty payments should be consistent across all sub-projects, and should be presented in a single summative account record.

- Documentation of expenditures and revenues should be presented to verify R&D expenditures and sales of goods produced as a result of the sub-projects.
- The financial condition of grant recipients should be monitored on a periodic basis to ensure that the firms are in a condition to continue the project in the near future.
- Sales of products or processes resulting from PACT-funded R&D should be monitored and audited regularly, with appropriate verification presented in the sub-project files.

D. The Need for Additional PACT Funds

Based on the analysis of PACT fund cash flows in section V.C.1., it appears that ICICI will not have funds for new projects from the end of FY 1990 until sufficient reflows become available in early FY 1992. One point of view would suggest that the PACT fund should receive additional funds to tide it through the dry period from the end of FY 1990 to early FY 1992.

Another view would suggest that USAID should wait until it has clear evidence that some sub-projects are succeeding (i.e., beginning to sell new products and processes) before additional funds are committed to PACT. The logic here is that if PACT sub-projects are not succeeding, then it is not worthwhile committing additional resources to the project.

After weighing these two extreme views, however, the evaluation team suggests that a compromise position be taken. If additional funds are available, USAID should provide the minimum amount needed to allow new project approvals to continue from the end of FY 1990 until the beginning of FY 1992. For example, if an additional \$1.6 million is provided, then the PACT fund can approve of four new projects during that year, with an average grant per project of \$400,000. This option would provide sufficient funds to continue reviewing and approving sub-projects, while minimizing additional losses if it appears that PACT sub-projects are not leading to commercial sales.

E. Improve Communication

Steps should be taken to improve communication between ICICI and PACT partners. The cases provide numerous examples of slow communication on the part of ICICI, falling into three categories: (i) informing partners of the status of their PACT proposals; (ii) responding to inquiries concerning the status of reimbursements and payments under the PACT grants; and (iii) communication concerning technical progress of a sub-project.

Because waiting and uncertainty impose real costs on private firms, it is important that ICICI be encouraged to communicate with applicants and grantees as quickly as possible and to set limits on the maximum time allowable for responses.

ICICI may also wish to consider providing assistance to grantees in establishing adequate arrangements for communication between the partners. Numerous U.S. companies mentioned that communication with their Indian partners was difficult and slow. ICICI may be able to provide at the least advice and possibly some assistance to solve these communication difficulties.

F. Clarify the role of Battelle in the PACT Project.

There is a need to establish the limitations of Battelle's role in technical oversight of projects, and to establish a formal protocol for technical progress reviews. Technical progress review should include an opportunity for the participant companies to respond to review findings. In addition, companies should not be required to provide PACT representatives with proprietary information unless proper arrangements are made to protect this information.

G. Policy Dialogue on Foreign Investment Regulations.

In some industries, India's foreign investment laws make it impossible for U.S. companies to hold equity positions that are sufficient to ensure technical control of dangerous technical processes and substances. This is a particular problem for industries that use or produce hazardous materials such as pesticides, pharmaceuticals and industrial chemicals. Some "high tech" companies will not be willing to collaborate on R&D projects leading to commercialization of processes that involve hazardous materials. It may be worthwhile to include this issue in policy dialogue between the GOI and private sector interest groups.

H. Policy Dialogue on Research Equipment Import Regulations.

Several companies mentioned that customs delays and import duties levied on research supplies and equipment have added significant costs to conducting commercial R&D in India. It may be worthwhile to encourage ICICI, local chambers of commerce and other associations of high tech businesses to engage the GOI in dialogue on regulations of research related supplies and equipment.

ANNEX 1: DATA COLLECTION GUIDE

Cases of PACT Grants:

1. Company Names

Indian:

American:

2. Project Title

3. Date Sanctioned:

4. Total Budget:

PACT Grant:

5. Disbursements to August 3, 1989:

6. Background and Progress

7. Profitability

8. Technical Transfer and Protection

9. Change in R&D Capability & Other Benefits to Indian Partner

10. Benefits to the U.S. Partner

**ANNEX 2: LIST OF SITE VISITS FOR THE
PACT PROJECT PHASE II EVALUATION**

<u>Company & Location</u>	<u>Team Member</u>
Scott Motors Alamogordo, New Mexico	M. Claeys
Sharples, Inc. Warminster, PA	M. Claeys, A. Eisendrath
Giorgio Foods Inc. Temple, PA	M. Claeys, A. Eisendrath
Globe Auto Ltd. Bombay	M. Claeys, A. Eisendrath, S. Lipsky
Cipla Ltd. Bombay	M. Claeys, A. Eisendrath, S. Lipsky
Pennwalt Corp. Bombay	M. Claeys, A. Eisendrath, S. Lipsky
Pest Control India Pvt. Ltd. Bombay	M. Claeys, A. Eisendrath, S. Lipsky
Ponds India, Ltd. Ooty, Tamil Nadu	M. Claeys, A. Eisendrath, S. Lipsky
Indchem Electronics and ATL India, Ltd. Madras	M. Claeys, A. Eisendrath, S. Lipsky
Spic Science Foundation Madras	M. Claeys, A. Eisendrath, S. Lipsky