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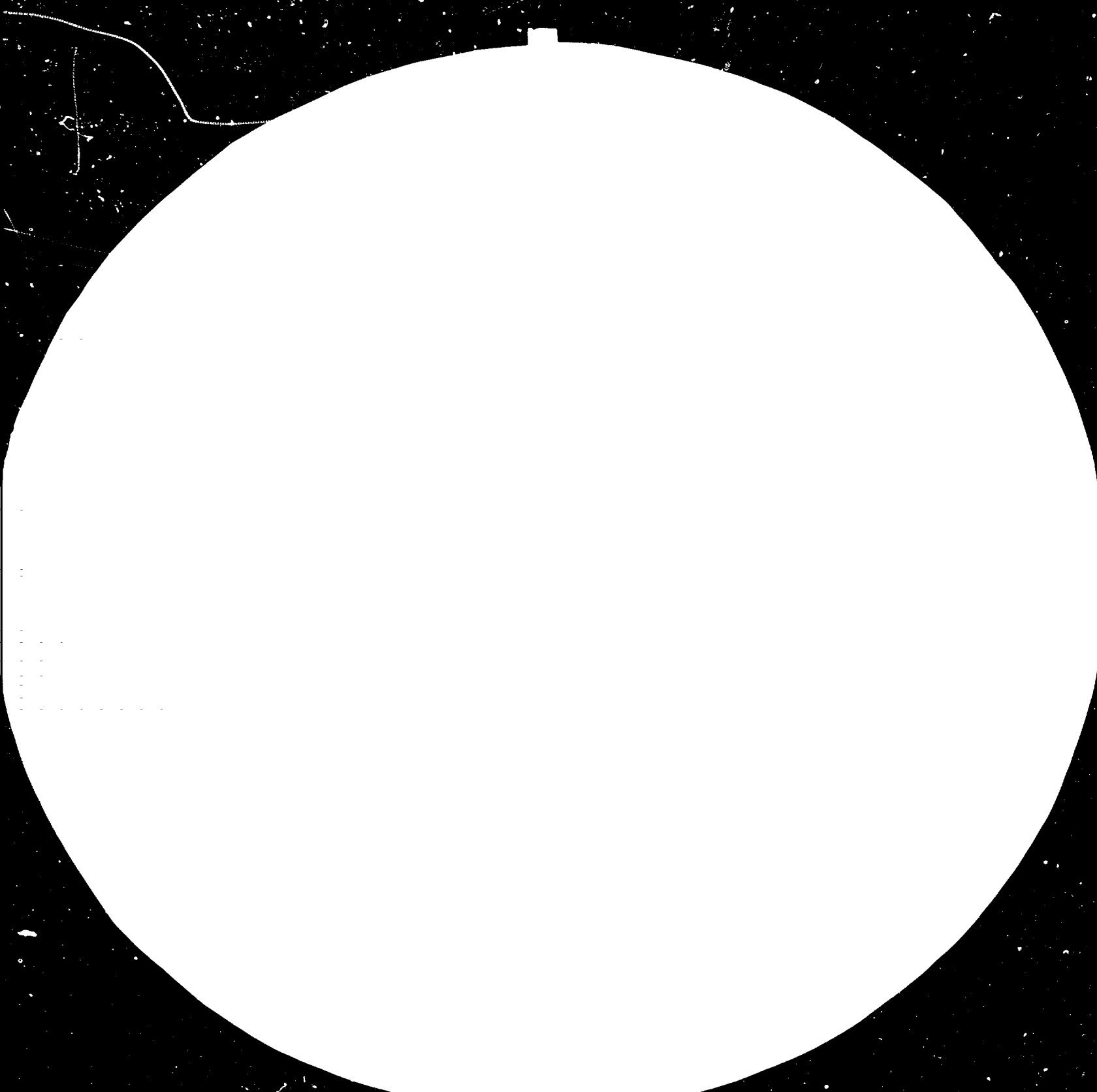

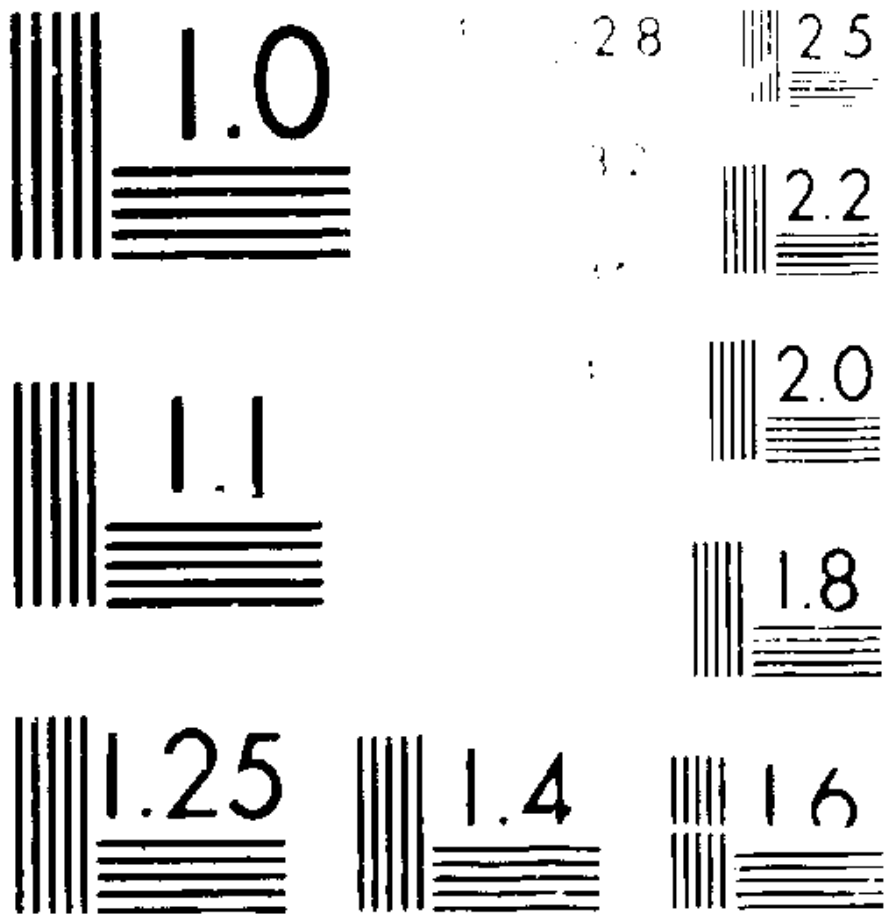
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TROPICAL TECHNOLOGY: THE PROBLEM AND SOME SOLUTIONS*

A summary of the activities of the Institute for Tropical Technology in Viet Nam

Based on the work of L. S. Bloch, UNIDO Consultant

818

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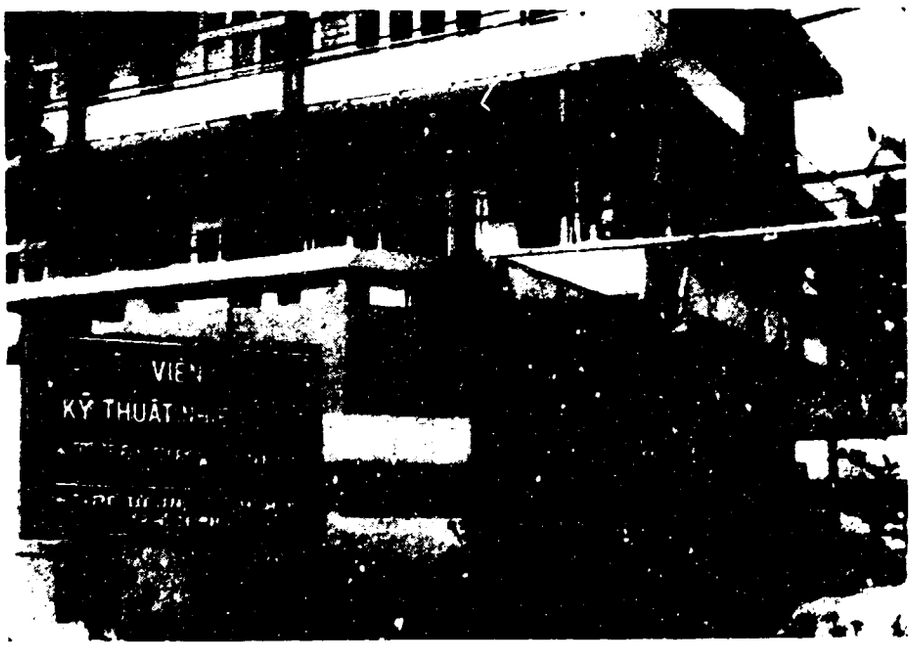
INTRODUCTION

On October 13, 1977, the General Assembly of the United Nations adopted a resolution calling for world assistance with the reconstruction of Vietnam. At that time, Vietnam was included among those nations in the world listed by the UN as suffering acutely from the myriad of problems inherent in the development process. Today, there are 12 approved and/or operational technical co-operation projects executed by UNIDO in Vietnam, ranging from the production of baker's yeast in the North to assistance for textile factories in the South. One of these projects involves assistance to the Institute for Tropical Technology (ITTV), which has its main operation in Hanoi and a branch in Ho Chi Minh City. The work of the ITTV and its accomplishments in the field of tropical technology have been significant and hold certain promise for the future, not only for Vietnam but also for other developing countries with similar problems.



INSTITUTE FOR TROPICAL TECHNOLOGY, VIETNAM

BACKGROUND

Vietnam is a country whose climate is greatly influenced by its geographical location in the tropical zone, as well as its extremely long coastline. Much of the country, moreover, has year-round high temperatures and constant high humidity. These combine to produce important and devastating effects onthe industrialization and economic development of the country. It has long been known that the primary causes of corrosion and deterioration of everything from ships in the harbours to microscopes in the laboratories are related to climatic factors, and in Vietnam these play a key role. Basic data on the actual extent of the problems of rust and corrosion and of annual losses attributed to equipment failure due to climatic factors are not available. However, it is estimated that direct losses of around 250 million Dongs (US$ 25 million) are suffered annually and that thousands of man hours must be spent in trying to repair the damage done to equipment by the severe climatic conditions in the country. Indirect losses are incalculable.

CLIMATIC MAP OF VIETNAM

Among the unfavourable climatic conditions that have a distinct effect on the life of equipment in the tropics are: air temperature; water in the atmosphere; sea salt; dust and sand combined with humidity; such atmospheric impurities as ash, ozone, nitrates and smoke; and solar radiation, both ultraviolet and infra-red. These often result in damage, for example, to the surface of insulating materials for electrical equipment, affecting dielectric strength and contributing to the ionization process. It is estimated, for instance, that only 25 percent of the small appliances imported into South Vietnam function properly because of corrosion of sensitive connections. In tropical countries also, biological factors such as moulds, bacteria, insects and other animals and plants work with the climate to produce microbial corrosion of organic materials as well as insulating materials. Even glass can be penetrated by mould, which, for example can destroy the precision of an opthamalogical instrument.

Vietnam is in the unfortunate position of having to import most of its products from abroad; and experience has shown that few, if any of the imported goods are so-called "tropic-proof". Enormous problems have arisen because of this. Steel plates on ships corrode within one year; small rotary motors often break down within a few months; electrical insulation deteriorates rapidly and causes power failures; the plastic sandals worn by the people last only a few months and then become too stiff to wear, or simply fall apart; radios and television sets often must be repaired even before they have been used. For example, it is estimated that 30 percent of the television sets imported from one country by Vietnam are already damaged by climatic conditions when they arrive; and then further deterioration occurs in the inadequate storage facilities, expecially at the ports.

These problems are compounded by the fact that Vietnam does not have sufficient foreign exchange to purchase what it requires from international suppliers. Having made the large initial investment to purchase an expensive piece of equipment, Vietnam is often not able then to buy spare parts. This, in turn, makes the maintenance and repair of imported goods virtually impossible. Moreover, a lack of sufficiently trained manpower is another serious drawback. Although the Vietnamese are highly skilled and adept technicians, their knowledge of imported products is often inadequate. As a result, when new

equipment arrives in a damaged condition, it must remain unused either because of lack of spare parts or of sufficient knowledge concerning its repair. Within a short period of time, the equipment is usually further damaged by climatic conditions; and the vicious cycle continues.

Attempts to find viable solutions to this untenable situation have been underway for a number of years. A pioneer in the field has been the Institute of Tropical Technology (ITTV) in Hanoi and Ho Chi Minh City. Located on the outskirts of Hanoi and situated with the National Centre for Scientific Research in Vietnam, the ITTV's main branch consists of 135 persons working within five laboratories and a pilot plant in 3,000 square metres of space. It is administered by the State Committee for Science and Technology, an advisory committee of which meets regularly with the ITTV staff and regulates its activities. The Ho Chi Minh City branch contains five laboratories and one pilot plant for producing on a small scale the products developed by the laboratories. Sixty scientists and engineers are engaged in the ITTV in the South, and they work in buildings containing 2,500 square metres of space.

THE ESTABLISHMENT OF THE UNIDO/ITTV PROJECT

The Government of Vietnam requested assistance from UNIDO to provide technical advice and equipment to the ITTV in order to strengthen its capacity for solving the growing problems of loss and waste caused by climatic conditions on technical equipment. The Government was concerned with not only the maintenance and repair of imported equipment but also with the question of how best to develop indigenous resources for the manufacture of domestic equipment which would be able to withstand the rigours of the climate. Thus, in 1978 discussions began among the Government of Vietnam, UNIDO and UNDP. These discussions led to the development of a project to provide assistance to the ITTV, preceeded first by a mission of UN experts to make recommendations regarding the basic objectives for the formulation of the project. In 1979, a mission of three experts visited Vietnam and made the following recommendations:

Primary Objectives

1. To provide assistance and consultation to the Institute in establishing links with industries and with other institutes in order to avoid duplication of effort.

2. To aid the Institute in establishing training programmes for tropical technology for managers and technical personnel within industries.

3. To assist in compiling, translating, testing and disseminating standard information in an easily understandable form for those in the industrial community who use the data.

4. To help the Institute in the establishment of an industrial advisory service designed to help identify and solve their own problems.

5. To promote the establishment of policies and procedures related to the designing, testing, inspection, installation, procurement, maintenance and protection of technical equipment.

6. To supply expert advice related to Objectives 1-5.

7. To organize and arrange training programmes for the ITTV technical staff abroad.

8. To procure and install new technical equipment for use in the laboratories of the ITTV.

Secondary Objectives

1. To establish a clearing house of information on tropical technology.

2. To develop within the Institute the capacity to

   (a) evaluate new products technically and economically; and

   (b) provide quality control audits of domestic products from the point of view of their suitability to tropical conditions.

Tertiary Objectives

1. To explore possibilities for using indigenous materials for domestically producing "tropic-proof" products.

2. To collect and analyze data on the impact of the environment in various areas of the country.

PROJECT IMPLEMENTATION

In December of 1980, the actual field work for the project began, and it ended in mid-1983. Altogether, the total amount allocated for assistance to the Institute was US$ 1,191,432 and Vietnamese Dongs 16,500,000. Purchases of approximately 180 pieces of equipment for the laboratories amounted to US$ 830,000; and US$ 160,000 was spent on training programmes for ITTV staff members to be trained abroad for short periods of time, usually two months. The remaining funds were allocated for administrative expenses, expert consultations, travel and miscellaneous costs.

PHYSICAL CAPACITY OF ITTV

The Institute for Tropical Technology in Hanoi is situated within the National Research Centre for Vietnam. It consists of five laboratories, one nature station and one special laboratory for pilot production. The branch in Ho Chi Minh City is located within its own buildings, occupying more than 2,500 square metres of space and also contains five laboratories and a pilot production plant. Altogether then, there are 10 laboratories, approximately 7,000 square metres of space, and around 200 professionals engaged in work related to tropical technology.

NB: The term Institute or ITTV will be used throughout; and it includes the Hanoi and Ho Chi Minh City branches, encompassing altogether 10 laboratories and two pilot plants for small-scale production of products that have been developed within Institute laboratories.

Work within the laboratories is divided into five categories:

Laboratory One - Electrochemical and Corrosion Testing and Metal Protection

Laboratory Two - Physical and Physiochemical Testing of Non-metallic Materials and Improving their Resistance to Tropical Climates

Laboratory Three - Development of New Technical Materials

Laboratory Four - Tropic-Proofing of Electronic Equipment and Environmental Testing

Laboratory Five - Tropic-Proofing of Electronic Components and Equipment

In addition to the laboratories, there are pilot production plants in both Hanoi and Ho Chi Minh City, where the new products that have been developed in the laboratories are produced on a small scale and provided to industries for their use. Also, 15 atmospherical stations in Vietnam carry out various environmental tests under natural conditions.

There is a three-way exchange between the laboratories of the Institute with industries and universities. One of the basic aims of the project is to provide industries with advice and technology based upon the findings of the laboratories. At the same time, research and training are provided within the laboratories for faculties and students involved in the field of tropical technology.

ACCOMPLISHMENTS

In accordance with the terms of the project contract, the ITTV organized its work within its laboratories. The Chief Technical Adviser from UNIDO was in Vietnam for approximately 18 months during the 2 1/2 year period. Each laboratory performed specific tasks and worked in close co-operation with industries as well as with universities and other institutes in order to develop expertise in a number of areas. The activities of each laboratory are detailed below.

Accomplishments of Laboratory One

INVESTIGATING THE CORROSION PROCESS

Work within this laboratory is concentrated on the problems of metal corrosion. Included in its wide-ranging interests and responsibilities are:

- defining and translating international standards and recommendations for corrosion testing;
- determining aggresive components in the atmosphere in industrial areas of Vietnam (SO_2 NO_2 NH_3 Cl etc.);
- ascertaining the quantity and distribution of sea salt contamination along the sea coast;
- measuring corrosion rates of different metals in the atmosphere and sea water in different areas of the country;
- selecting the most effective protective coatings for steel and other metals used by various industries;

- drawing up of guidelines of general instruction for choosing tropic-resistant metal coatings for industries;

- inspecting, on a regular basis, the damage and losses caused by corrosion in industrial plants and proposing measures to avoid them in the future; and

- consulting with industries regarding the selection of the most suitable materials for their purposes and recommending protective methods to ensure their resistance to environmental dangers.

Under the terms of the project, Laboratory One received a number of new pieces of equipment to perform its tasks, including a salt spray chamber, the WENKING potentiostat, which determines the electrochemical properties of metals. Two UNIDO fellowships were given to members of the laboratory staff to spend two months at the Department of Inorganic Chemistry of the Chalmers University of Technology in Gothenburg, Sweden. There they had practical experience in the use of such equipment, carried out studies and performed research on atmospheric corrosion under controlled conditions.

During the contract period, Laboratory One conducted various experiments in an effort to discover the most effective and economical methods for producing protective coating for steel plate that will hold up under tropical conditions. It found that an optimal thickness and minimal thinness of 24 microns, consisting of layers of copper, nickel and chrome, with 7, 14 and 3 microns respectively, will protect steel plates from atmospheric corrosion in the tropics.

In another series of experiments, the scientists and engineers of Laboratory One developed a nitrate oil that has proven five to ten times more effective in prolonging the life of steel equipment and machine components. The process is now being used by the General Storage House Number 2 of the Coal and Mining Industry.

Another new method for protecting steel laminations used in electric motors, which were known to corrode within 24 hours during the manufacturing stage, was discovered by Laboratory One. To provide temporary protection for these laminations during their production, they are placed in a solution called a "phosphate bath". This has proven to

be an effective protective coating.

Vietnam has experienced great difficulties in its construction industry. For example, housing complexes and bridges are badly needed, and in the construction stages the problems of rust and corrosion have caused many delays and serious breakdowns. The scientists and engineers in Laboratory One have now developed a protective material which mixes casein taken from soya oil with cement, and this has proven successful in preventing deterioration during the construction process.

Altogether, 19 new procedures were developed by Laboratory One for the surface protection of metallic materials. These are now in the process of being standardized and distributed to industries.

Activities of Laboratory Two

TENSILE TESTING OF PLASTIC MATERIAL

This laboratory concentrates on the problems of organic material deterioration. Its main objectives are:

- developing standards and recommendations with regard to testing the effects of temperature, humidity, moulds, solar radiation and salt water on organic materials;

- obtaining information regarding the properties and functions of native and imported non-metallic materials and comparing them by systematically performing accelerated atmospheric testings;

- collecting, processing and classifying the results of testing, and information from scientific literature and then providing industries with guidelines for their practical application;

- investigating a number of indigenous materials, such as anti-oxydants, anti-ozodants, fillers, etc., for plastic materials and resins with the aim in mind to increase the resistance of non-metallic materials to the effects of high humidity, solar radiation and microbial infestations;

- supplying general instructions for industries with regard to the selection of materials needed to protect products while they are being stored;

- consulting with industries and firms involved in importing materials and advising them on the plastics, resins and other materials that are most suitalbe for use in the tropics; and

- inspecting regularly the deterioration rates of various non-metallic materials and proposing measures to reduce the incidence and severity of deterioration.

Laboratory Two developed a standard for the testing of atmospheric and accelerated ageing of lacquers and varnishes. It has been given to the Institute for Standardization for publication and use by industries.

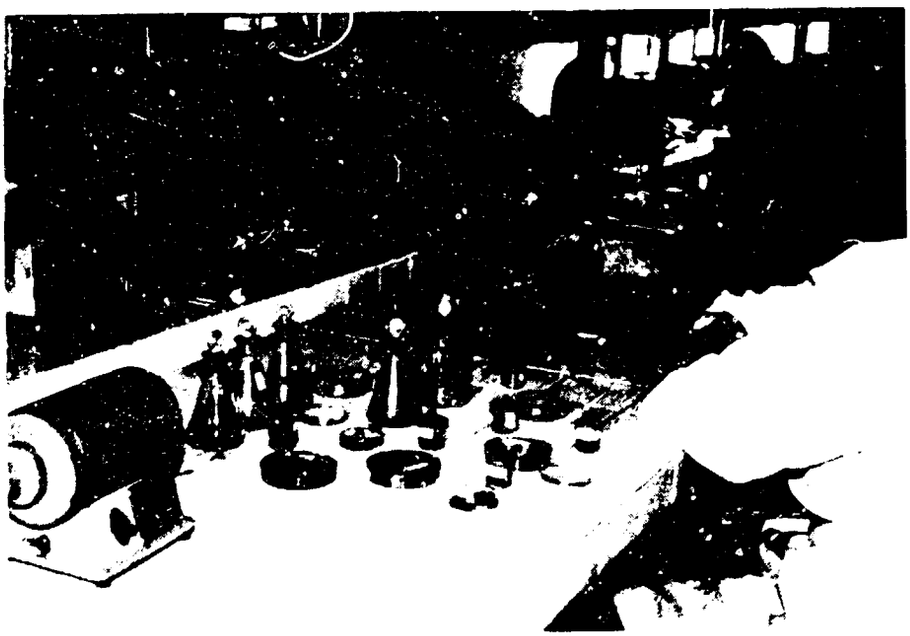
Continuing research activities include experiments on the effects of humidity, temperature, solar radiation and biological forces on polymer materials. Tests are being carried out in which the PVC of Vietnamese manufacture is compared with the properties of Japanese and Soviet products. These tests are conducted in accelerated and natural atmospheric conditions. Other investigations are being carried out to determine the power portions at various times of the year of the solar spectrum in Vietnam. Finally, life testing of different kinds of plastics - polyethylene, polypropylene, rubber, etc. - are being

conducted in atmospheric conditions. Practical applications of the results are being provided to such industries as the PVC Producing Factory in Viet Tri, and to factories in Haihung Hat producing such plastic products as foils, sandals and kitchen products.

On the basis of Laboratory Two's experiments, some important stabilizers and anti-oxydants have been developed. These include:

1. Stabilizers based on isoxyanats.
2. Antioxydants containing sulfur atom based phenols.
3. Antioxydants based on natural phenols.
4. Stabilizers developed on other bases.

Activities of Laboratory Three



PREPARING COMPONENTS FOR NEW ORGANIC MATERIALS

The primary concerns of this laboratory centre around the development of new technical materials that are produced from indigenous resources. In

the period in which the UNIDO project of assistance was in effect, this laboratory developed two standards that were translated and introduced into industrial production. In addition, its research activities generated a number of new materials which have been put to use within the country. Among the most significant have been:

1. An electrical insulating varnish for impregnating the electrical cords of Insulation Class B. This varnish replaced imported varnish from the GDR and is made from domestic raw materials. It uses an alkyd-phenol resin base and is now being produced in a pilot plant.

2. A varnish to protect printed joints and electronic components using an epoxystyrene base.

3. A varnish based on wood oil and colophony as an insulation for transformer core laminations. This replaces varnish previously imported from the USSR and is now being produced in a paint factory 20 kilometers from Hanoi.

4. A sealing compound based on epoxide filled with SiO_2, which replaces bitumen impregnation in small transformers. It has proven to be highly effective as a sealer that is resistant to humidity.

5. An enamel based on alkyd-epoxy resin used as an insulating layer in copper wire. Co-operating with the Bach Tuyet Varnish Factory in Ho Chi Minh City, the Ministry of Mechanical Engineering and Metallurgy and the Haiphong Electrical Engineering Enterprise, Laboratory Three succeeded in developing a system whereby copper winding wires can be covered with this enamel for maximum protection. It has been tested and proven heat-resistant and mould resistant and possesses excellent mechanical properties. This varnish is comparable in many respects to those previously imported and is now used in the manufacture of electric fans and small motors. On September 24, 1982, the developers of this varnish were awarded a patent for it by the Vietnamese authorities.

6. A new protective coating for steel plates. Using a rubber seed oil extracted from the plentiful rubber trees in Vietnam, the

members of Laboratory Three developed this protective coating as a temporary protection to be used on steel plates, while they are in storage.

7. Various uses of cashew nut shells. By using the natural phenol that comes from cashew nut shells - a liquid called cardanol - resins can be produced that are good for use in varnishes, oils, adhesives and plastics. Moreover, a lacquer based on cardanol - for aldehyde epoxy styrene - has shown excellent mechanical and electrical properties. The laboratory hopes to put this into use as an electrical insulation, since it is highly resistant to heat, humidity and atmospheric conditions.

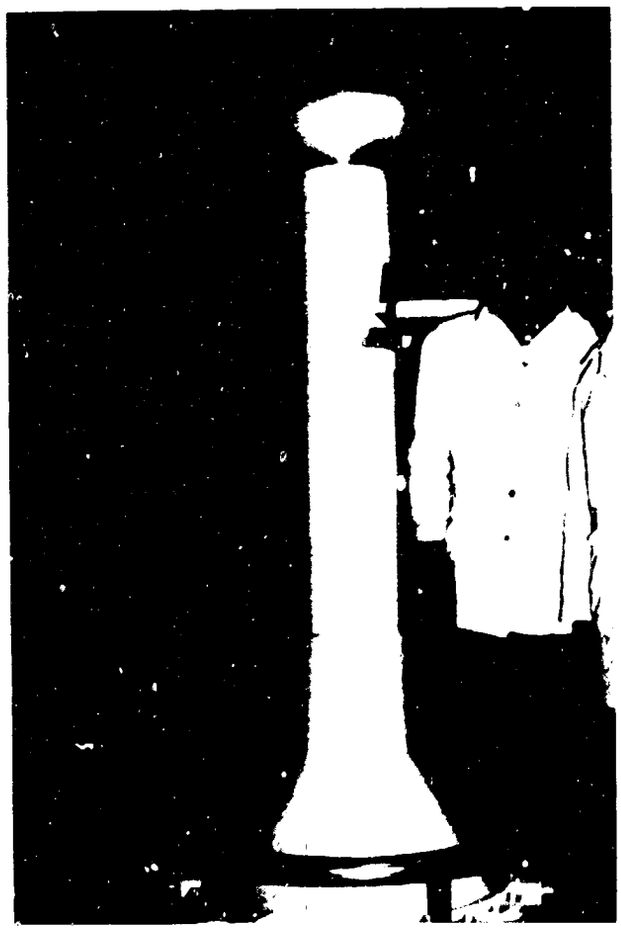
PREPARING CASHEW NUT SHELLS TO BE USED AS A BASE FOR VARNISH

A number of new materials are also being analyzed for their effectiveness and will soon go into pilot production. Among these are various new adhesives which are being developed in an effort to find

the best methods for modifying natural rubber. In addition, another varnish which will form a protective coating for electrical equipment is being developed from vegetable raw materials such as tung oil, linseed oil, rubber seed oil and dammar gum. Also, experiments are being conducted related to other environmental problems. For example, Laboratory Three of the ITTV in Ho Chi Minh City, working in co-operation with the Ministry of Health, Mother and Child Care/Family Planning Section, has been carrying out studies on the chemical, mechanical and other properties of plastic materials that can be used to manufacture domestically a new type of interuterine device (IUD). The intention is to replace imported copper devices with plastic ones made in Vietnam from indigenous materials.

The work and contributions of Laboratory Three have been widely recognized throughout Vietnam. Its laboratory test results and findings are published regularly in the quarterly Journal of Science and Technology, and there have been a number of newspaper articles related to the laboratory's work.

Activities of Laboratory Four



PREPARATION OF HIGH VOLTAGE ELECTRICAL BREAKDOWN TESTER FOR EXPERIMENTS

The main thrust of this laboratory's activities has been to develop ways to make electrical equipment "tropic-proof". In order to accomplish this aim, the scientists and engineers of the laboratory have been involved in high voltage testing, research in accelerated life testing and research and development designed to discover better and more efficient methods for making electrical equipment more resistant to tropical conditions.

During the project period, Laboratory Four developed 16 standards related to electrical measurements of materials and products as well as to such general problems as the classification of climatic conditions, terminology and standards of the Council of Mutual Economic Aid and the International Electronics Commission. All of these will be turned over to the Institute for Standardization for publication. In addition, "Specifications for the Production of Electrical Equipment Intended for a Tropical Environment" have been translated and adapted to Vietnamese conditions, especially those related to material bases for protecting electrical equipment.

The professionals in Laboratory Four have been involved in a number of research tasks related to the technology of producing motors and transformers that are sufficiently well insulated to withstand the rigours of the climate. For example, transformers are imported by Vietnam from several different countries; and within a few months, humidity damages their insulation and results in major breakdowns. When there is more than 80 percent humidity in the air, exposed insulation must be made from materials that will inhibit its penetration. A nitrogen barrier for oil filled transformers has been developed in the laboratory, and it is now being used by the Industry for the Production of Motors and Transformers, Tran Nguyen Han, Hanoi.

The laboratory has also been co-operating with the construction of a new bridge spanning the Red River into Hanoi. During the project period, it was discovered that the imported screws that hold the joints of the bridge were rusting rapidly, thereby creating a dangerous situation. These screws were tested in the laboratory's salt chamber in order to determine the best materials for providing them with a protective coating which would make them more resistant to the corrosive effects of the combined humidity and salt.

Atmospheric stations have been constructed in 15 different locations in Vietnam, and 17 detailed maps were drawn up by the members of the Laboratory Four. These indicate areas where humidity is higher or lower, where mean average temperatures vary, where salt spray is a major factor, where SO_2 is particularly significant, etc. The stations are monitored constantly, and the information derived from them is passed on to industries so that they will know where best to locate their future activities.

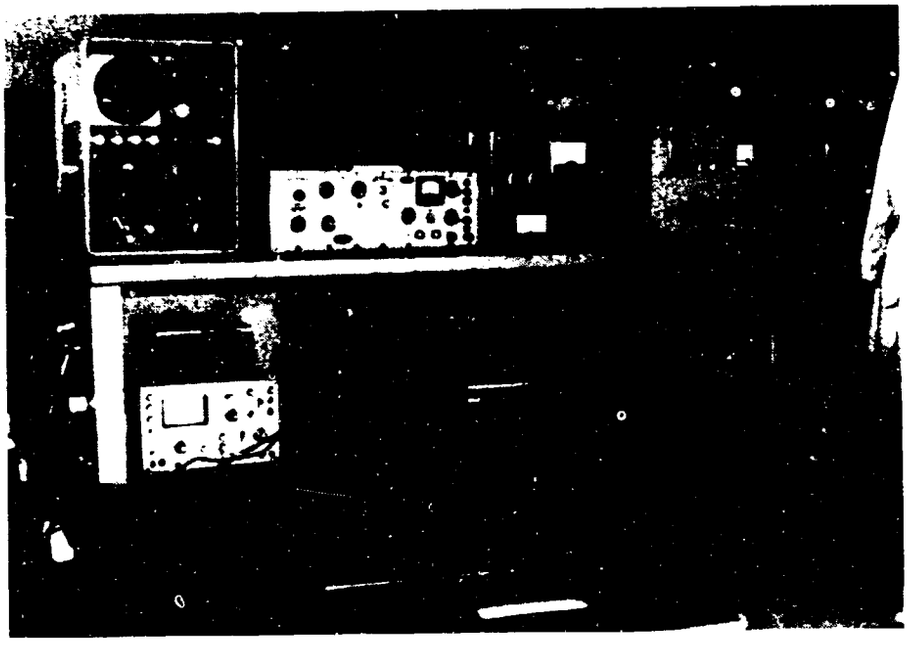
The ITTV has also been provided with modern equipment for accelerated environmental testing, which is carried out in special climatic chambers. These chambers are capable of simulating driving rain, dust storms, solar radiation, high humidity, etc.

SALT SPRAY CHAMBER USED TO TEST METALLIC COATINGS

Micro-climatic and environmental factors affecting equipment that is in storage has formed a large part of Laboratory Four's tasks. Vietnam has experienced considerable losses as a result of rust and corrosion of equipment in transit or in storage. Therefore, the scientists of Laboratory Four have been studying the reactions of equipment stored in

different conditions - heated, closed, ventilated and air-conditioned. The aim of these investigations is to determine optimal ways for storing electrical equipment under tropical conditions, as well as to develop new methods to recommend to suppliers for packing and shipping such equipment.

Activities of Laboratory Five



MEASURING ELECTRICAL COMPONENT PARAMETERS
AFTER ACCELERATED LIFE TESTING

This laboratory is concerned with problems and solutions related to the tropic-proofing of electronic components and equipment. During the project period, the work of the laboratory concentrated on comparing various appliances imported from abroad, research and development on the reliability of both imported and domestic electronic components; and research and development of new technology for the protection of such sensitive elements of electronic equipment as capacitors, resistors, high voltage transformers and printed circuits.

As a direct result of its testing, the laboratory has been able to identify which components and which equipment from various countries are most suitable for Vietnam. For example, tests of electronic millivoltmeters that come from the GDR have shown what must be done to adapt them for use in Vietnam. A set of recommendations covering this has been developed by the laboratory.

The laboratory also conducted a highly complex series of tests related to the effects of the environment on condensers - both imported ones and those produced in Vietnam. These tests clearly indicated that only those condensers that are encased in metal which has been coated with a protective humidity resistant finish are suitable for use in Vietnam. All others soon deteriorate and cause breakdowns in electronic equipment.

The laboratory developed an adaptive process for TV high voltage transformers by using a local impregnating agent in a vacuum pressure impregnation procedure and adding a varnish for surface protection. This is particularly significant, for often equipment which has not been properly impregnated during the production stage must be impregnated later as a repair operation.

The scientists of Laborato Five work closely with industries in both the northern and southern parts of the country. They have working agreements, for example, with the Telecommunications Equipment Factory in Hanoi; the Repair Shop for Imported Electronic Equipment Mai Huom in Hanoi; the Factory for Electronic Elements Nimh Hoa in Ho Chi Minh City. Joint studies between the laboratory in Hanoi and the repair shop for imported electronic equipment have shown that over 30 percent of the television sets imported from one country by Vietnam arrive in an unusable condition and must be repaired even before being installed in homes. Therefore, the problems involved in sea transport and storage facilities at Vietnamese ports play a large role in the laboratory's research and development activities. Tests have shown that equipment which has deteriorated upon arrival in Vietnam does not perform adequately and that breakdowns of strategic parts frequently occur even in new equipment or components. Therefore, the laboratory continues to work on guidelines which will outline the necessary

protective measures that suppliers should meet in order to ensure that expensive and sensitive electronic parts and components are well-protected during the production process and will, therefore, neither be damaged by rust, corrosion or other deterioration en route to Vietnam nor breakdown shortly after their arrival.

ORGANIZATIONAL RELATIONSHIPS

INAUGURAL CONFERENCE FOR TROPICAL TECHNOLOGY:
APPLICATIONS FOR PRODUCTION

Government Ministries and Industries

One of the most important aims of the UNIDO/ITTV project was to encourage the development of close working relationships between the Institute and industries. In order to find some solutions to the many problems they were confronting, it was essential that the laboratories of the ITTV work on practical solutions to the most pressing problems and to provide both Government and industries immediately with the

results obtained. Therefore, each laboratory within the ITTV has had a number of contracts with industries, and the results of the research and development activities of the laboratories have been distributed to the appropriate industries as soon as they have been thoroughly tested. The following list of groups with whom the ITTV maintains contacts reflects the scope of its industrial/governmental links:

1. Ministry of Mechanical Engineering and Metallurgy
2. Factory of Lacquers and Paints
3. Corporation of Non-ferrous Metals and Alloys
4. Service of Electric Power Distribution of Hanoi
5. Institute of Electrical Equipment Design and Construction
6. Hydro-meteorological Station
7. Institute of Chemical Industry
8. Institute of Transport Technology
9. Institute for Standardization in Hanoi and Ho Chi Minh City
10. Factory of Cables and Insulated Wires
11. Factory of Electric Motors
12. Electric Machine Repair Factory
13. Factory of Transformers
14. Factory of Electric Components and Devices
15. Petrol Industry Plant
16. Institute for Mother and Child Care
17. Factory for Manufacturing Plastic Materials
18. Medicine Station in Ho Chi Minh City

Meetings and Conferences

INAUGURAL CONFERENCE FOR TROPICAL TECHNOLOGY:
APPLICATIONS FOR PRODUCTION

In addition to direct contracts with government and industries, the ITTV has held a number of conferences, seminars and other meetings with regard to the problems of tropical technology. One large conference on "Tropical Technology: Applications in Industry and Production" took place in Hanoi on 25-26 March, 1982. Another on the same subject was convened in Ho Chi Minh City in June, 1982. The conference in Hanoi was attended by over 200 representatives of industries, the Government and academia. Its importance was underscored by the attendance of the Prime Minister of Vietnam; and among other dignitaries, the Resident Representative of UNDP also took part. Fifteen papers were presented by members of the professional staff of the ITTV, and their reports and recommendations have received widespread attention. Moreover, each of the 15 projects is now being practically applied in industries throughout the country.

In brief, the subjects covered by the reports were:

1. The development of a steel pickling process to remove rust from steel parts
2. The nitration process of industrial oils AC 10 and DC 11 to be used as protective agents for storing steel equipment
3. Phosphatation for restoring electro-magnetic silicium steel sheet
4. Some results on atmospheric corrosion and their application to industries and civil engineering
5. Normative procedures for protecting scientific equipment and materials
6. New impregnating varnish (Class B insulation) developed on the base of phenolic and alkyd resins
7. The use of epoxy resin in manufacturing high voltage inductors
8. Varnish for use in the canning industry, using a base of alkyd-epoxy and phenol-epoxy composite resins
9. An enamel based on alkyd-epoxy resin for copper winding wire
10. Some varnishes for electrical insulation and corrosion protection on the base of cashew seed shell liquid
11. Techno-climatological atlas of Vietnam
12 Climatological and environmental tests for quality control of tropical products
13. Nitrogen barrier for protection of power transformer oils
14. Impregnating process for small capacity transformers
15. Developing within the ITTV of a direct current supplier that can hold up well under tropical conditions

In June of 1982, a one-day Conference on Applied Technology was organized in Ho Chi Minh City, and over 50 representatives of industry, Government and academia were in attendance. Subsequently, in April of 1983 an Inaugural Conference was convened in Ho Chi Minh City to

acquaint the public with the research and development results of the ITTV. One very important development, the result of close co-operation between the ITTV and the Institute for Standardization in Ho Chi Minh City, has been an agreement to grant the trade mark "TROPIC PROOF" to Vietnamese products that meet the standards as set forth by these two Institutes.

Seminars and Lectures

The ITTV also maintains close links with universities and technical colleges throughout the country, and members of the ITTV staff often give seminars and lectures for both professors and students. There are a number of on-going exchange programmes, and frequently the laboratories of the ITTV are visited by students and faculty members from universities who are provided with information from the laboratories and are sometimes invited to participate in some of the research projects. During the course of the UNIDO/ITTV project, there were over 65 such seminars, attended by approximately 1,000 participants.

Fellowship Programme

An integral part of the project has been to provide training programmes for ITTV staff members. Thirty-four fellowships were granted, involving a total cost of US$ 160,000 during the project period. Each training period lasted approximately two months, and the fellows studied in 11 different countries.

An example of how the fellowship programme worked is the training received by one staff member from the ITTV, Hanoi and one from the branch in Ho Chi Minh City. During the course of their training period abroad, these two men spent two weeks in Giessen, West Germany, for instruction given by Weiss Technik on operating, servicing, maintaining and repairing environmental testing devices. Subsequently, the following equipment was supplied and installed in ITTV laboratories by Weiss Technik:

- a salt spray chamber, Type S 1000
- a temperature shock test cabinet, Type 2x64/80-200 DUST

- an ozone climate testing cabinet, Type 100AB/5 JU-CZ 9
- a climate testing cabinet, cold-heat, Type 1000RB/40 DU
- a splash water test unit, basic model, Type SWT600/800
- a dust test unit, Type ST750

Another significant result of the training programme has been the publication of 29 articles in local and international journals dealing with various topics related to the problems of tropical technology.

Pilot Production

Both branches of the ITTV have pilot production workshops where the new materials that have been developed by the laboratories can be produced on a small-scale within these shops. During the course of the project, approximately 200 tons of new materials, such as varnishes, cement, preserving oils and greases, were produced. The aim of the ITTV is not to produce, however, but to supply industries with advice and technical know-how that will permit them to produce the products themselves.

Equipment

Under the terms of the project, US$ 830,000 were allocated for the purchase of equipment for the laboratories in Hanoi and Ho Chi Minh City. During the two-year period that the project was underway, more than 180 pieces of equipment were purchased and installed in both locations. These range from large pilot plant equipment to precision instruments to air-conditioning units.

Experts

Altogether, four experts and a Chief Technical Adviser were sent by UNIDO to assist with one area or another of the Institute's activities. The UNIDO experts were: expert on metallic corrosion, one on organic material deterioration, one on the utilization of local raw materials for developing new technical materials and one for preparing and publishing a brochure on the work of the ITTV. In addition, several

experts from equipment suppliers assisted the ITTV with installing new equipment and instructed its members on ways to employ, maintain and repair it. A total of seven and a half man months were devoted to expert consultation.

Applicability to Other Countries

The work of the Institute for Tropical Technology in Vietnam and its accomplishments to date have been significant and hold promise for the future, not only for Vietnam but also for other developing countries faced with similar problems. The ITTV is confident that it has developed the competence and experience to continue making progress in order to solve the complex problems that a harsh climate imposes on its industrial development. Therefore, Vietnam has offered, in principle, to share the findings and experience of its Institute for Tropical Technology with other developing nations with corresponding problems.

Inspections and Reports Available

There are, en toto, ten reports on the project which are available in English. These include five Progress Reports, four Inspection Reports and one Report on the Fellowship Programme. They are on file with UNIDO, Vienna.

Plans for Future Activities

Having been placed on a sound footing by the project assistance programme of UNIDO, the ITTV plans to continue with its research and development activities. It views its main goal at present to be the continued development of ways and means to prevent equipment deterioration and breakdowns caused by the severe climatic conditions of Vietnam. The climate remains the same. Therefore, the challenge will continue to be finding better ways to preserve imported equipment, while at the same time developing domestic capabilities that will decrease Vietnam's dependence upon outside resources. As the country industrializes, however, the combination of high humidity and pollution will become

increasingly important, and the scientists of the ITTV are already considering what measures must be taken to deal with that prospect.

The essential problems still persist. The overriding one involves the technology used in the manufacture of goods destined for use in tropical climates. Those who produce equipment for export must be convinced that it should be produced in such a way as to ensure that it will withstand not only the rigours of the climate in Vietnam, but also the long journey, usually by sea, to the country. Then, as a general rule, since equipment is left in storage for a certain period of time before it is transported to its final destination, the producers must be prevailed upon to pack it in suitable containers. At the same time, importing nations, such as Vietnam, must have specific instructions, or standards, by which they purchase goods from abroad. It will take years to develop all of these procedures and agreements between suppliers and importers, especially those with the specific problems that Vietnam faces. Therefore, the ITTV will have a considerable amount of work facing it for years to come.

A great deal of progress has been made. Much remains to be accomplished. The ITTV is now an established Institute that operates on a sound base of professional competence and expertise. It has wide-ranging interests, and its contacts with both industry and government continue to expand. It is possible, therefore, that the ITTV can assume a major role in the development of Vietnamese industry.