# LOOKING BACK TO MOVE FORWARD

**A forty-year retrospective of the Science and Technology Policy Instruments (STPI) project**

**Looking Back to Move Forward:**

**A forty-year retrospective of the Science and Technology Policy Instruments (STPI) project**


Francisco Sagasti

(Editor)


**2015**

Looking Back to Move Forward:

A forty-year retrospective of the Science and Technology Policy Instruments (STPI) project



Av. Monterrico (Ex- Manuel Olguín) 533 oficina 403

Lima 33-Perú

Phone number: +51 1 4373792

Mail: fni@fni.pe

http://kind-cind.org/blogstpi/?lang=esWeb: http://kind-cind.org/blogstpi/?lang=es

blog: http://kind-cind.org/blogstpi/?lang=es

web: www.fni.pe

ISBN: 978-612-45122-1-6

Digitalizado y Distribuido por YoPublico S.A.C.

yopublico

www.yopublico.net
Telf: 51-1-221 9998
Dirección: Av. 2 de Mayo 534 Of. 304, Miraflores
Lima-Perú

"This document reports on research carried out with the help of a grant from Canada's International Development Research Centre."

## Preliminary note

It is seldom that science, technology and innovation policy researchers and policy makers get an opportunity to examine the results and reflect on the impact of their work with a long-term perspective. At the beginning of August 2013 there was a rather unique event that did precisely that. With support from the Canadian International Development Research Centre (IDRC), FORO National Internacional organized a 40-year retrospective review of the Science and Technology Policy Instruments (STPI) project.

The fortieth anniversary of the STPI project identification meeting provided an opportunity to examine the long-term impact of the first large-scale, international policy-oriented research initiative in science and technology policy for development; to evaluate the ways in which the knowledge acquired through the project helped to shape policy and decision making; to assess how it affected the professional and personal development of those who participated in the project; and to explore its implications for the future.

Most of the country coordinators are still professionally active, and although some have moved to other fields, several are working on science and technology policy issues. Members of the STPI network have frequently acknowledged the influence that the STPI project had on their professional careers, on the advice they have provided and decisions they made, and on their contributions to the field of science and technology policy for development. Sadly, some of the country coordinators are no longer with us, but a sufficiently large number of STPI network members participated in the STPI+40 event, which looked back at the experience of STPI.

The first part of this report contains one chapter summarizing the background, organization, methodology, results and dissemination of the STPI project, and is based primarily on material produced during 1973-1979 available at the STPI+40 website.[1]

The second part consists of two chapters. The first is a report prepared by Geoffrey Oldham based on a questionnaire answered by participants in the STPI research network, which examines its impact on the development of science and technology capabilities of the participating countries and on the members of the country teams. The second chapter was prepared by Juana Kuramoto takes a look back at the results of STPI, presents an overview of the main changes that have taken place in the policy environment for science and technology during the last four decades, and outlines new research issues on policy implementation.

The third part comprises six short chapters. The first provides a brief account of the dissemination efforts and the influence of the STPI project over time, and the second offers an overview of the evolution of science and technology capabilities in STPI countries. The third contains a contribution from Tran Ngoc Ca, which indicates the STPI project influenced a review of science and technology policy in Vietnam. The fourth and fifth chapters present the main conclusions of the STPI+40 meetings in

[1] See: http://kind-cind.org/blogstpi/?lang=en

Paracas and Lima that took place in August 2013. They incorporate contributions by Francisco Sercovich, Alberto Araoz, Carlos Contreras, Mónica Salazar and Sussan Cozzens outlining possible agendas and future initiatives in the field of science, technology and innovation policies for development.

This report gives readers a long-term perspective on the opportunities and constraints faced in the design and implementation of science and technology policies. We hope it will contribute to improve efforts to build science, technology and innovation capabilities in developing countries.

Lima, May 2014
Francisco Sagasti

## PART I: THE SCIENCE AND TECHNOLOGY POLICY INSTRUMENTS (STPI) PROJECT: BACKGROUND, APPROACH, METHODS AND RESULTS (by Francisco Sagasti)

## 1. BACKGROUND TO THE STPI PROJECT

"I know what I need to do, but how do I do it?" was the question asked by Carlos Añez, the newly appointed President of the Venezuelan Science and Technology Council at meeting of the Organization of American States held in in Lima and Cusco in February 1971. His concern was widely shared by Latin American science and technology policy authorities, most of who worked in institutions that had been recently created. This led Dr. Geoffrey Oldham, Director of Science and Technology Policy at the Canadian International Development Research Centre (IDRC), to embark in consultations with senior policy makers and researchers in several developing countries to determine how best to design and implement science and technology policies.

A major gap in knowledge was identified during the IDRC consultations: the lack of rigorous and useful information on the effectiveness of public policy instruments to promote the creation of science and technology capabilities. In January 1972 a meeting was held at the Science Policy Research Unit in Sussex University to discuss the project identification report commissioned by IDRC. Following this, Máximo Halty, Director of the Technology Development Unit of the Organization of American States (OAS), commissioned feasibility studies carried out in Peru and Argentina to explore the viability of the project and its approach. With this background, IDRC and the OAS convened a "project identification meeting" in Barbados in January 1973. The purpose was to design, organize and launch what became the "Science and Technology Policy Instruments" (STPI) project, the world's first large-scale, action-oriented, comparative research network on science and technology policy. The project proposal was prepared collectively by the participant in this meeting, and then submitted to IDRC, the OAS and national entities in the participating countries to secure funding.

The Barbados STPI project identification meeting gathered active policy makers and researchers from six Latin American countries (Argentina, Brazil, Colombia, Mexico, Peru and Venezuela) and from the Republic of Korea, India, Egypt and the Republic of Macedonia. In addition, it brought together consultants who had developed background material for the project and representatives from the IDRC and the OAS, the two institutions interested in supporting science and technology policy research.[2]

The first research phase of STPI project started in August 1973 and concluded at the end of 1976, and a second dissemination phase took place during 1977-1979. More

[2] The meeting was held at the Centre for Interracial Studies of the University of the West Indies. Several of the participants had met before, for some had attended a science, technology and development study seminar organized by the Institute of Development Studies (IDS) and the Science Policy Research Unit (SPRU) at Sussex University in August 1972, while others had participated in similar events organized by the OAS, the OECD, UNESCO and the Inter-American Development Bank in the early 1970s. For a list of institutions participating in the STPI project and a chronology of activities see annexes A and B.

than one hundred and twenty researchers from Argentina, Brazil, Colombia, South Korea, Egypt, India, Macedonia, Peru and Venezuela worked in the project. A Field coordinator's office with three staff members was established in Lima for the first phase, the dissemination phase was carried out at the IDRC Latin America Regional Office in Bogota, and about thirty consultants were engaged to prepare reports on special topics. Coordinating such a large international research network was a challenge at a time when neither Internet nor fax machines were available. International travel, regular mail and telex machines were used to remain in contact, and the Coordinating Committee met twice a year in the various participant countries.

More than thirty books and reports were produced as part of STPI, and the country teams produced numerous working papers, documents and policy briefs. Many meetings were held in various parts of the world, and this helped to build a tight and quite effective policy research network that quickly spread best practices. The impact of the STPI project was significant in most of the participant countries, and its results helped to shape the international debate on science, technology and development during the 1970s and 1980s.

## 1.1. Emerging science, technology and development concerns[3]

Science and technology policy, as we know it, emerged as a distinct area for government initiatives shortly after World War II, a few years after J. D. Bernal outlined the scope of the field in his seminal work The social function of science in 1939. Stimulated by the success in applying science and technology to military ends during World War II, governments in the industrialized countries emphasized the application of science to promote economic growth, address social problems and improve standards of living. A 1945 report by Vannevar Bush for the President of the United States, Science: the endless frontier, proposed a series of measures to strengthen scientific research and technological development, which were reinforced by the pressures of the Cold War, the nuclear arms race, and the space race that pitted the United States against the Soviet Union. Similar initiatives were undertaken in Europe and Japan, and even in India, where Primer Minister Nehru's "Science Policy Resolution" was approved by Parliament on March 4, 1958.

The roles of science and technology policy advisors, designers and implementers shifted and changed over time, as did the content policies and strategies. In the 1950s and 1960s, "science policy" placed emphasis on promoting scientific research and technological development, and less on the way in which knowledge and technology were utilized in production activities and the provision of services. As governments adopted economic growth as a primary national objective, during the 1970s emphasis shifted towards technology and its role in the economy and "science and technology policy" broadened its scope, incorporating issues such as technology transfer, appropriate technologies, and interactions between research institutes and enterprises.

Advances in scientific research and technology development opened vast new fields for economic activity during the 1980s and 1990s (e.g., information and

[3] Parts of this section are based on Francisco Sagasti, *Ciencia, Tecnología, Innovacion. Políticas para América Latina*, (second edition) Lima/México, 2013.

communications technology, biotechnology, nanotechnology, automation), the content of policies expanded to cover "science, technology and innovation", which sought to stimulate innovative behavior and became more closely intertwined with economic social and environment policies.

The range of concerns, approaches and methods of policy advisors and researchers expanded and shifted in parallel with the changing content of policies and strategies, as did the activities of government agencies and international organizations. The design and implementation of science and technology policies became a subject of research in institutions such as the Lund Research Policy Institute Science established in 1965, and the Science Policy Research Unit (SPRU) at Sussex University, established a year later. Interdisciplinary programs were also created about the same time at American universities, including MIT and Cornell, and courses on science and technology policy emerged in science and engineering schools in Europe, the United States and Japan.

International institutions played a key role in the promotion of science and technology policies starting in the 1960s. The Organization for Economic Cooperation and Development (OECD), UNESCO and UNCTAD, among others, conducted studies, published reports and provided advice to governments on the design of science and technology policies. The United Nations Conference on Science and Technology for the Benefit of the Less Developed Countries, held in Geneva in 1963, marked the beginning of widespread international interest in science and technology policies, and the UN World Plan of Action on Science and Technology for Development, approved by the UN General Assembly in 1970, placed emphasis on international cooperation to build science and technology capabilities in less developed countries.

As an example of the emerging concerns about the application of science and technology for development purposes, it is pertinent to quote a speech given by President John F. Kennedy to a gathering of Latin American diplomats in the White House:

*"The genius of our scientists has given us the tools to bring abundance to our land, strength to our industry, and knowledge to our people. For the first time we have the capacity to strike off the remaining bonds of poverty and ignorance -- to free our people for the spiritual and intellectual fulfillment which has always been the goal of our civilization.*

*[…], all the people of the hemisphere must be allowed to share in the expanding wonders of science -- wonders which have captured man's imagination, challenged the powers of his mind, and given him the tools for rapid progress. I invite Latin American scientists to work with us in new projects in fields such as medicine and agriculture, physics and astronomy, and desalinization, to help plan for regional research laboratories in these and other fields, and to strengthen cooperation between American universities and laboratories."*[4]

[4] John F. Kennedy Speeches, Address at a White House Reception for Members of Congress and for the Diplomatic Corps of the Latin American Republics, March 13, 1961. Retrieved from http://www.jfklibrary.org/Research/Research-Aids/JFK-Speeches/Latin-American-Diplomats-Washington-DC_19610313.aspx

In a similar vein, the Latin American Presidential Summit held in 1967 focused on the role of science and technology in reducing the development gap, and led two years later to the establishment of the OAS Program on Science and Technology, which would channel up to US$100 million to Latin American during the following decade and a half:

*"Latin America will share in the benefits of current scientific and technological progress so as to reduce the widening gap between it and the highly industrialized nations in the areas of production techniques and of living conditions. National scientific and technological programs will be developed and strengthened and a regional program will be started; multinational institutes for advanced training and research will be established; existing institutes of this kind in Latin America will at the same time be strengthened and contributions will be made to the exchange and advancement of technological knowledge.*[5]

By the late 1960s and early 1970s, most developing countries had created science and technology policy-making bodies and financing institutions, which took usually the form of Research Councils and Science and Technology Councils at high levels of government. This led to a growing interest in the design and implementation of effective science and technology policies, and bolstered studies, research and international cooperation in this field. In addition to the OECD and UN agencies, the World Bank, the Inter-American Development Bank and the Organization of American States designed programs to support capacity building in science and technology. The US National Academy of Sciences also became involved in cooperative initiatives to assist newly created science and technology policy making bodies in Latin America and other developing regions.

## 1.2. The international context for research in the STPI project

The 1970s were a propitious time to raise questions about how to design and implement science and technology policies for development. What economic historian Angus Maddison called the "Golden Age" of economic growth was still under way, with most developing countries raising their income per capita; the Cold War presented developing countries with two alternative routes towards development, each supported by development assistance initiatives led by the United States and by the Soviet Union; the Organization of Petroleum Exporting Countries had raised oil prices significantly, which led to a massive transfer of resources towards less developed countries; the North/South Dialogue was launched to agree on a "New International Economic Order" that was hoped would lead to a redistribution of wealth and power; and the United Nations was adopting measures to regulate the conduct of transnational corporations through a "Code of Conduct", and to improve the trade prospects of developing countries through technical assistance and commodity stabilization funds.

In addition, import substitution policies were working in Latin America and other developing regions, development planning was considered essential for developing

[5] Declaration of the Presidents of America, Punta del Este, Uruguay, April 14, 1967. Retrieved from: http://avalon.law.yale.edu/20th_century/intam19.asp

regions, and the role of science and technology in improving living standards was increasingly recognized. An example of the later was the 1970 UN General Assembly adoption of the World Plan of Action on Science and Technology, which was supposed to guide international cooperation initiatives in this field for at least a decade. The 1979 United Nations Conference on Science and Technology for Development, held in Vienna, agreed on a Plan of Action and an Interim Fund that was initially expected to raise $250 million, which would help developing countries to build their endogenous science and technology capabilities.

While the international setting for science and technology development initiatives would radically change in the 1980s with the developing country debt crisis, the spread of trade liberalization policies, the reduction of the role of the State and the abandonment of development planning, and the emergence of the so-called Washington Consensus on development policies, none of this was anticipated during the 1970s, when the STPI project was carried out.

More relevant to the STPI project was the creation of IDRC in October 1970, which had as its explicit mandate to help develop science and technology capabilities in the developing regions, and the launching of the OAS Program on Science and Technology in 1969 to support scientific and technological research in various field, and to carry out and finance policy studies. At that time in Latin America the Inter-American Development Bank was providing loans for higher education and engaged in studies on science and technology, while the UN Economic Commission for Latin America conducting studies on the impact of technical progress on economic development.

Simultaneously, policy researchers in India had been conducting studies on the impact of research on economic development and on the history of science and technology for several years, seeking to develop their own capabilities in a several advanced fields, including nuclear physics and energy. In Europe and the United States the appropriate technology movement was in full force, with proposals to develop and adopt intermediate technologies in developing countries, while leading economists (including Amartya Sen) focused on the choice of techniques and its determinants. In addition, science and technology policies in China became a subject of great interest to many policy researchers, even though access to primary sources was severely restricted especially during the period of the Great Leap Forward and the Cultural Revolution.

The intellectual climate of the late 1960s and early 1970s was ripe for attempts to understand the most effective ways of building science and technology capabilities in developing countries. The STPI project generated widespread interest in the participating countries, although not everywhere to the same extent. Its ambitious nature, unorthodox approach and large scale generated comments, both positive and negative, in the participating countries and in the wider science and technology policy research community. Some academic researchers were wary of the leeway given to national research teams, fearing that it would impair comparability; staff members of some international organizations resented what they saw as an intrusion into their field of competence, and were jealous of the resources, flexibility and access to policy makers of the STPI teams; and some policy makers in participating countries viewed STPI as an intellectual diversion, rather than as a support for their activities.

Nevertheless, by and large, most members of the international science and technology policy research community saw STPI as an interesting and worthwhile exercise, which could yield some useful insights. In particular, as will be mentioned later, the STPI project was able to provide a large amount of background information and ideas for the UN Conference on Science and Technology for Development (UNCSTD), to the extent that several of the results and recommendations found their way to national and regional position papers, and to the documents prepared by the UNCSTD Secretariat and by the Group of 77 that gathered developing countries.

A statement towards the end of the project by KunMo Chung, country coordinator for the Republic of Korea team, summarizes the key features of STPI:

*"The STPI project was a unique experiment. It was designed and performed by Third World researchers, who gained invaluable experience in working with other Third World counterparts. It involved a wide spectrum of specialists, many of who rarely had opportunities for professional interaction with experts in other areas, and gained new perspectives on the problems of developing countries. It was not research in the pure sense: the exchange of experience was as important as generating new knowledge. Close examination of such issues as technological self-reliance, technological diplomacy, consulting engineers and design organizations, and evaluation of industrial technology, gave the participants a long-term, broad view of the technological system in the context of economic development".*[6]

[6] KunMo Chung, "Making industry competitive", in David Spurgeon (editor), *Give us the tools: science and technology for Development*, Ottawa, International Development Research Centre (IDRC), 1979, p. 51.

## 2. THE ORGANIZATION OF THE STPI PROJECT AND ITS EVOLUTION[7]

The STPI project was an experiment —a large, self-managed, action-oriented international research project by researchers and policymakers from developing countries. The STPI network comprised autonomous country teams, led by country coordinators who were responsible for the project in their countries. The coordinating committee, composed of all the country coordinators, was the top authority of the project. It met twice a year to monitor and evaluate the progress achieved, as well as to exchange information on the work of each team and the field coordinator's staff.

### 2.1. The organization of STPI

To ensure continuity and facilitate communication in the STPI network, a field coordinator was appointed to oversee the international component of the project. He was responsible for organizing communication and information flows, providing methodological assistance to the country teams, and for organizing and preparing the comparative reports. The field coordinator also acted as secretary to the coordinating committee, and the functions of the coordinating committee and of the field coordinator were defined as follows:

*Coordinating committee:*

- Approves the work of the field coordinator, who is accountable to the committee for all technical matters;
- Identifies the international consultancy studies to be commissioned for the project;
- Sets the time, location, and agenda of its own meetings, and chooses its chairperson;
- Establishes the procedures for preparing the comparative reports in the final phase of the project; and
- Specifies the terms on which additional funds will be accepted for the international component of the project.

*Field coordinator:*

- Helps to develop methodological guidelines for the country studies and consultancy studies and makes the reports available to the country teams;
- Coordinates the work of the country teams and encourages communication among them;
- Carries out troubleshooting at the request of the teams;
- Organizes the meetings of the coordinating committee;
- Organizes training courses, commissions consultancy studies, and carries out other duties that might be assigned by the coordinating committee within the limitations imposed by the budget for the international component of the project; and
- Prepares a comparative analysis of the project.

---

[7] This section is largely based on Francisco Sagasti, *Science and technology for development: main comparative report of the Science and Technology Policy Instruments Project.* Ottawa, Ont., IDRC, 1978, pp. 104-107.

The IDRC Board of Governors approved the Barbados proposal in June 1973. The governors agreed that the results and experience obtained in the STPI project should be made available to countries that did not participate in the network and encouraged the dissemination of experiences and results.

The first meeting of the coordinating committee took place in Rio de Janeiro, in August 1973, and the operating procedures and rules by which the project was to be managed were drafted. Discussions were held and decisions made on the chairperson of the committee, the frequency and attendance of meetings, the maximum number of countries in the project, the sources of funds, the relations with other projects, and related issues. In particular, it was decided that the field coordinator would be accountable to the coordinating committee in all technical matters, and to the IDRC for administrative matters.

Procedures for handling potential conflicts were also devised; it was agreed that the main decisions were to be taken by consensus, and voting procedures were also specified should the need arise. A distinction was made between working meetings and coordinating committee meetings, restricting the former to technical issues and opening them to any member of a country team, Finally, decisions on training programs and consultancy studies were made, expanding on the initial ideas put forward at Barbados.

The relations with the sponsoring agencies, IDRC and OAS, were also defined at this meeting. The IDRC representative would monitor the progress of the international component through the field coordinator and would establish a similar relationship with the country teams. The OAS liaison officer with STPI would observe the work of the coordinating committee and would oversee the use of OAS funds. A country coordinator characterized the relations between IDRC and the STPI teams indicating that, in spite of being financed by IDRC, *"the project was entirely in the hands of researchers from developing countries. There were no strings attached ... IDRC was not trying to 'teach' developing countries. The selection of participating countries was not limited by political economical considerations. There were countries with widely different political systems. A number of countries were resource rich but a few were not."*[8]

The field coordinator's office was established in Lima in October 1973, and staffing was completed in April 1974, with the arrival of two assistants to the field coordinator. A bimonthly newsletter began to be issued in October 1973.

## 2.2. STPI meetings

The first working meeting took place in Lima in January 1974, where the draft of the first part of the methodological guidelines was discussed in detail. Suggestions were made with regard to the contents of the consultancy studies. The second meeting of the coordinating committee was held in Mexico in May 1974. The revised guidelines were discussed in depth, consultancy studies were examined, and the first draft of the

[8] KunMo Chung, "Making industry competitive", in David Spurgeon (editor), *Give us the tools: science and technology for Development*, Ottawa, International Development Research Centre (IDRC), 1979, p. 52.

report on technology policies in the People's Republic of China was presented. Approval was given for three other consultancy studies, and there was a discussion of the country progress reports.

Cairo was the location of the third coordinating committee meeting, which took place in November 1974. The problems of communication among country teams were highlighted, the second part of the methodological guidelines was discussed, progress reports on consultancy studies were presented, the report of technology policies in post-war Japan was distributed, and there were discussions on the nature of the research in STPI, the pace of the research, the usefulness of some background studies, and the publication policies. Initial ideas on the evaluation of the organizational structure and of the approach to STPI were also put forward at this meeting. It was agreed that technical discussions of country team reports should be expanded at coordinating committee meetings, and that working meetings should be programed on a variety of topics. A schedule of working meetings on technology transfer, science and technology planning, state enterprises and technology policies, and consulting and engineering design organizations was set up.

The next meeting of the STPI network took place in Ohrid, Macedonia, in April 1975. A working meeting, it dealt exclusively with technology transfer. In May 1975 another working meeting took place in Villa de Leyva, Colombia, where the problem of science and technology planning was discussed. Seoul, South Korea, was the location of the coordinating committee's fourth meeting, which took place in July 1975. Country team reports and the issue of the final comparative reports were discussed at length. A policy on publications and dissemination of results was agreed upon, two working meetings were planned, decisions on consultancy studies were made, and a general overview of the evolution of STPI was presented and discussed.

Two working level meetings were organized for the second half of 1975. The first took place in Buenos Aires in August and dealt with the role of state enterprises in technology policy. The second was in Naiguata, Venezuela, and examined the problem of consulting design organizations in developing countries. The fifth and final meeting of the coordinating committee took place in New Delhi in January 1976, where substantive discussions of the teams' research results were held. In particular, the difficulties encountered in examining technological behavior and enterprise-level technical changes were considered. The general structure of the final comparative report was discussed at length and an agreement was reached, which defined the framework for the final synthesis workshop to take place in Sussex. Responsibilities were allocated in the preparation of reports, an executive editorial committee was created to review the work of the field coordinator and his staff after the Sussex meeting, and the procedures for the Sussex workshop were defined in detail.

The Sussex workshop was organized in June/July 1976, and the preliminary drafts of many parts of the main comparative report were prepared. Participants at the meeting divided into working groups and reported regularly to plenary sessions. They also took responsibility for tasks, working closely with the field coordinator.

## 2.3. Organizational challenges

As could be expected in a large and complex undertaking like the STPI project, many difficulties emerged during its lifetime. The problems encountered at the country level, which were varied in nature and complexity, were dealt with for the most part by the country coordinators, although in some cases the field coordinator intervened. A few problems affected the international coordination and the subsequent comparative reports that emerged from the project.

The first problem was the limited communication among the participating teams, particularly on technical matters. Excluding three or four teams, which remained in close contact with each other and with the field coordinator's office, the flow of information was limited and took place mostly at the coordinating committee meetings.

The lack of communication meant that researchers did not fully benefit from one another's experience. For example, researchers who encountered difficulties in interviewing firms in some industrial branch might have gained from another team that had already encountered and addressed the problem. However, by the time a question was formulated and posed to either another team or the field coordinator, and an answer received (generally by mail), it was too late. There were many examples where a more flexible and closer interaction among teams would have helped greatly. Two solutions to the communication gap were rejected because they were inconsistent with the STPI approach. One proposal was to slow the pace of the research to allow for greater interaction, and the other was to require a highly centralized management of the project.

A second problem was that the meetings of the coordinating committee, which all country coordinators were supposed to attend, took place at 6-month intervals. In practice, the participants hardly had enough time to absorb the ideas from one meeting before they were asked to prepare a progress report for the next. This problem was related to the relatively short time available to complete the multiple tasks of the project.

A third problem related to the way in which coordinating committee meetings were conducted. In retrospect, too much time was allocated to discussions on operations, and to the presentation of progress reports, leaving insufficient time for in-depth discussions of empirical results, technical issues, and problems encountered during the research. Although the working meetings offset this problem, they were limited to a single technical issue and did not cover the range of issues on which the national teams worked.

The last problem was the uncertain relationship between the country teams and the field coordinator. Exacerbated by the communication problems, difficulties emerged from the multiplicity of technical and administrative roles the field coordinator and his staff were supposed to play. These roles were in conflict at times and required that efforts be spread among a variety of functions. The fact that the field coordinator was not engaged in empirical research limited his ability to answer specific technical queries, although his involvement with an institution dealing with industrial technology policy helped him to remain sensitive to the requirements of policy-oriented researchers in the national teams.

The relationship between the country coordinators and the field coordinator went through three distinct phases. In the first, the field coordinator provided the country teams with organizational and methodological support, helping the coordinators to establish their teams and launch their research efforts. The second phase saw the field coordinator and the country teams working more or less independently, the former on the organization and supervision of the consultancy and background reports and the latter on the conduct of the research in their own countries with occasional troubleshooting support from the field coordinator. In the third phase, the field coordinator prepared the comparative report, using the inputs provided by the teams. The first phase went approximately from the beginning of the project (August 1973) until the Mexico meeting of the coordinating committee (May 1974); the second phase from that meeting to the Seoul meeting of the coordinating committee (July 1975); and the third from then to the end of the project in December 1976.

Finally, there were several delays in the project. Although the timetable called for all the country work to be completed by February 1976 and the comparative analysis by August 1976, the complexity of the research tasks and the organizational difficulties encountered by some teams made it impossible to meet deadlines. The project was extended, and the teams were asked to present their results at least by June/July 1976. Most of the teams did so, although a few delivered their reports to the field coordinator's office after the Sussex meeting. Consequently, the inputs to the international comparative reports vary considerably in content and degree of completion.

Nonetheless, the setup for the conduct of comparative action-oriented research succeeded in keeping the STPI network together and in providing a forum for the exchange of points of view and results. It also created a learning environment for the participants, who were highly motivated and took advantage of the opportunities offered by the unique structure of STPI's autonomous teams and international coordination.

In organizational theory terms, the structure established to manage the STPI research process was “circular organization” in Russell Ackoff’s words.[9] In this setup, managers at all levels are accountable to a board that defines objectives and evaluates performance, and this board is made up of those staff under the supervision of the manager. This means that, in effect, the manager is under the supervision of his own staff when they act collectively as a board, but once objectives and performance standards are agreed upon and given to the manager, those same board members are individually accountable to the manager for achieving what they have agreed upon collectively. Each manager is both under his staff when they act collectively as a board, and over them when they act as individuals who report to him. In STPI the field coordinator was accountable to the coordinating committee made up of the country coordinators; in turn, country coordinators were accountable to the field coordinator, who was responsible for ensuring that as individuals they did what had been collectively agreed. In addition, the field coordinator’s office and the country

[9] Russell Ackoff, *Creating the corporate future*, New York, John Wiley & Sons, 1981, pp. 163-168.

teams were accountable to IDRC, the OAS and their domestic funding counterparts in financial matters.

## 3. THE STPI PROJECT: OBJECTIVES AND APPROACH

When the STPI Project was initially designed, there was practically no body of structured knowledge about the implementation of science and technology policies. Whereas the art (or science?) of formulating policies was relatively well advanced, little was known about the procedures, ways, and means to put these policies into practice. The STPI background studies showed that no concerted efforts had being made to study this problem in developing countries.

### 3.1. Objectives[10]

The general purpose of the project was to gather, analyze, evaluate, and generate information that would help policymakers, planners, and decision-makers in developing countries to specify the ways and means for orienting science and technology toward the achievement of development objectives. In particular the project was supposed help in:

- Developing indigenous capabilities in science and technology appropriate to the countries' needs;
- Better utilizing these capabilities in the productive sector and other areas of socioeconomic activity;
- Improving the process of importing technology in such a way as to maximize its beneficial effects and minimize its detrimental effects;
- Absorbing and adapting the imported technology linking it to the indigenous scientific and technical activities.

The realization of these general objectives will require the project to focus on:

- Identifying the general role that science and technology play in attaining development goals in different socioeconomic and political systems. This involved an analysis of the functioning of the scientific and technological system and its relation to the national economy and development objectives in each of the participating countries;
- Identifying major instruments and mechanisms that are most likely to be effective in implementing science and technology in a given context. This required an analysis of the use of both direct and indirect policy instruments on the technological behavior of government agencies and productive units;
- Identifying and analyzing, key factors that affected the technological behavior of enterprises in selected sectors of the economy. The purpose was to examine the effectiveness of policy mechanisms and instruments from the perspective of the manager or entrepreneur who makes technological decisions in the productive unit;
- Examining the major controls, practices, and procedures followed by government agencies and departments that make policy decisions for science and technology.

[10] This section is based on: Francisco Sagasti, *The Science and Technology Policy Instruments (STPI) Project: A Comparative Research Effort Among Less-developed Countries to Examine Ways and Means of Implementing Science and Technology Policies in the Industrial Sector*. Ottawa, IDRC, 1975, pp. 7-8.

This implied examining the factors that affect the behavior of government officials with regard to administrative controls that refer directly or indirectly to science and technology policies;
- Exploring and identifying the policy instruments, including those in other areas of government policy, that were likely to have a significant effect in promoting the development of an indigenous scientific and technological capacity geared to the needs of development;
- Carrying out comparative analyses of the effect that different instruments were likely to have in diverse environmental conditions.

There was one additional feature of the objectives of STPI project that was highlighted by a former country coordinator a few years after the conclusion of the first phase of the project:

- "The objectives of the individual country studies and the methodological guidelines were not firmed-up [in advance] and were intentionally left to the research participants. Country teams were able to define the individual STPI projects with a clear mandate. After heated discussion and amendments, methodological guidelines were accepted at the second coordinators' meeting in Mexico City. (The coordinators' meeting was in charge of the STPI project. Coordinators of the participating research teams formed the ad hoc council and directed the field coordinator). The adoption of the methodological guidelines was a major achievement [that provided a] framework for the research.[11]

### 3.2. Approach

After agreeing on what the project was to achieve, the first task was to develop a research approach and philosophy, which were summarized as follows: [12]

- The research was action-oriented in the sense that it aimed at producing knowledge that would feed directly into policymaking, decision-making, and planning activities. It was also supposed to generate a learning process shared by all the participants that would lead to better implementation (and formulation) of technology policies. This implied leaving aside the more traditional concept of academic social science research, replacing it with an action-oriented research approach on science and technology policy implementation.

- The research did not focus on the policy formation process at the macro level, or on the individual processes of technology decision-making at the micro level (productive unit, government agency, research institute), but rather on the interrelations between these two. The idea was to examine the instruments and mechanisms that mediate between the macro and the micro decisions. One of the main aspects to study was the divorce —or coincidence— of individual

---

[11] KunMo Chung, "Making industry competitive", in David Spurgeon (editor), *Give us the tools: science and technology for Development*, Ottawa, International Development Research Centre (IDRC), 1979, p. 52.

[12] Francisco Sagasti, *The Science and Technology Policy Instruments (STPI) Project: A Comparative Research Effort Among Less-developed Countries to Examine Ways and Means of Implementing Science and Technology Policies in the Industrial Sector*. Ottawa, IDRC, 1975.

rationality at the micro level and of collective rationality at the macro level, always in relation to science and technology policies, plans and decisions.

- The research was both interdisciplinary and inter-institutional in each participating country. Teams consisting of lawyers, economists, administrators, scientists and engineers studied policy implementation mechanisms. They jointly identified and characterized instruments and assessed their relative effects. The research also required participation from government agencies, private enterprises, and research organizations. Not all of these were directly involved in carrying out the research, but their collaboration to supply information and to feed their points of view into the project was necessary.

- The research was contextual in the sense that it postulated that instruments and mechanisms to implement science and technology policies couldn't be adequately studied without taking into account the specific context in which they operate. It also postulated that the interactions among different government policies play an important role in shaping scientific and technological behavior. Starting from the point of view of technology and science policies, it became necessary to examine the interrelations between economic, educational and social policies to uncover the overall resultant policies for science and technology. The same applied to the instruments and mechanisms that are employed to implement these policies.

The action-oriented nature of STPI was clearly summarized by a country coordinator as follows:

> *"One of the central ideas of the STPI project was to conduct research that would have a direct impact on science and technology policy formulation and implementation in government and industry. The term 'action oriented research' was used to describe this characteristic: to provide positive advice to decision-makers, based on solid, respectable work — data gathering, analysis and problem solving.*
>
> *Although the idea of action-oriented research immediately drew acceptance from the participating teams, it became clear that its implementation would be difficult. Generation of policy alternatives is the easier part; incorporating new policy ideas into the political-economic system requires thorough understanding of that system. The decision-making hierarchy is a dynamic system and involves actors. Under the rapidly changing conditions in the developing countries, coordination among different agencies requires authoritative power and persistent persuasion.*
>
> […]
>
> *Action-oriented policy research requires a sacrifice. Since most real-life problems are complicated by a large number of factors, one usually cannot simplify them enough to make possible a thorough policy analysis. Yet these problems require action and action must be taken in time. Very often policy making must proceed with only limited knowledge and "bad" solutions are adopted in favor of "worse" solutions. Decision-making under imperfect conditions and adoption of less-than-satisfactory solutions calls for actions that many policy analysts would have tried to avoid in the first place. If a*

*research project sets out to be action-oriented, the project becomes a "learning" project rather than a "teaching" project. Since researchers wish to find new knowledge that can be transmitted to others, the STPI research team had to give up the teaching and credit-taking aspect of research work. This is not acceptable to many serious policy analysts, but it does not bother engineers and scientists whose ambitions are less likely to be in the area of policy research. In this sense, the early decision to invite non-policy analysts to the STPI project turned to be a smart move in many participating countries.*

*It is difficult and unwise to recognize individual contributions by STPI project teams in actual policy-making. Such recognition should be given to the decision-makers in government and industry. However, there have been many instances of positive contributions by the STPI teams. Among other initiatives, they were instrumental in introducing new R&D funding formats; evaluation techniques for investments projects; import regulations for foreign technologies; the use of state enterprises to increase adaptation of foreign technologies; reorganization of research institutions; the use of promotional measures for consulting engineers and design organizations; the introduction of technology policies into economic planning; tax incentives for technological activities; standardization and quality control."*[13]

[13] KunMo Chung, "Making industry competitive", in David Spurgeon (editor), *Give us the tools: science and technology for Development*, Ottawa, International Development Research Centre (IDRC), 1979, pp. 53-56.

## 4. THE STPI PROJECT: METHODOLOGY[14]

The basic approach of the STPI project influenced the methodological guidelines in three ways. First, theoretical aspects were stressed less than in an academic exercise because of the action oriented nature of STPI. Second, the research did not focus on the formation of science and technology policy either at the macro level or at the firm's level; it was rather concerned with the interaction between macro policies and micro decisions on technology. Third, contextual factors were taken into consideration, primarily by focusing on the historical evolution and specificity of the relations between the economy, industry, science and technology in each country under study.

The diversity of contexts precluded preparing precise instructions for research that would be relevant to all country teams. Rather than a blueprint, the methodological guidelines offered a common framework with concepts, language and procedures to guide research and facilitate comparability. One limitation of the guidelines was that they gave a static picture of science and technology policy formulation and implementation. Country teams were asked to assess the functioning of policy instruments in the light of a desired societal model and the role that science and technology should play. Otherwise it would have been almost impossible to suggest improvements in the design and operation of policies and policy instruments, for the teams would not know the direction that changes should take.

### 4.1. The effects of policy and contextual factors on science and technology

The main research task in STPI was to explore cause-and-effect relationships in an ordered way, generating partial explanatory hypotheses that, once verified, may increase the effectiveness of science and technology policy instruments, and improve their contribution to development objectives. These cause-and-effect hypotheses will not usually be simple and unidirectional, and it may not be easy to express them in quantitative terms.

Three groups of independent variables or sources of influence affecting the behavior of agents in the science and technology system were identified:

- Explicit science and technology policy and instruments: They have a definite, clear and identifiable purpose of having an impact on science and technology functions and activities, and of the agents involved in them;
- Implicit science and technology policy and instruments: Their purpose is to produce effects and influence behavior of agents not directly involved in science and technology functions and activities, but that have unintended effects and consequences on these activities. A better knowledge of implicit policies and their impact would enable policymakers to minimize or eliminate their negative influence and to heighten their positive effects. Eventually, these implicit policies

[14] This section extracts and summarizes key ideas put forward in Francisco Sagasti and Alberto Aráoz, *Methodological Guidelines for the STPI Project*, Lima, Office of the Field Coordinator, STPI Project/Ottawa, IDRC, 1975.

and their related instruments may be transformed into purposeful "indirect" policy instruments for science and technology policies;
- Contextual factors: These factors are consequence of a country's history, culture, society, resources and geography, among other factors. Some of these could be modifiable in the long run, but for the purposes of STPI research they can be considered as fixed. They refer to broad economic, cultural, or social aspects, as well as to the characteristics of enterprises, research institutions, government agencies and academic organizations that emerge out of historical evolution. Contextual factors set the scene and condition the design and implementation of explicit and implicit policies and policy instruments.

Explicit and implicit science and technology policies and instruments may act directly on the dependent variables, but usually they do so through various institutions in charge of wielding them. The institutional setting may enhance, dampen, modify or distort the objectives and intentions of a given policy, thus affecting its impact on the dependent variable, its influence on the behavior of the relevant agents, overall and the effectiveness of the policy instrument. Contextual factors condition the institutional setting and the way policies are formulated and put in practice.

Dependent variables are those functions and activities having to do with the production, diffusion, transfer, and utilization of science and technology. They were divided into three groups:

- Those on the demand side, related to the technological behavior and the technological decisions of productive units;
- Those on the supply side, related to the activities in the science and technology system proper that have as end products new technological knowledge and various scientific and technological services;
- Those in what may be termed the linkage area, which put in contact the productive system with domestic and foreign sources of science and technology knowledge.

### 4.2. The concept of "policy instruments"

A focus on policy implementation required that the concepts of policy and policy instrument be clearly defined. While the definitions that follow refer to explicit policies, they are also applicable to implicit policies and indirect instrument.

An explicit science and technology policy is a statement by a high level government official or institution that deals with a particular "issue" in science and technology: it expresses a purpose, sets objectives, defines desired outcomes, and may also establish quantitative goals. Policies should also specify criteria for choosing among alternative options to perform of science and technology functions and activities, and thus provide guidance for decision-making. The issue dealt with may be very specific, referring to some particular purpose or decision to be taken and the criteria associated with it, or it may be of a general nature.

Implicit policies and their instruments refer to public policies and decisions aimed at functions and activities other than science and technology, but that have unintended or side effects upon the latter. These second order consequences are seldom taken into account in the design of policies and policy instruments, and policymakers have, at best, a dim awareness of the ways their actions in one area of public policy may affect policies in other areas.

A policy may remain a mere rhetorical statement if no provisions are made to implement and realize its potential effect. A policy instrument comprises the set of ways and means employed to put in practice a policy. It is the vehicle through which those in charge of formulating and implementing policies make use of their capacity to influence decisions taken by others. It is the connecting link between the purpose expressed in a policy and the effect that is sought in practice.

A science and technology policy instrument refers to the ways and means that aim to implement policies that affect science and technology variables and the behavior of agents associated with them. It is direct when it focuses explicitly on science and technology functions and activities, and indirect when, although referring primarily to policies, functions or activities other than science and technology, it has an important indirect effect on science and technology functions and activities.

A policy instrument comprises the following components:

- A legal device that carries prescriptive weight and is backed by recognized authorities. It embodies the content of the policy in the form of laws, decrees, regulations, contracts or similar formal agreements. A legal device goes one step beyond the simple enunciation of a policy by stipulating obligations, rights, rewards and penalties connected with abiding by its injunctions.

- An organizational structure in charge of administering policy implementation, and include:

    - One or more institutions. A policy may be implemented through existing institutions, or through a newly created one. Institutions may be thought of as the "hardware" component of the organizational structure.
    - The procedures, methods, decision criteria and programs employed by these institutions. They specify the administrative and technical steps to be carried out when applying the policy. They may be considered as the "software" of the organizational structure.
- A set of operational mechanisms, which are the levers, or actual means, through which the organizational structure implements decisions on a day-to-day basis. They involve interactions and transactions between those in charge implementing the policy and the agents whose behavior the policy aims to influence.

Throughout the analysis of a policy instrument it is important to keep in mind the actors or key decision-makers who are directly involved in its design. An instrument does not act on its own; it responds to the will of the policymakers and decision-makers using it.

Figure 1 summarizes the structure of a policy instrument. Figure 2 shows four cases of incomplete policy instruments. The first has no legal device, and the instrument is made up of just the organizational structure and the operational mechanisms (policies are to be implemented without introducing new legislation or other legal device). The second lacks an organizational structure and operational instruments, and the legal device supposedly causes the desired effects just on its own (this is the case of many laws and decrees that remain on paper). In the third case no instrument is provided to implement a policy (its effects are supposed to result from exhortation and persuasion). In the last case, there is no high level policy or legal device, and policy decisions are made and implemented by an organization that does not have a broad policymaking mandate (policies made in a piecemeal fashion by government agencies and other organizations).

FIGURE 1: **Structure of a policy instrument**

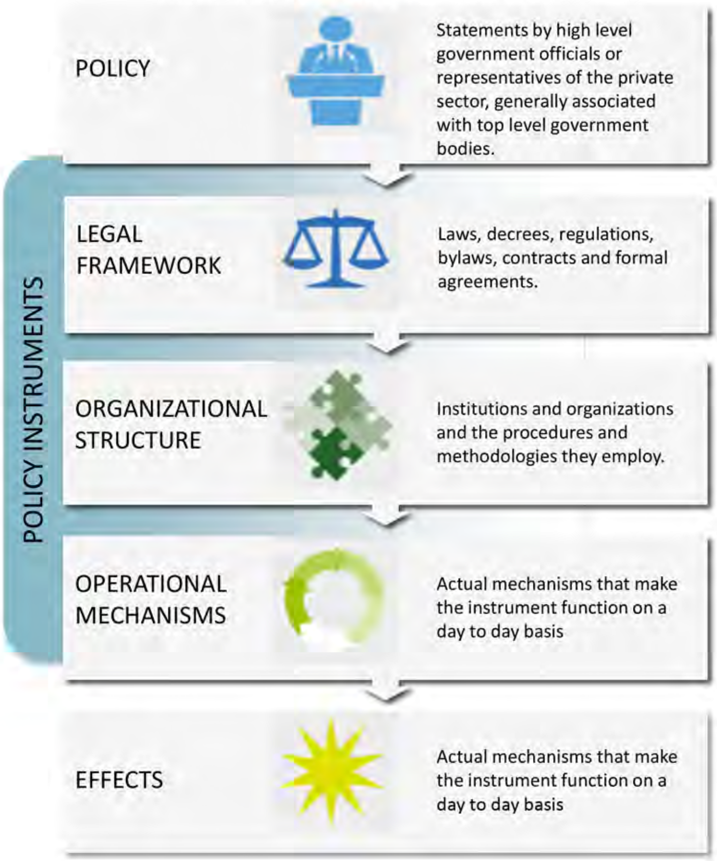
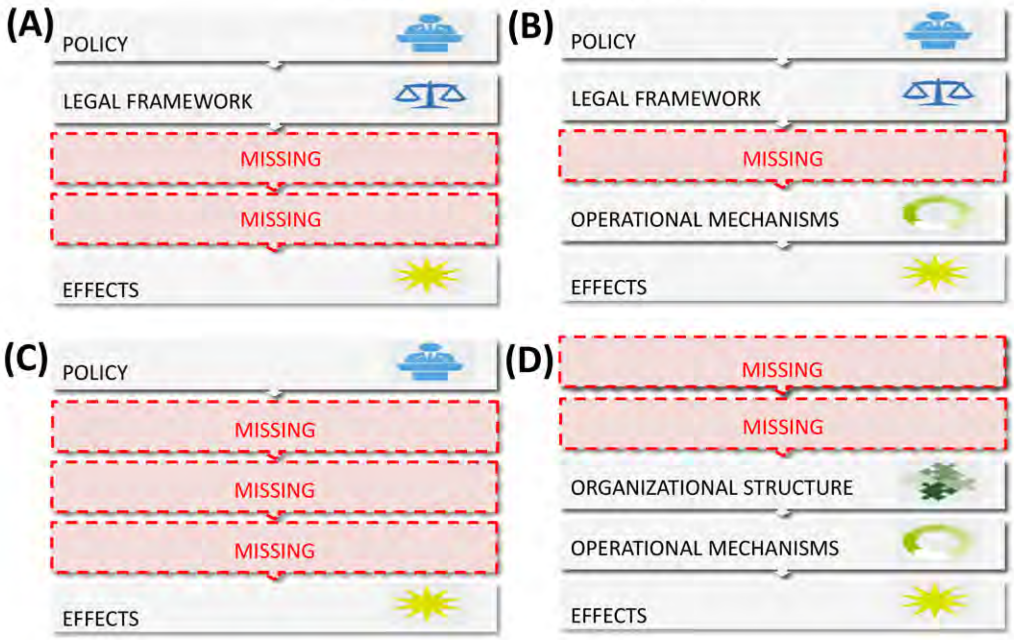



FIGURE 2: **Pathologies of policy instruments**




*Source*: Figures 1 and 2 are based on; Francisco Sagasti and Alberto Aráoz, *Methodological Guidelines for the Science and Technology Policy (STPI) Instruments Project*, Ottawa, IDRC, 1975, pp. 17-19, but using the graphic presentation of figure A in the UNESCO report *Mapping Research and Innovation in the Republic of Botswana*, GO-SPIN Country Profiles in Science, Technology and Innovation Policy, Paris, 2013, p. xxii.

### 4.3. The operation of a policy instrument and the role of the "policy-keepers"[15]

In practice a policy instrument does not remain fixed and immutable, but evolves through a series of stages before it becomes obsolete and is replaced by other policy instruments. In this process of growth, maturation and decay, the agents in charge of operating them, who may be called the policy-keepers, are the main actors.

The genesis and lifespan of a policy instrument spans a period that begins with the formulation of the policy itself. At this stage the policymaker plays the most important role and is responsible for steering the formulation of a policy up to the point where the instruments for its implementation are designed and approved. The actual life of a policy instrument begins when the legal devices, organizational structures, and operational mechanisms necessary for its functioning are established.

Over time, the dynamics of policy implementation will lead to many changes in one or more of the components of the instruments. Modifications of the initial laws and decrees may be enacted, organizations could be restructured, operational procedures changed, and, in general, it is likely that the instrument will undergo a process of adaptation and adjustment to improve implementation. Mutation and change take place through the active intervention of those in charge of operating the instrument: the policy-keepers. The policy keeper operates within the framework provided by the legal devices and the organizational structures, and is in charge of the day-to-day operation of the policy instrument.

The policy-keeper has the task of making the instrument function in accordance with the objectives and criteria established in the policy. Over time, it is likely that he or she will modify the legal and organizational framework within which he or she works, and the operational mechanisms employed. The scope for action of a policy-keeper will be much greater when dealing with discretionary instruments that require decisions by those in charge of administering the policy, than it is in the case of non-discretionary instruments where there is no room for administrative interpretation.

In practice, the distinction between the policymaker and the policy-keeper may be artificial, for the responsibility of designing and operating the policy instrument could fall on the same person. In addition, the policy-keeper of a particular instrument may be more than one individual, for example, a committee. Some policy-keepers may handle several policy instruments at the same time and manage a cluster of policy instruments, configuring a network of formal and informal contacts that support each other. Networks of policy-keepers are particularly important, for the performance and impact of policy instruments may depend more on shared knowledge and experience than on the legal device, the institutional structures and the operational mechanisms.

---

[15] This section is based on *Agents in the process of scientific and technological development: the policy-keepers*, a report prepared by Phactuel Rego from the OAS, and presented at the Cairo meeting of the coordinating committee of the STPI project in November 1974.

### 4.4. Factors affecting technological behavior of industrial firms

The effectiveness of a science and technology policy instrument should be appraised in terms of the changes it induces in the behavior of agents it aims to influence. Its impact on the way firms make technological decisions is particularly important, for this shapes the demand for technology. As enterprise decisions are subject to a variety of influences, the task is to single out their effect, separating it from the variety of factors that mold the technological behavior of firms.

From the perspective of a particular policy instrument and the firm whose technological behavior it seeks to shape, contextual factors are a first source of influence. These include geography, climate, resource endowments, and the like, which are invariant and usually do not affect directly a specific firm, but condition the whole economy; attitudes toward work, educational levels, labor force competences and so on, which shape the social and cultural milieu in which the enterprise operates; and the accumulated effects of policies sustained over long periods, which lead to managerial mindsets and habits that are difficult to change.

Government policies at the national, sectorial, and branch level are a second source of influence that constitute the overall policy environment comprising explicit and implicit policies for science and technology, which surround the specific policy under study. The structural characteristics of the industrial branch in which the firm operates would be a second source of influence, for it determines the patterns of competition, the type of technologies employed, and backward and forward linkages, among other factors.

Another source of influence that conditions the impact of a policy instrument on technology decisions are the internal structure and characteristics of the firm. Enterprise organization, human resources, finance, ownership and governance are also among the issues to consider. Special attention should be given to factors that limit the range of technological decisions, such the stock of capital equipment that configures path dependency, capacities for technical problem-solving, quality control practices, the performance of research and development activities, access to external sources of technology, both foreign and domestic.

All of these sources of influence compete with a given science and technology policy to shape decision making in matters of technology at the firm level. Assessing the relative impact of the instrument in relation to those other sources of influence is no easy task, but is essential to determine the effectiveness of policy design and implementation.

### 4.5. Evaluation of the performance of policy instruments

Assessing the performance of a science and technology policy instruments raises several questions: Should an instrument be evaluated independently of the policy it is associated with? Is there an absolute measure of the effectiveness of an instrument, or should they just be compared with one another? Should the performance of policy-keepers be taken into account? Should instruments be evaluated on an individual basis, or considered as clusters? While each STPI team answered these questions in its own context, a few evaluation criteria were suggested to assist the national teams.

The scope and specificity of an instrument refers to the range of science and technology functions and activities it affects, or the types of technological decisions it can influence. An instrument would have a wider scope the larger the number of science and technology functions and activities it affects. It would be a very specific instrument if designed to affect one particular science and technology function, and to focus on some predetermined group of enterprises, agencies or research institutions.

The coverage of an instrument was defined as the number or proportion of productive units, government agencies, research organizations and similar entities the instrument was capable of affecting. The equity or fairness of an instrument focuses whether it had the same impact on all units with similar characteristics. Diverse circumstances, exceptions and loopholes may give rise to situations in which the instrument cannot be applied in the same way to all cases with similar characteristics.

The efficiency of an instrument focused on the relation between the effort (administrative, financial, technical) and the effects that result from its application. The effort may include quantitative considerations such as cost, or qualitative such as expertise needed to operate it. Other parameters for evaluating the performance of policy instruments include the flexibility with which it can be used and the amount of information required for its application. The time lags involved in the application of an instrument are also crucial, for policies may be changed before the policy instruments associated with a preceding policy vintage have had time to filter through the organizational structure, and to influence the behavior of the agents performing science and technology functions and activities.

Of particular importance was the concept of effectiveness of an instrument, which referred to the likelihood of obtaining the desired result: that is, implementing the policy to shape the behavior of agents in accordance to its objectives. It was difficult to evaluate effectiveness, primarily because instruments do not function in a simple, linear way, and it is also necessary to consider its side effects. In addition, policy instruments are often designed to influence more than one science and technology function, achieving this with varying degrees of success. It was also necessary to consider their effects on the functioning of other policy instruments, to acknowledge, and that the performance of an instrument depends on the skills and ability of the policy-keepers in charge of its operation.

### 4.6. An overview of the research in STPI

The contribution of science and technology to development depends on the behavior of the agents involved in the performance of science and technology functions and activities, including enterprises, research centers, academic institutions, technology suppliers and government agencies. It is the result of interactions among myriad technological decisions made by a multiplicity of agents at various levels, as well as decisions that do not focus on science and technology functions and activities, but that affect them indirectly. (Figure 3)

The task of science and technology policy implementation is to design and operate policy instruments to orient the performance of science and technology functions and activities according the objectives of the policy. This is a process that must bridge the gap between policymaking at the level of public policy agencies and that of decision-making at the level of enterprises, research centers, academic institutions, engineering firms or technology suppliers level.

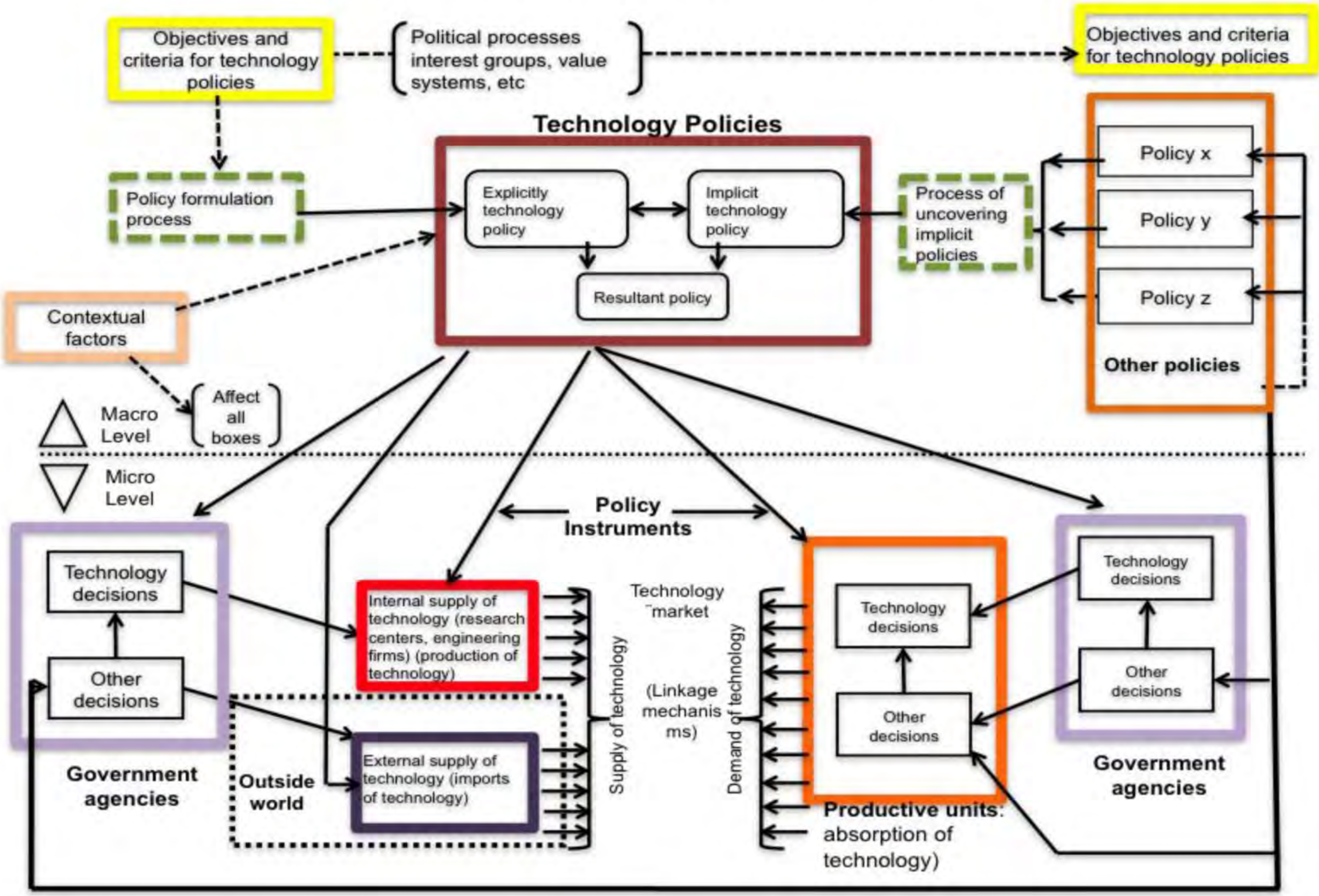
Policies for science and technology in the real world are the result of complex interactions between explicit and implicit policies, and not a simple translation of science and technology objectives into criteria for decision-making. If, on the one hand, we have the objectives and criteria that lead to the formulation of explicit technological policies, on the other hand there are many objectives and criteria for the formulation of other policies (industrial, financial, labor, foreign trade, and so on) that have an important impact science and technology activities. It is necessary to uncover the implications of other policies to assess the results of interactions between implicit and explicit policies.

When examining the interaction between implicit and explicit policies, many inconsistencies are likely to be found, and the resultant policy will contain many contradictory elements whose predominance will be determined by the relative strength of the policy instrument used to implement it. For example, it is generally recognized that fiscal incentives for research and development in industrial firms are relatively weak in comparison with financial and credit instruments support the purchase of foreign capital equipment and technology. Therefore, it is likely that the component of the resultant policy that promotes the import of technology will prevail over the component that induces the performance of domestic research and development.

Figure 3 also points out that the technological decisions made by enterprises determine the technology absorption capacity of the country or industry, as well as the pattern of demand for technology. The decisions made by research centers and engineering firms determine the internal supply of technology, whereas the decisions of foreign consultants, multinational enterprises, licensers, suppliers of equipment, and so on, determine the external supply of technology. Among the factors conditioning the decisions made by each of these agents we find the policy instruments employed by the government. The crucial problem in the design and operation of an instrument is that of determining its relative influence on the decisions taken by these actors. Unless this is known with a degree of certainty, it will be virtually impossible to anticipate the real effects of a particular policy and its corresponding policy instruments.

In the study of science and technology policy implementation it is also necessary to consider the individuals in charge of designing and operating the policy instruments, for these do not come into existence and function independently of the policymakers and the policy-keepers. An assessment of the relative impact of policy instruments must take into account the skill requirements and the characteristics of those in charge of operating them. Finally, the influence of contextual factors must also be taken into account, for policies, policy instruments, and policy-keepers do not exist in a vacuum.

FIGURE 3: **An overview of the STPI approach to research on policy implementation**



## 5. AN OVERVIEW OF STPI FIELD WORK AND RESULTS

The various country reports and the main comparative report of the STPI project describe the main results obtained during the research, focusing on the working of policy instruments and their impact on building science and technology capabilities, and on the technological behavior of the industrial branches chosen for study. This part of the report offers a brief overview of the work carried out by each country team, highlights a few findings on policy implementation, and describes the common features and main characteristics of the industrial science and technology policy instruments that were analyzed.

### 5.1. Survey of the country teams' work

The organization, composition, and orientation of each of the country teams reflected their own interests and those of the institutions that hosted them, but within the framework of STPI project concerns, approach and methodology. A brief review of the work of each team and the field coordinator's office describes how STPI was carried out

**Argentina**: The initial location for the Argentine team was the Department of Economics of the Catholic University. However, after some months, the university decided to withdraw its application and the country coordinator moved to the Argentine branch of the executive secretariat of the Latin American Social Science Council (CLACSO). Economist Eduardo Amadeo was the country coordinator and the team consisted of two full time researchers and several consultants to work on specific topics, with the support of an advisory committee of researchers and policymakers active in science and technology.

A significant change took place when the country coordinator was named president of the Instituto Nacional de Tecnologia Industrial (INTI), the largest and most important industrial research organization in Argentina. Part of the team's work was reoriented to be most useful to the coordinator in his new position. Mr. Amadeo never relinquished his formal role as coordinator; after several months, he left his new post and resumed his position as country coordinator. Because most of the work was well under way, his absence did not substantially alter the team's pace, although the preparation of the Argentine synthesis report was somewhat delayed.

The Argentine research team focused on two branches of industry —machine tools and petrochemicals— but studied many other issues. For instance, the reports include a document on the technological content of the three-year development plan (1974-77), a study of the Argentine industrial structure, a description and analysis of technology policy instruments in Argentina, a study of the system for regulating technology imports, and a report on international technical assistance as an instrument of technology policy.

The structure of the Argentine scientific and technological system was studied in detail, as were the conditions under which it could be made more responsive to industry's needs. The Argentine team examined the role of the public sector as promoter of scientific and technological development, with case studies on two state-owned enterprises; one in charge of generating electricity in Buenos Aires (SEGBA), and the other in charge of generating and distributing gas for household and industrial consumption. Other subjects covered by the Argentine team were: a study of the emergence and development of engineering and consulting firms in the chemical process industries, a detailed analysis of two research centers within the national industrial technology institute (INTI), and studies on capital accumulation and on the crisis of capitalism from an Argentinian perspective.

The Argentinian team adhered closely to the STPI methodological guidelines, but carried out complementary studies that were more attuned to the policy requirements of public sector institutions

**Brazil**: The Brazilian team was hosted at the research group of the Financiadora de Estudos e Projetos (FINEP), the state agency in charge of financing studies for investment projects and also the executive arm of the national fund for scientific and technological development. The first coordinator was the director of the research group, Fabio Erber. When he took a leave of absence from FINEP in September 1974, he was replaced by ]osé Tavares, the new head of the research group. The group at FINEP had been carrying out research on science and technology policy for some time, and the STPI assignment was one of its tasks for 1973-76. Members of the FINEP research group did most of the research for the STPI project, although a few reports were contracted to independent consultants.

From the beginning, the Brazilians decided to concentrate on the role of state enterprises in technology policy. They chose branches of industry that were dominated by state enterprises (oil and petrochemicals, steel, and electricity), and studies issues such as the selection of equipment and processes, the purchase of engineering services, the performance of research and development activities, and the planning processes at these state enterprises.

In addition to the new material generated by the Brazilian team during STPI, several reports based on past research carried out by FINEP were made available to the STPI network. These included background reports on the organization and structure of the Brazilian science and technology system, a study on the machine tool industry, a report on the demand for services of twelve research institutes, and a background report on industrial policies in Brazil during the last two decades.

In parallel with the work for STPI, the FINEP team was also engaged in a research project on the diffusion of technical innovations in three industrial branches (pulp and paper, cement, and textiles) and they agreed to put their results at the disposal of the STPI network as an additional contribution. The Brazilian team used the guidelines only as a general reference, given that most of their work went along different lines from those originally envisaged for the project.

**Colombia**: No Colombian participant was present at the Barbados meeting, and the Colombian application to join the STPI network was received later and formally accepted at the Rio meeting of the coordinating committee. The team was hosted by the Colombian Council for Science and Technology, COLCIENCIAS, and was headed by a sociologist, Fernando Chaparro. In spite of joining the STPI network late, the Colombian team caught up with the pace of work and finished all its work by the deadline.

COLCIENCIAS organized a special team with five members who devoted practically all their time to research in STPI, and several consultants were asked to prepare reports on specific issues. Studies were commissioned on the impact of tariff mechanisms, the influence of price controls, and the possible use of the state's purchasing power as instruments of technology policy. The branches chosen for study were all linked to agriculture: fertilizers and pesticides, agricultural machinery and food processing. Reports prepared by the Colombian team included a study of science and technology planning, an analysis of implicit industrial technology policies, a conceptual framework for the study of consulting and engineering organizations, a series of reports on industrial branches based on discussions with panels of experts, a study of science and technology policies in the agricultural sector (to complement the analysis done for industry), and two essays on the process of industrialization in Colombia and its technological implications.

**Egypt:** Although an Egyptian representative participated in the initial deliberations leading to the STPI project, it was not possible to organize the team to carry out research and prepare inputs for the international comparison. There were several administrative difficulties and staffing problems that prevented the organization of a working team. The host institution was the Academy of Scientific Research and Technology and the first coordinator was Adel Sabet, who was replaced by Gamal A. Samie in ]uly 1975.

The Egyptian team presented papers that were personal contributions based on past experience rather than the result of original research. Nonetheless, the field coordinator and other members of the STPI network interacted with Egyptian science and technology policy authorities, and in particular with the director of the National Research Centre, during visits to Cairo and the meeting of the coordinating committee that took place in that city. These interactions supported initiatives to involve the Centre more closely in contract research, and not depend exclusively of central government budget allocations.

**India:** The host organization in India was the National Committee on Science and Technology, and the first coordinator was Anil Malhotra, who was replaced in June 1975 by S.K. Subramanian. Dr. Subramanian resigned in March 1976, and no one replaced him. No funds were requested to set up a country team in India, and the Indians provided background material that had already been collected as background for a new science and technology plan.

Three background documents were distributed along with the final S&T plan to all the teams in STPI. In addition, a report on foreign collaboration, a note on science and technology planning in India, a survey of engineering consultancy services, a report on the development of the electronics industry, and two papers on small-scale industries and technology transfer were distributed by the Indian coordinator.

**Republic of Korea:** The South Korean team was one of the first to be organized and was established at the Korean Advanced Institute of Science, KAIS, as part of the activities of its science, technology, and society program. KunMo Chung was named country coordinator and the team consisted of five other members. All but one of them had other academic duties and could allocate only a portion of their time to STPI research. Consultant Graham ]ones was retained to advise the Korean team in the preparation of the report for phase 1. The South Korean team advanced rapidly and completed its work in time for the Sussex workshop, largely following the methodological guidelines.

The branches chosen for study were electronics, petrochemicals, and powder metallurgy. In addition, the team prepared reports on engineering services and industrialization, on the role of the Korean Institute of Science and Technology (KIST), on transfer of technology in the electronics industry, on the interface between the science and technology plan and the economic development plan, and on state enterprises in technical development.

Recognizing the difficulty of carrying out action-oriented research at an academic institution, the Korean STPI team invited a number of governmental and industrial planners and decision makers to be advisors and critics, and also functioned as a sounding board for their initiatives and ideas. In addition, team members were involved in high technology industrial activities as advisors and consultants, served on various government committees that drafted and reviewed policy papers, and acted as liaison between local and international policy researchers. As the STPI team and decision-makers gained confidence in each other, the STPI team succeeded in making inputs into the policymaking process without seeking recognition for their contribution.

**Mexico:** The Mexican team was among the first to start working in STPI and was located at El Colegio de Mexico, an academic and social research and graduate training organization. Alejandro Nadal was country coordinator and there were four other members of the team who worked full time on STPI. The Mexican team initially followed the guidelines rather closely and was one of the first in suggesting modifications and changes as a result of contrasting concepts with preliminary research findings. In particular, the team found it difficult to interpret the results of interviews in enterprises using the schema proposed to study technological behavior. The branches chosen for detailed study were capital goods, food processing, and petrochemicals.

A background report on the structure and evolution of the Mexican scientific and technological system was prepared, together with a description of the industrialization process and of agricultural development. Documents on particular subjects included a report on engineering firms, a study of the technology policy of PEMEX (the state oil monopoly). The work of the Mexican team covered practically all the research topics considered in STPI, and its contribution to the comparative report reflects this. The Mexican report was published in Spanish and was awarded second prize in a contest for the best works in economics published in 1977.

**Peru:** The Peruvian team was established within the research group of the National Planning lnstitute. A series of administrative difficulties affected the progress of the team, including a change of technical director, when Roberto Wangeman replaced Fernando Gonzales Vigil in February 1975. The team decided to adopt a sectorial approach to the research. Efforts were focused on the study of industrial branches connected with the extraction and processing of minerals and with the provision of machinery for the mining industry. The steel industry was also studied, with emphasis on the state enterprise in charge of the largest steelworks. This meant that the guidelines were u used primarily in sectorial studies and in the analysis of policy instruments.

Background reports on the situation of the scientific and technological system and on the evolution of Peruvian industry were prepared following the general framework of the guidelines. In addition to these and the sectorial reports, the team prepared documents on explicit and implicit science and technology policies, consulting and engineering capabilities, the use of state enterprises as instruments of technology policy, and the government administrative machinery for science and technology policy.

The Peruvian team was located within an official government organization, but its direct impact on policymaking is difficult to assess because it took the form of daily contact with government officials. Nevertheless, it influenced decisions taken by the National Planning Institute, the National Research Council, and the Industrial Technology Research Institute.

**Venezuela:** The Venezuelan team was hosted by the national council of science and technology (CONICIT) and was among the first to start working. Initially dominated by sociologists, economists were incorporated to the team at later stages. Luis Matos replaced the first coordinator, Dulce de Uzcátegui, and was soon followed by Ignacio Avalos, which three members working full time. A government change punctuated the two stages of work of the Venezuelan team. During the first stage, background reports were prepared on the science and technology, political, educational, and the economic systems, but these were made obsolete by the policies adopted after the change in government. In the second stage, the team adjusted its work program to the new situation, updating the earlier studies and moving forward with the research. The branches chosen for study were capital goods, electronics, and petrochemicals, and reports were written on institutional arrangements for science and technology policy, industrial science and technology policy instruments, and the relations between the financial system and technology policy.

The Venezuelan team was located in a government agency and took an active role in science and technology policy, particularly after the change in government created both opportunities and problems. The new roles and tasks assigned to CONICIT altered the pace and continuity of the STPI work, but made it possible to actively contribute to policy design and implementation.

**Yugoslavia (Macedonia):** The research in the STPI project took place before the Macedonia became independent, and the Macedonian team was organized at the faculty of economics of the University of Skopje. A senior faculty member, Nikola Kljusev, was appointed coordinator. The team was composed of a large number of faculty members and researchers who devoted part of their time to STPI. The tasks were subdivided and individual reports requested from various members of the team, although at a later stage two team members were asked to work full time on STPI. In general, the Macedonian team did not follow the guidelines, except in the preparation of a background report for the Macedonian project. Individual reports were submitted on issues of interest to the STPI network, covering topics such as the problems of research and development in industrial enterprises, aspects of science and technology policy in Yugoslavia, the metallurgical industry in Macedonia, and the growth of engineering firms in Yugoslavia.

The Macedonian team made a limited contribution to the comparative reports. At any rate, given the high degree of participation of professionals at all levels in policymaking in the Yugoslav self-managed economy, many of the findings of the STPI project probably made their way into policy circles, although it was difficult to assess their contribution in practice. The fact that the country coordinator became Primer Minister of Macedonia after independence could have channeled some STPI results into policy-making, although in an indirect way.

**Field Coordinator's Office:** At the first meeting of the coordinating committee, Francisco Sagasti was appointed field coordinator of the project. The office began operating in August 1973, and Onelia Cardettini and Carlos Contreras joined as members of the office. The field coordinator's office was independent from the teams and was not engaged directly in empirical research. It offered organizational and technical support and contracted consultants to prepare reports on topics defined by the coordinating committee.

The field coordinator and Alberto Araoz, working as consultant to the field coordinator’s office, prepared the methodological guidelines for STPI. Background reports on technology policy in China, on technological dependence/self-reliance, on science and technology planning, on technology policies in Japan, and on technology transfer were also prepared, either by staff members of the field coordinator's office or by consultants. The office also organized the August 1976 Sussex workshop and drafted the comparative reports. The field coordinator was also active as vice-chairman of the board of the Peruvian Industrial Technology Institute (ITINTEC).

With the exception of the teams that were engaged in science and technology policy research as part of the activities of their institutions (the Brazilian and South Korean teams, for example), the teams were dismantled after the STPI project was completed. The field coordinator's office was closed in December 1976, and the comparative reports were prepared during 1977-1978, although some teams finished their work in early 1978. The STPI project was designed to be a temporary exercise, bringing together researchers and policy makers for a specific purpose during a limited period. The formal organizational structure was dismantled at the end of the project, even though most STPI network members remained active in the field of science and technology policy research. Several of them attained high policy making positions in their countries and at the international level, and the network of personal contacts was kept active for a long time.

## 5.2. Some STPI findings on policy implementation

The main comparative report and the various country reports summarized the findings and results of the STPI project. As an illustration, a few issues identified in the main comparative report, which were common to several participating countries and the contexts in which their policy making and implementation activities, will be highlighted in this section.

First, STPI identified the "style" of policy implementation in each participating countries, focusing on the role of the state in orienting industrialization and the structure of industrial activities. At that time, in the STPI countries, with the exception of Peru and South Korea, the state provided only general support to industry across a wide front, without attempting to define the direction of industrial growth and leaving the structuring of industry primarily to market forces. Peru had adopted an authoritarian style, with laws providing a detailed framework for industrial evolution, with a clear definition of industry priorities, and with active state enterprises in some branches. South Korea adopted a style of selective but intensive support of a few key industries (mainly the export-oriented branches) through close interaction of the state with private industry, measures to support large industrial conglomerates, and with a key role reserved for state enterprises in some sectors such as steel. Nevertheless, even in the countries that left their industry to be shaped by market forces, there were efforts to promote specific branches, such as capital goods in Brazil and Mexico, and agroindustry in Colombia.

Another dimension of the implementation style referred to the reliance on command and control or on promotion and incentive policy instruments. Although these options are not exclusive, most STPI countries used promotional measures and provided incentives to industrial firms, with some countries focusing them on specific branches and others applying indiscriminately regardless of the specific industrial activity. The exceptions were Colombia and Peru, which had a number of restrictive measures to control technology imports, regulate the use of foreign exchange, or reserved some industrial activities for state enterprises.

The coherence between science and technology policies on the one hand, and industrial development policies, was another dimension of the style of policy implementation. South Korea and Brazil were outstanding cases in this regard, while Argentina and, to a lesser extent, Colombia, Peru and Venezuela, did not articulate well the two sets of policies. In the latter instances, it was possible to appreciate the inconsistencies between explicit and implicit policies that undermined the development of industrial science and technology capabilities.

Second, it became clear that the unequal distribution of industrial and innovative capabilities between industrialized and developing countries prevailing in the 1970s could not be drastically altered in the short or medium term. It was acknowledged that the process of building up endogenous scientific and technological capabilities for industry took a long time and required determined efforts sustained over decades. It also became clear that it was possible to undertake capacity building initiatives that could yield results in the medium term, while preparing the ground for more substantive efforts at a later stage. It was also possible to identify measures to limit the negative effects of indiscriminate technology imports, and to turn them into a positive force for the development of local science and technology capabilities.

Third, it was recognized at an early stage that opportunities for improving industrial science and technology capabilities are bounded by the growth and evolution of industry, and the two should evolve hand in hand. If capacities for research and development, technical education, support services, laboratory facilities and information systems, among others, outstrip local industry demands, they would fall into a vacuum. Research institutions become self-centered, skilled scientists and engineers emigrate, and investments in infrastructure are wasted. More frequent was the case in which industrial development outpaced the growth of domestic science, technology and engineering capabilities, and which led industry to look abroad for sources of technology. This often led to import turnkey industrial plants as a package, without the participation local scientists and engineers, which prevented any build up of local capabilities and reinforced the isolation of the scientific and technological community. Both situations were found in the STPI countries.

The need to balance the growth and diversification of industrial production with science and technology capacities, so that one reinforces the other, became evident. Considering that some basic research activities were under way in most STPI countries, and that these had little connection with industry, adaptive research, engineering design and consulting, project management, and the preparation of highly skilled scientists and engineers were seen as a priority. This would be the only way to unbundle, examine and absorb imported technology, linking it to domestic capabilities. At a later stage, when adaptive research and engineering capabilities had been acquired, a gradual shift towards applied research and development, and towards basic research would be appropriate.

This realization led to emphasize the need to integrate science and technology policies with industrial policies. A strategic perspective was indispensable to exploit to the fullest possible extent the limited opportunities available to develop local capabilities when facing an onslaught of imported technologies. The prerequisite was developing a shared view among politicians, businessmen, civil servants and members of the scientific and technological community regarding the role that science, technology and engineering capabilities play in industrial development. In this regard, a core group of like-minded persons from these different groups could play an important role, as happened in some of the STPI countries.

Fourth, an initial implicit belief that guided research on policy implementation was that policymaking mistakes were primarily due to ignorance and could be reduced by producing and sharing information. It was expected that the various parties intervening in the process of industrial science and technology development would work in harmony, only if they understood the direct and indirect effects of their actions. This implicit belief changed as STPI findings indicated that other public policies were being made and implemented with complete disregard for their technological implications, and that this was not only due to ignorance or lack of information, but to conflicts of interest between groups with stakes in industrial growth. Towards the end of the project, it became clear that an understanding of the objectives, motivations and values of these groups was necessary to examine the way in which conflicts of interest played out, and to assess their impact on the development of industrial science and technology capabilities.

Fifth, the evidence gathered in the STPI project showed that, with the exception of policy instruments oriented towards building human capital and providing some types of infrastructure, explicit science and technology policy instruments have little impact on technological change, particularly at the early stages of industrialization. The interactions among contextual factors, implicit policies and, to a lesser extent, explicit policies are the main determinants of technological change in industry, and of the development of industrial science and technology capabilities. Furthermore, it was found that enterprises often made technological decisions without considering at all the influence of science and technology policy instruments. After decisions have been made, firms either take advantage of the benefits they provide, or look for ways of getting around the constraints they impose.

Explicit policy instruments were successful in developing human resources and in building an infrastructure for industrial science and technology, but not necessarily in linking them to industrial enterprises. This has been due to the lack of demand for domestic research activities, and the fact that the industrial scientific and technological institutions had not been geared to respond to specific enterprise requests, but rather to support industry as a whole or some industrial branches. In addition, these institutions placed little emphasis on the development of capacities to evaluate, choose and absorb imported technology and to assist industrial firms in making effective use of the technology acquired abroad. Furthermore, the importance of combining explicit and implicit science and technology policy instruments to promote and support the capital goods industries was identified as a priority in several STPI countries.

Sixth, it was found that policy instruments do not affect technological change at the branch and enterprise level in a linear, straightforward manner. Many complex factors and conflicting sources of influence intervene to shape industrial science and technology policy design and implementation. In addition to the overall context for industrial development, the functioning of the government machinery, the orientation and pace of technical change in itself was a key to understanding the possible impact of policy instruments. The experience in STPI suggests that the appropriate level of analysis for policy design and implementation is the industrial branch, even though the opportunities and constraints within a particular branch are not the same for all enterprises and the impact of policy instruments varied accordingly.

The predominant form of competition among firms in an industrial branch, and the role that technology plays in it, were identified as key characteristics that shape the performance of industrial science and technology policy instruments. Competition patterns varied according to the structure of the branch and the relative power of firms in it, the main features of the technology used and its evolution over time, and the behavior of the dominant firms in it.

Competition mechanisms included price reductions to capture larger market shares, product diversification to expand the existing market or create a new one, building distribution channels to bring products close to the consumer, provision of after-sale services to secure consumer loyalty, specialization of production to exploit market niches, promotion of exports to transcend the limitations of local markets, regionalization of production to take advantage of lower transport costs, vertical integration to ensure the control of raw materials and intermediate products, and productivity improvements, among others. Technology plays a different role in each of these mechanisms, which are combined by firms combine these mechanisms to configure their competition strategies.

The predominant pattern of competition resulting from the interaction among firms in an industrial branch determined the relative importance of technical change in individual firm strategies and, in consequence, the impact that policy instruments had on the development of science and technology capabilities in the branch.

The STPI teams adopted different perspectives when studying the impact of policy instruments on the development of science and technology capabilities in industrial branches. Teams in which engineers had a major presence emphasized the nature of technical change, those with economists focused on the structure of the branch, and those that had sociologists tended to pay attention to enterprise behavior. Participants in the STPI project agreed on the combined importance of the three sets of factors, but could not agree on which one was the most important.

### 5.3. Common features of industrial science and technology policy instruments

The array of policy instruments employed to orient the development of industry and of industrial science and technology capabilities was characterized in different ways by the STPI country teams. However, it was possible to identify a few common characteristics that emerged across countries: generality, heterogeneity, passivity, redundancy, incompleteness and formalism.

***Generality***: The majority of the policy instruments identified in the STPI project were general and applied across the board to all industrial branches and all types of enterprises, regardless of the products they manufactured or the technologies they used. An impression remained that policy instruments lacked selectivity to effectively orient the creation of industrial science and technology capabilities, or the technological behavior of firms. Tax incentives, import restrictions and foreign exchange controls were among general policy instruments that lacked selectivity.

Some policy instruments gave discretionary power to government agencies, with the idea that their decisions on a case-by-case basis would counteract the generality of the policy instruments, and adjust them to specific circumstances. However, the lack of well-defined criteria for exercising discretionary power precluded a more selective use of policy instruments. For example, registries of licensing agreements, which were designed to regulate technology imports and gave discretionary power to the officials approving the agreements, were seldom used to regulate the flow of imported technology in accordance with industrial development priorities, primarily because of the lack of well-defined industrial policies and the lack of criteria for screening and approving licensing agreements.

***Heterogeneity***: In most STPI countries the coexistence of policy instruments of various types, responding to different policy orientations, and assuming different forms of rationality of industrial enterprises —many of which were not actually employed— led to a cacophony of policy signals for enterprises, research institutes and other agents in the industrial science and technology system. Heterogeneity was largely a consequence of the temporary presence in government of certain power groups that adopted policies to promote their interests, but that left unchanged the previous array of policies and policy instruments. In some countries, such as México and Argentina, it was possible to identify different vintages of policy instruments, of which only the latest was applied.

Heterogeneity in the array of policy instruments emerged in some cases from conflicts within the state apparatus. Governments are not monolithic; groups with different objectives and rationales compete with each other, and attempt to influence the design and implementation of policy instruments to advance their purposes. The result is a collage of policies and policy instruments, usually associated with conflicting criteria to guide implementation. This was evident when policy instruments involved discretionary power, when several government agencies were involved, and when there was a coordination deficit. The lack of administrative continuity and the erratic behavior of government agencies also contributed to the heterogeneity of the array of policy instruments and led to inconsistencies and contradictions.

***Passivity***: Most policy instruments were passive, in the sense that the agencies in charge did not initiate their application or use. Initiative to make use of an instrument rested on the enterprises, research institutes, consulting and engineering design organizations, among other entities, that were to benefit or withstand their effect. Passivity was associated especially with incentive schemes to promote the development of technology capabilities and influence the technological behavior of firms: their effectiveness was limited because the intended beneficiaries were often unaware of their existence.

Moreover, conditions for the application of instruments were often defined in such a complex way that they became irrelevant to all but a small number of large industrial enterprises having the means to apply for and secure the benefits. The Mexican STPI team found that relatively few enterprises took advantage of incentives to promote research and development activities, and that a handful of industrial firms accounted for a large share of the benefits. This was partly due to the heavy administrative and technical load involved in applying for the incentive, the high transaction costs with government bureaucracies, and the need to have dedicated personnel to secure the benefits.

***Redundancy***: The STPI country teams found instances of several policy instruments aiming at the same objective, attempting to influence the behavior of enterprises and other agents in the industrial science and technology system in the same direction. The effect of one of these instruments makes redundant the other ones and limits their impact. This was the case of incentives to lower the cost of capital for industrial enterprises that undertook science and technology activities, which included special credit lines, tax rebates for equipment purchases, subsidized loans, low tariffs for capital goods imports, tax exemptions for reinvesting profits, accelerated depreciation rates, special tax credits for investing in certain geographical, regions, state provision of infrastructure at low or no cost, among others. These policy instruments conferred a cascade of benefits to firms with the capacity to apply, obtain and utilize them.

Even though individual policy instruments were designed and implemented with a specific purpose in mind, their combination limited their selectivity and influence. Redundancy blunted the impact of policy instruments, and reinforced the tendency for a few large firms that knew their existence, and had the means to take advantage of them, to reap a disproportionate share of the benefits.

***Incompleteness***: This characteristic was often found in policy instruments that aimed at regulating the technological behavior of industrial firms, such as import restrictions, foreign exchange controls, registry and approval of licensing agreements, special visas for foreign experts, among others. Most of these instruments did not cover all enterprises in an industrial branch, and left ample room for exceptions. In particular, it was found that state enterprises were particularly prone to circumvent regulations designed to promote local industry and foster the development of indigenous technological capabilities.

The pathologies of policy instruments described in section 4.2 and figure 2 of this report were observed in most STPI countries. Legal frameworks, organizational arrangements and operational mechanisms were often absent, rendering policy instruments incomplete and inoperative. Legislators passed laws that remained largely on paper, organizations supposed to implement policies were not given the means to do so, and in some cases the lack of policy direction or legal framework allowed existing organizations to use their operational mechanisms to decide, on their own and without coordination with other government agencies, how to influence the behavior of agents in the industrial science and technology system. Another frequent case of incompleteness involved the simple enunciation of a policy, without providing a legal device, organizational structure and operational mechanisms to implement it, and expecting that just exhortation and hectoring could do the job.

***Formalism***: STPI teams found that explicit industrial science and technology policy instruments were just one of the many factors that influenced decision making in enterprises, that they were often viewed as a formality, and that they rarely affected the initial decisions taken by firms on products, inputs and technology. Other factors, such as competition patterns, technological trajectories, and enterprise managerial and technical capacities, were more significant in determining decisions to purchase equipment and technology, conduct research and development, adapt technologies to local inputs and market conditions, among others.

STPI country teams found instances in which firms made technological decisions without considering explicit policy instruments aimed at building industrial science and technology capabilities. These instruments existed as a formality, did not shape enterprise behavior in practice, and could have been removed without adverse consequences. Enterprises paid attention to policy instruments only after technological decisions had been made, primarily to determine whether they imposed constraints or provided benefits. Tax incentives were a case in point. Firms convinced of the value of research and development activities were likely to perform these activities whether tax incentives were provided or not, and tax incentives were too weak an instrument prompt a reluctant enterprise to undertake research. Explicit science and technology policy instruments did not affect the profitability or competitiveness of enterprises sufficiently to induce behavioral changes.

## 5.4. The array of policy instruments studied in STPI[16]

The findings of the STPI teams suggested the following categories for classifying policy instruments:

- Policy instrument to build and infrastructure for industrial science and technology;
- Policy instruments for the regulation of technology imports;
- Policy instruments to define the pattern of demand for technology;
- Policy instruments to promote science and technology activities in enterprises and influence technological change; and
- Policy instruments for the support of science and technology activities.

The main comparative report provided a summary account of the way policy instruments functioned in each of the participating countries, and characterized their policy implementation styles. It then compared the operation of policy instruments in each category across countries. Tables 1 through 6 summarize the main policy instruments analyzed and case studies conducted in the STPI project, although some country teams did additional work that did not find its way to the main comparative and is not reflected in these tables.

Policy instruments for scientific and technological infrastructure included institution building, science and technology planning, and financing of science and technology activities, and were extensively employed in all STPI countries. Instruments in the regulation of technology imports category comprised import controls, foreign investment regulations, registries of licensing agreements, industrial property rights, and regulations for joint ventures between domestic and foreign firms. They were aggressively employed in Peru, Colombia and Venezuela, to a lesser extent in India, Mexico and Brazil, and only for a very brief period in South Korea.

Policy instruments for the development of industry aimed primarily at industrial growth and diversification. They shaped the pattern of demand for domestic scientific and technological activities, but were not intended to build capabilities in this field. However, these implicit instruments were decisive in defining the room for maneuver to utilize the capacities created by explicit science and technology policy instruments, and particularly those aimed at building infrastructure. This category included industrial planning and programming, financing for industrial development, use of the purchasing power of the state, fiscal incentives, price controls, export promotion measures, and administrative support for industry. Industrialization strategies and policies were found to pay little attention to their impact on the creation and use of domestic science and technology capabilities.

Policy instruments to induce industrial firms to perform scientific and technological activities had the ultimate objective of improving productivity and helping enterprises to absorb and acquire in-depth knowledge of the technologies they operated. It was found that STPI countries had not paid much attention to this category of policy instruments, and only credit lines for scientific and technological activities and tax incentives for research and development were identified. Moreover, these two

[16] This section is based on chapter 3 of the *Main Comparative Report of the Science and Technology Policy Instruments Project* Ottawa, IDRC, 1978, pp. 54-88.

instruments were not very effective and did little to improve the science and technology capabilities of industrial firms.

The last category of policy instruments comprised three diverse groups of measures to support science and technology activities: technical norms, standards and information; training of scientific and technically qualified personnel; and assistance to consulting and engineering design activities. Technical norms and standards were geared towards quality improvements, and played a key role in South Korea, the only STPI country that had a clearly articulated export-oriented industrialization strategy. Information was provided to research centers and enterprises through documentation centers, industrial extension services, technical assistance programs and technology intelligence gathering, and training programs ranged from postgraduate education in science and technology, to technical training for industrial workers. However, the STPI teams did not obtain enough evidence to assess their impact on the development of science and technology capabilities.

Support for consulting and engineering design organizations was also identified as a key policy instrument. These organizations were seen as contributing to more efficient technology purchases, better use of domestic research and development, adaptation of imported technology to local conditions, and linking domestic science and technology capabilities with industrial enterprises and public investment projects. Specific measures associated with this policy instrument included requirements that pre-feasibility and feasibility studies be conducted by local firms, registries of foreign consultants, fiscal incentives and financial support for engineering design firms, among others. Brazil, India, Mexico and South Korea examined the role of these institutions and preliminary findings led to a new, post-STPI research project focusing on consulting and engineering design organizations financed by IDRC.

The main comparative report also recounted how contextual factors and explicit and implicit policy instruments interacted in the STPI countries to influence the development of industrial science and technology capabilities. Several examples were given of how policy instruments in different categories converged or diverged in specific context to configure the patters of demand and supply for domestic and foreign technology. In addition, several case studies of industrial branches and technological behavior of enterprises helped to complete a picture of policy instruments at work. This led to assessments of how changes in the context (for example, a foreign exchange crisis), altered the relevance and impact of policy instruments (for example, low depreciation rates, tax credits for machine repair and reconstruction).

In general, the STPI project found that policies for building industrial science and technology capabilities should be designed to suit the specific needs and situations in which they were to be applied. They were bound to fail unless they were embedded in a broader political, economic, social and cultural context that acknowledges the importance of science and technology; unless they were closely articulated with industrial development policies, and with other economic policies; and unless they took into account and incorporated the characteristics of technological change, of the industrial branch structure, and of the enterprises in particular branches of industry.

## 6. CONCLUDING REMARKS

The STPI project was a rather novel form of collaboration among developing countries in science and technology policy research. When it was carried out in the 1970s, STPI was the largest policy-oriented research project organized on this subject, and also one of the few that focused primarily on providing information and advice to policy and decision makers in the participating countries.

This chapter has summarized the background, context, organization, objectives, methodology, country work, findings and results of the STPI project. Mucho more information is available in the reports prepared by the country teams, the field coordinator's office, and the dissemination exercise undertaken between 1977-1979, after the research phase ended.[17]

[17] All STPI reports and supporting material can be found in: http://kind-cind.org/blogstpi/?lang=en

TABLE 1. **Policy instruments for infrastructure building**

| *Country* | *Institution Building* | *S&T Planning* | *Financing S&T Activities* | *Other mechanisms* |
|---|---|---|---|---|
| Argentina | National Institute of Industrial Technology | | Permanent national fund for pre-investment studies | |
| Brazil | | Basic Plan for Scientific and Technological Development | S&T Development Plan; S&T fund of the National Development Bank; national fund for scientific and technological development | |
| Colombia | Industrial Technology Institute | Sectorial plans for S&T development | Research fund of COLCIENCIAS; national budgeting for S&T; national development fund (FUN ADE) | |
| Egypt | | Plans for research and development | | |
| India | Network of institutions in the electronics industry. | Plan for S&T development | | Import facilities for S&T Institutes |
| South Korea | Network of institutions involved in S&T activities; Korean Institute of Science and Technology | Interfacing economic with S&T plans | Funds for S&T through national budget; fund established by the Technology Promotion Law | |
| Mexico | | Plan for S&T development | Special fund for S&T of CONACYT; national fund for pre-investment studies | |
| Peru | Network of sectorial Technological research institutes; Industrial Technology Research Institute (ITINTEC) | | Financial mechanism of ITINTEC and other research institutes | |
| Venezuela | | Plan for S&T development | Financing of S&T activities through government budget | |

TABLE 2. **Policy instruments for regulating technology imports**

| *Country* | *Import Controls* | *Foreign Investment Controls* | *Registries of Licensing Agreements* | *Patent System* | *Joint Ventures and Technology Transfer* |
|---|---|---|---|---|---|
| Argentina | Protection of National labor and production law (20.545), decree 751/74 | Foreign investment law (20.557), decree 461/73 | National registry of technology transfer | | |
| Brazil | Tariffs to regulate imports of goods embodying technology | Foreign capital control laws 4131 /72 and 4930/64 | Registry of licensing agreements of the National Institute of Industrial Property | National Institute of Industrial Property | State, local, private, and foreign firms (petrochemical sector) |
| Colombia | Tariffs to regulate imports and affect the choice of equipment | Foreign exchange control law 444/67; regulation of foreign capital, decree 1900/73 (decision 24 of the Andean Pact); division of foreign investment in national planning agency | Regulations on foreign collaboration agreements | Industrial property regime | |
| India | | Foreign investment board for electronics sector | | | |
| South Korea | Government mechanisms to regulate foreign trade (import licenses, foreign exchange controls, etc.) | Foreign capital inducement law | Technology Transfer regulations | | |
| Macedonia | | Regulation of foreign investment in domestic organization of united labor | Regulations for obtaining industrial property rights | | |
| Mexico | Tariff mechanisms; import permits; public sector import committee | Commission and national registry of foreign investment | National registry of licensing agreements | Industrial property law and the patent system | |
| Peru | National register of manufactures; import permits; allocation of foreign exchange for imports | Law for the regulation of foreign investment 18900 and 18999(decision 24 of Andean Pact) | Registry of licensing e agreements (ITINTEC) | Industrial property regime | |
| Venezuela | Tariff mechanisms; import permits | Regulation of foreign investment law (decision 24 of sector Andean Pact) | | Industrial property regime and patent laws | Joint ventures In the petrochemical sector |

TABLE 3. **Policy instruments for defining the pattern of demand for technology**

| *Country* | *Industrial Programing* | *Industrial Financing Mechanisms* | *State Purchasing Power* | *Fiscal Measures* | *Price Controls* | *Export Promotion Measures* | *Other Mechanisms* |
|---|---|---|---|---|---|---|---|
| Argentina | Industrial promotion laws (including decentralization); state corporations to promote industrialization (corporations of medium and small enterprises); Reconversion of the Automobile Industry Law | Corporation for the Development of Medium and Small Enterprises | "Buy Domestic" Law | | | Special credit lines for the promotion of exports | |
| Brazil | Industrial development policies and programs | Special fund for Industrial Financing (FINAME); subsidiaries of the National Development Bank (FIBASE for basic inputs, EMBRAMEC for capital goods; and IBRASA for other sectors); Fund for the Modernization and Reorganization of Industrial Activities; Regional and sectorial financing agencies | State enterprises purchasing local technology | | | Financial mechanism to promote exports (CACEX) | |
| Colombia | Industrial development policies and programs | Credit lines for purchase of local capital goods (IFI); credits for agriculture with impact on industry | | Depreciation coefficient for capital goods; tax deduction for expenses in repairing and reconstructing machinery; fiscal treatment of payments for royalties | Price control mechanisms | Export promotion measures and regulations | |
| India | Industrial programing for the electronics industry | | | | | | Procedures for developing ancillary industries |
| South Korea | Set of laws to define industrialization priorities | Array of financial mechanisms for industry | | Taxation of industrial enterprises | | Export Inspection Law; free export districts | |
| Mexico | Decentralization of industry manufacturing programs; Law of New and Necessary Industries | National Fund for Industrial Equipment; National Fund for Industrial Promotion; Fund for the Study and Promotion of Industrial Parks and Cities; Fund for the Promotion of Small and Medium Industries | | Depreciation of coefficient for fixed assets; fiscal treatment of payments for royalties; taxation of industrial enterprises (income taxes) | Fund for the promotion of exports of manufactured goods | | |
| Peru | General Law of Industries | Development financing corporation; Industrial Development Bank; Mining Development Bank | | | | Fiscal incentives for export promotion | |
| Venezuela | Set of laws to define Industrialization priorities | Financial system for industrial development; leasing companies for industry | | Tax and fiscal system for industrial enterprises | | Export promotion policies | |
| Macedonia | | | | | | Long-term production cooperation agreements | |

TABLE 4. **Promoting science and technology activities in enterprises**

| *Country* | *Special Credit Lines* | *Tax Incentives* | *Other Measures* |
|---|---|---|---|
| Argentina | Special loans for pilot plants (National Development Bank) | | |
| Brazil | National fund for scientific and technological development (administered by FINEP) | For S&T activities in enterprises | |
| India | | For R&D expenditures | Administrative facilities for S&T activities in enterprises |
| South Korea | Technological Development Promotion Law; fund Created to support S&T activities in industry | For R&D expenditures in industrial enterprises | |
| Mexico | | For R&D expenditures in industrial enterprises | |
| Peru | | ITINTEC system to promote S&T activities in enterprises | |

TABLE 5. **Policy instruments for supporting S&T activities**

| *Country* | *Technical norms; standards; quality control* | *Technical Information Systems* | *Manpower Training* | *Consulting and Engineering Activities* |
|---|---|---|---|---|
| Argentina | Technical standards; preparation procedures (Argentine Institute for Materials Rationalization) | | National Council for Technical Education | Permanent National Fund for Reinvestment Studies; Buy Domestic Law; registry of licensing agreements technical assistance contracts |
| Brazil | | Institute of Bibliography and Documentation | Funds for supporting training activities (FUNTEC and others) | Financing of studies and projects (FINEP) |
| Colombia | National Council of Technical Standards; Colombian Institute of Technical Standards (ICONTEC) | | National Apprentice- ship Service | National Fund for Pre-investment Studies (FONADE) |
| India | | National Information Center for the Electronics Industry | Manpower training for the electronics industry | |
| South Korea | Industrial Standards Law, Korean Standards Research Institute; Korean Standards Association; Quality Control Inspection Law; Weights and Measures Law; Export Inspection Law | Korea Scientific and Technical Information Center (KORSTIC) | Korea Advanced Institute of Science(KAIS); other related institutions; science popularization movement | Engineering Services Promotion Law |
| Mexico | Technical standards system | Fund for Technical Information for Industry (INFOTEC) | Centers of industrial and technical training | National fund for pre-investment studies |
| Peru | Technical norms; standards | | Educational reform with emphasis on S&T training; National Service of Technical Training for Industry (S EN ATI) | Development Financing Corporation |
| Venezuela | Technical norms; quality control | | | |

TABLE 6. **Selected studies on technical change conducted in the STPI project**

| *Country* | *Industrial Technological Studies at the Branch Level* | *Studies of Technological Behavior of Enterprises* | *Specific Studies of Technical Change* |
|---|---|---|---|
| Argentina | Machine tools | Case study of SEGBA (state enterprise in charge of electricity generation); Case study of Gas del Estado (state enterprise in charge of gas distribution and marketing) | |
| Brazil | Machine tools | Case study of ELECTROBRAS (state enterprise in charge of gas distribution and marketing) | Case studies on the diffusion of Innovations (textiles, paper, cement industries) |
| Colombia | | Technological behavior of agricultural implement firms; Technological behavior of firms in the fertilizers industry | |
| India | Electronics Industry | | |
| Mexico | | Case study of impact of transnational corporations on technological development | Orientation of technical change in the capital goods, petrochemical, food industries |
| South Korea | Powder metallurgy | | |
| Venezuela | Capital goods | Case study of the petrochemical industry | Atypical cases on innovation |

## PART II: REVISITING THE STPI PROJECT FORTY YEARS LATER

Part II contains two chapters that revisit the STPI experience in the light of what has happened during the last four decades. Geoffrey Oldham looks back at how the STPI project emerged in IDRC and, based on a questionnaire responded by members of the original STPI research network, offers a perspective on what happened in each of the participating countries as a result of the project. In addition to reporting on the impact of STPI at the country level with examples drawn from responses to the questionnaire, Geoffrey Oldham provides an overview of the impact of STPI project as a whole, highlighting commonalities and those aspects on which there is general agreement among respondents, such as the interaction between research and policy making.

The chapter by Juana Kuramoto looks back at the STPI reports and, after a brief overview of the background and results, describes how the science, technology and innovation policy-making environment has changed in the four decades since STPI. Juana Kuramoto emphasizes the impact of globalization and the change in policy focus it has led to, particularly in Latin America, which is quite different from the import substitution context in which the STPI research took place. The emergence of new global concerns and challenges and changes in the prevailing technological paradigm are also examined in this chapter, before assessing how the STPI project results stand in the light of new approaches to the study of technological innovation. Kuramoto's chapter ends suggesting issues for research in science, technology and innovation policies that take advantage of the STPI focus on policy implementation.

### 1. REFLECTIONS ON THE SCIENCE AND TECHNOLOGY INSTRUMENTS PROJECT[18] (by Geoffrey Oldham)

This chapter is based on the personal reflections of people who were involved in the STPI project. Only a few of the documents produced for and by the STPI teams were available to me at the time I first drafted this note. It is, therefore, not a detailed historical record. It is much more subjective as it captures the reflections of people who were involved in the design and implementation of the project. The objective is to try to find lessons, which might be of value to policy-oriented research initiatives that are designed to tackle similar issues today.

The report is in two parts. The first is a brief review of the project as seen from an IDRC perspective. The second part draws heavily on the responses to a questionnaire which I sent to members of the STPI project a couple of months ago, and begins the process of learning lessons. I will include my own views in both parts of the report.

[18] Prepared in May 2013, revised February 2014.

### 1.1. An IDRC Perspective

Before discussing the specifics of the STPI project it might be useful to say a little about the origins and objectives of the International Development Research Centre. I will focus on those issues that ultimately had a bearing on the design and operation of STPI.

#### 1.1.1. Early History of IDRC

The origins of IDRC owe much to the success of Expo 67 that took place in Montreal. There had been widespread international acclaim for this exhibition and the Canadian government decided to commemorate this success by starting some new initiative that would have international overtones. Several ideas were canvassed, but the idea that the Prime Minister, Lester Pearson, most liked was the idea put forward by Maurice Strong. Strong was the head of the Canadian aid agency (CIDA) and he suggested setting up an organization in Canada which would do research on the problems facing the developing world.

Strong initially had in mind something akin to the Institute of Development Studies (IDS) recently established by the UK government at the University of Sussex. He asked Wynn Plumtree, the Principal of the Scarborough Campus of the University of Toronto to visit Sussex to find out more about the IDS experience. He brought with him a list of possible issues on which such a Canadian Institute might do research. One of about 10 issues on this list was the role of science and technology in development. The Science Policy Research Unit (SPRU) had been started at the University of Sussex at the same time as the IDS, and the Secretary of the IDS suggested that when he was in Sussex Plumtree should also visit SPRU. That visit took place in the Spring of 1968.

I had a good discussion with Plumtree and was delighted when a few weeks later I heard from him that in his report to Strong he had given highest priority to the science and technology issue. Maurice Strong also visited SPRU as a follow up to the Plumtree report. I learnt that his vision at that time was to establish laboratories in Canada that would do research and develop technologies of particular relevance to the developing world.

I suggested that this was an old fashioned approach. It was the approach being followed in the UK and France and was being considered by the US. Based on my time studying these issues in Asia, I felt that the time had come to help the developing countries to strengthen their own research capabilities so they could solve their own problems. This was where Canada could make a real difference.

Strong was interested in this approach and invited me to join him in Canada for six months helping to design what became known as the IDRC. David Hopper was appointed its first President and the Centre was opened for business in 1970.

David asked me to write a paper that might convince him that science and technology policy research was an issue that the IDRC should support. He was convinced, and invited me to head a program on this topic but based at SPRU in Sussex. The program was to be part of the Social Sciences Division headed by Ruth Zagorin.

Those early days with IDRC were quite remarkable. Hopper and the Board embraced the approach first defined in the IDRC Act of Parliament. The Board itself was international. The Centre's staff was expected to respond to needs identified by the developing world.

But when the STPI project was first conceived the IDRC was still in its early innovative phase and almost all things were possible. I recall early discussions among the staff of the Social Sciences Division about whether the Centre should just support academic social science research or rather emphasize policy research and help to bring academic researchers together with policy makers. The latter approach was warmly endorsed. There was also strong support for the idea of encouraging teams from different developing countries to work together in networks. The STPI project ticked all these boxes.

### 1.1.2. The STPI Project: Its origins[19]

In early 1972 The Organization of American States (OAS) convened a meeting in Lima of the Chairmen and Secretary Generals of the Research Councils of Latin America. SPRU had been working with the OAS and several Latin American teams on a project on technology transfer. It was for this reason that I had been invited to attend the Lima meeting by Maximo Halty Carrere the head of the OAS Technology Programme. The purpose of this meeting was to discuss the science and technology policies of the countries in the region.

Over the first two days each country representatives presented glowing accounts of their science and technology policies. During the weekend of the meeting the Peruvian Research Council arranged a field trip to Cuzco and Machu Picchu. About two thirds of the participants went on the field trip. The intention was that they would travel on the early morning flight from Cuzco to Lima on the Monday morning arriving in time for the restart of the Inter Governmental meeting.

However the weather conditions on Monday morning were too bad to enable the flight to take off. In order not to waste the day the stranded participants rented a conference room at a nearby hotel and continued the discussion about Latin American science and technology policies in an informal setting.

It was Carlos Añez the Secretary General of the Venezuelan Research Council who started the discussion. He pointed out that every word he had spoken in Lima about Venezuelan science policy had been true. Venezuela had an excellent policy. Its Government had increased its funding of science significantly. There were now more scientists who published many more scientific papers. But none of this seemed to have any benefit for the poor in Venezuela. "We have a good policy" he said "but we

[19] In this section I will give my recollection of the origins of the project, but to get the full story it will need other members of the STPI project to provide their version of events.

don't know how to implement it. The scientists are happy at the increased resources given for science, but the rest of society is no better off."

Other participants joined in the discussion. It seemed that a similar story could be told for each country represented at the meeting. There were good policies but poor implementation. Whereas economic policy makers had handbooks on the policy instruments they could use to help them implement their policies, there seemed to be no equivalent sources for the science policy communities.

It was decided at this informal meeting to follow up in two ways. First a few Latin American countries volunteered to do pilot studies to explore the feasibility of carrying out major studies on the scientific and technological policy instruments that had been used in their countries. IDRC offered to hire a consultant to review the situation in OECD countries.

Both of these commitments were carried out. The IDRC consultant's report showed that the issue of the effectiveness of different science and technology (S&T) policy instruments had not been researched in the OECD countries. The pilot studies in Latin America showed that a major study on the topic was not only feasible but would be welcomed by policy makers. The OAS and IDRC decided to bring together a group of researchers from six Latin American countries to develop a proposal for a major new initiative: The Science and Technology Policy Instruments project.

One very strong memory of that Cuzco meeting was the return flight to Lima. We learned that the flight was going to take place late that afternoon and we all moved to the airport. It turned out that flights from Cuzco can only take off in one direction due to the surrounding mountains, and only if there is a headwind. There was still an insufficient head wind when we arrived at the airport but there was an approaching thunderstorm. The pilot judged that when the thunderstorm approached the winds would change and we could take off. Several people refused to fly under these circumstances. On the flight I was sat next to a very young Francisco Sagasti. We agreed that if the plane made it to Lima and we ever met again we would treat each other to a pint of Guinness. We did make it and we have met several times a year ever since!

### 1.1.3. How other developing countries became involved

Before the first STPI meeting took place I visited other Asian and Middle Eastern countries, wearing my IDRC hat, to discuss their science and technology policy research priorities.

South Korea. The first country I visited was South Korea. In an interview with the Minister of Science and Technology I mentioned the Latin American interest in S&T policy instruments. The Minister's reaction was immediate. "How long will it be before the results are known? I am faced with the problem of how to implement our S&T policies now" I explained that it would be about two years before there would be any results that could be shared. He then asked if South Korea could participate in the research project. This seemed an excellent idea and I said I would explore this possibility with the Latin American teams. The Minister said he would identify the

Korean institution and project leader. He subsequently chose the Korean Advanced Institute of Science as the location and KunMo Chung as the team leader.

India. My contact in India was a long-standing friend Ashok Parthasarathi. At the time of my visit he was Mrs. Gandhi's Special Assistant for Science and Technology. He too saw the need for further research on S&T policy instruments and said that he would like to see an Indian team participate. He had Anil Malhotra in mind to lead it.

Egypt**.** In Egypt I met with Mustapha Tolba who was the President of the Academy of Scientific Research and Technology. He too was very interested in the STPI project and was keen to have an Egyptian team participate. However at that time Egypt was still closely allied with the Soviet Union. It would be difficult for them to participate in such an international project unless there was another socialist country participating. If one did participate he said he would help identify an Egyptian team leader and appropriate institution. We did identify another socialist participant and Tolba suggested Adel Sabet as team leader.

Macedonia. At the time Macedonia was still a part of Yugoslavia, but had a degree of independence in its economic policies. Chris Freeman has met Nikola Kljusev at a meeting in Europe and had been impressed by his contributions. Nikola was professor of economics at the University of Skopje. Freeman thought he would be a key person to meet. I therefore visited him there and he too became enthusiastic about the possibility of joining the STPI project. This also meant that Egypt would join.

Latin American countries. The Department of Scientific Affairs at the OAS had begun a program of "Basic Studies" on science and technology policy issues, in which Fernando Chaparro, who later was coordinator of the Colombian team, and Francisco Sagasti, who became the Field Coordinator of STPI, were working among other young researchers who later became involved in the STPI Project. Maximo Halty was the Director of the Technology Division at that OAS department, and became an early supporter of STPI. Discussions on the possibility of a comparative project continued during 1972, and several policy makers and researchers from the informal OAS network joined the project identification meeting for STPI in Barbados.

In addition, several Latin American researchers went to Sussex in August 1972 to participate during three weeks at the IDS Study Seminar No. 23, organized in collaboration with SPRU and led by Charles Cooper. Among them were Mauricio de Maria Campos and Alejandro Nadal from Mexico, Eduardo Amadeo from Argentina, Carlos Añez from Venezuela and Fabio Erber from Brazil. They later joined the STPI network as country coordinators. During this IDS Study Seminar one of the sessions was dedicated to the issue of policy instruments, in which one of the participants was Francisco Sagasti.

### 1.1.4. Next steps and the Barbados meeting

The first step was to ensure that IDRC, the OAS and the various Latin American teams approved of the expansion of the project from a purely Latin American event to a wider international project. Everyone seemed in favor, so we began to plan what IDRC called the Project Identification Meeting (PIM)

There were two reasons for choosing Barbados as the site for the meeting. The first was that given the majority of the participants would come from Latin America and only a few from Asia and Europe, Barbados was the least cost place for total airfares. The second was that Sussex University had a Centre for Multi Racial studies located at the University in Barbados. I could use this at minimal rental. These two cost figures played a major role in persuading my boss Ruth Zagorin that we should hold the meeting in Barbados!

The meeting took place with participants from nine countries, two consultants (Alberto Araoz and Gennie Dean), Maximo Halty from the OAS and myself and Gil Struthers from IDRC. My role was to convene the meeting and to explain the IDRC approach. This approach was for the teams to prepare the proposal. It was going to be their project and not IDRC's. The IDRC representative would comment on the researchability of the proposal and perhaps help with organizational matters. What we did not want was for the IDRC to design the project and then get teams to collect the data. That had been the approach of too many donor agencies in the past and was deeply resented in the Developing world. We wanted to give as much freedom to the teams as possible.

By the end of the Barbados meeting an exciting proposal had been prepared. It was decided to focus primarily on the industrial sector and all teams agreed to address some research questions in common. But it was also agreed that there should be a substantial degree of freedom for each team to address the issues of greatest relevance to policy makers in their own country.

All agreed that it would be a project that aimed to build bridges between the policy researchers and policy makers, but at the same time be good social science research. There was to be interaction between the team leaders at biannual coordination meetings where the results of the previous six months would be presented and a set of priorities for the next six months agreed. It was also agreed to travel and live parsimoniously on trips so that the travel money could be stretched and additional technical meetings held. It was also agreed to establish a Field Coordinators Office that would prepare a methodological guidelines report, help with overall coordination, keep abreast with the international literature on the project theme, and prepare synthesis reports. It was also required to account for the budget allocated to the FCO. Separate budgets were to be prepared by each national team to cover their own costs. The project was scheduled to last for three years, starting in August 1973.

The proposal was then submitted to IDRC and to the OAS for funding. As mentioned earlier it ticked all the IDRC boxes. It was action oriented involving interaction between policy researchers and policy makers; it was a network involving ten countries, and it addressed an important policy issue. It was however an expensive project by IDRC social science standards and I was not sure it would pass over all the project approval hurdles. Thankfully it did. In the case of the OAS Maximo Halty was able to secure partial funding for some of the Latin American teams.

### 1.1.5. Post Barbados events involving the IDRC

Once the project began the IDRC role was mainly one of monitoring. I tried to attend most of the semi annual meetings, but I was also responsible for several other projects and could not attend them all. The purpose of the monitoring was mainly to ensure that the project remained true to the original proposal, or if there was a divergence then there were good reasons for this divergence. I have found that project proposals in the social sciences are difficult to write. The funders tend to want a proposal that could only be written when the research had been completed. Research results are usually unpredictable and good research can lead to important unanticipated results that deserve to be followed. I tried to keep this in mind whenever I saw evidence of divergence!

This note reflects what happened within the IDRC regarding STPI. It does not provide a history of all that happened with each of the teams or the work of the Field Coordinators office, and between that office and the teams. That is a story for others to write.

There were however two events within IDRC which had a bearing on STPI and which deserve to be recorded.

The first of these occurred about two years after the project started. At an IDRC Board meeting one of the Governors, from the University of Guelph, complained that there had been very few publications emanating from the STPI project. He thought it had been an expensive project with very little output. He also thought that what he had read was common sense and did not need an expensive research project to discover.

It was explained that the teams had been encouraged to prepare reports in their own languages for the main benefit of their own policy makers. It was also explained that the Field Coordinators Office were preparing several synthesis reports and that these would be published by the IDRC. He seemed to remain unconvinced.

Several years later I met him again in Ottawa. I was there visiting from England and he was chair of a Canadian Government science policy advisory committee. He remembered the occasion when he had been critical of STPI and gave me an unreserved apology. He thought the final out comes had been excellent!

The second event was more serious. As the original STPI project was reaching its end it was clear that the results warranted widespread dissemination. The main targets of this dissemination were to be S&T policy makers and the main mode was through meetings. It was planned to have five meetings, in Kenya, Manila, Khartoum, Dakar, and South America. For each meeting there were to be Ministers from the region and senior science policy analysts and advisers plus a few members of the STPI network. A budget was prepared and submitted to IDRC. It was approved although there were some reservations regarding the total cost.

The dissemination meetings began in 1978 with the Kenya, Manila and Khartoum meetings. However as we proceeded with the meetings the IDRC reservations became outright opposition. I was unaware of this opposition at the time as I was already in

Manila and Khartoum helping with those meetings. It seemed that IDRC staff members in Ottawa argued that money spent on dissemination meant less money for others to do research. The outcome was for the South American meeting to be cancelled. I think we were at the Khartoum meeting when Ruth Zagorin conveyed the news. It was a shock for us all.

In hindsight it is difficult to know whether the dissemination meetings that did take place had any lasting impact. There was a lot of interest among the participants at the time, but there was no assessment of any follow up actions.

The dissemination activities were continued but in a different way. The IDRC agreed to second Francisco to the UN Secretariat preparing for the UN Vienna conference on S&T for Development. Here he was able to play an important role in influencing the agenda and by preparing briefing papers for the Group of 77. Through these and other activities he was able to give widespread dissemination of the STPI results. It meant the political impact of the project was not only felt at a national level through each country's efforts, it also had considerable repercussions at the international level.

#### 1.1.6. The aftermath of STPI at the IDRC

By the end of the first decade of the IDRC there had been a change in leadership. David Hopper went as Vice-President for South Asia to the World Bank. Ruth Zagorin took a law degree and then joined US AID.

I decided it was also time for me to leave. I returned full time to SPRU at the University of Sussex, and was asked to succeed Chris Freeman as Director. After 12 years as Director I returned to the IDRC as Keith Bezanson's Science and Technology Adviser. Keith had just been appointed as the new President of IDRC.

By this time I found that STPI had been recognized as one of the Centre's most successful projects. The career development of many of the STPI team leaders had been remarkable and some of the countries had made good use of the results. Indeed the project is reviewed in a very positive way in a new history of IDRC called IDRC: 40 years of Ideas, Innovation and Impact published in 2010 by Wilfred Laurier University Press.

Our meeting in Peru in 2013 provides an opportunity for others to fill in the gaps in these personal recollections, and to attempt to draw lessons that might be of benefit to today's S&T policy researchers and policy makers.

### 1.2. Responses to a questionnaire

One of the main objectives of the STPI + 40 meeting are to draw lessons which might have general interest, but also be of particular relevance to the next generation of science, technology and innovation policy researchers. The time at Paracas and Lima will be limited and so it was decided to encourage participants to respond to a questionnaire about their experiences both during and after the STPI project. If there were major differences in responses on certain issues then these might be suitable issues for further discussions at the Peruvian meetings. In the event there were very few fundamental differences, which warranted further debate.

What follows will be a concise summary of the responses. The original responses will be posted on the STPI+40 website.

- ***Question 1.*** *What were considered the key S&T policy issues of the early 1970s that the STPI teams thought warranted their attention? In hindsight were there other issues which were not addressed but which should have been?*

  The responses to the first part of the question accepted that the main focus of STPI was to address the policy instruments related to science and technology for industrial development. However the particular issues to be addressed depended on the various government macro economic policies. For most of the Latin American teams this meant working within their government's intention to promote import substitution industrialization. India, Egypt and Macedonia were also following this approach. The South Korean approach was entirely different. The Korean team was working within their governments stated objective of export promotion.

  There was general agreement amongst the ten teams that the main subcomponents of industrial science and technology policy which needed to be investigated were Technology Transfer, both international and domestic; the role of intermediary organizations to help link domestic and regional research institutions with enterprises; the development of relevant human resources; ways and means to stimulate research and development within enterprises.

  Not all of the country teams addressed all of the issues. Priority was given to those issues that were currently most relevant to the needs of their country. For example India was in the process of formulating a five-year science and technology plan at the same time as the STPI project was underway. Anil Malhotra was not only the leader of the Indian STPI team but also a member of the Prime Ministers S&T Advisory Committee and a member of the team drafting the five year plan. The Indian STPI team consequently gave priority to policies for transferring technology from government laboratories to industrial enterprises and the role of Consulting and Engineering Design Organizations (CEDOs) in that process.

  Korea gave priority to the development of scientific and technological human resources for industrial development, and also studied issues in technology transfer.

  The responses to the second part of the question revealed the particular interests of the respondents. For example Alejandro Nadal felt that there should have been more theoretical studies that examined such issues as the evolution of the international economy, macroeconomic policy, and the limitations of the Bretton Woods institutions. These studies would have helped set the context for the more specific science and technology policy studies actually carried out by the STPI teams.

José Tavares observed that in Brazil in the early 1970s science and technology policy issues were not a high priority. There was some R&D carried out in government laboratories, but virtually none by the private sector. The main concern of the Brazilian STPI team was how their country could achieve a higher share of R&D investments in GDP. The team did not consider the role of competition as an instrument to promote innovation by the private sector.

Onelia Cardettini thought the teams should have given more attention to patent issues and to the obstacles of dealing with multinational corporations.

Eduardo Amadeo pointed out that at the time of the STPI start up technology was being considered as one of the key factors that could support a "non dependent" development policy. Also there was quite a gap between the results of academic social science research and the practical needs of policy makers. STPI addressed this gap.

Anil Malhotra suggested that the Indian team should perhaps have devoted more time to studying the weakness of domestic research and the need to stimulate better links between research and industry. He also thought they had underestimated the resistance of the Civil Service to what they perceived to be the encroachment on their rights by the scientific community. This was a major obstacle for the implementation of the five-year science and technology plan. They had also underestimated the lack of understanding of financial and economic issues by scientists.

Kun Mo Chung thought that in hindsight the Korean team, in addition to industry and energy, should also have included work on biomedical issues. They also missed recognizing the growing power of private industrial groups in Korea

Ignacio Avalos thought that the STPI menu of issues was quite complete and reflected the key S&T policy issues of the day.

Sergio Barrio's view was that a part of the STPI project's success was that it began to recognize that the Import Substitution Industrialization policy was leading to protectionism and industrial inefficiency, and that some other model was needed. At that time in Latin America many politicians were dubious about the ability of their countries to develop technology at home and did not appreciate the need for incremental technological change.

Fernando Chaparro felt there were two important shortcomings in the STPI project. The first was the lack of work on the generation of knowledge for the benefit of the community. This included science and technology for basic human needs and redressing inequalities, i.e. social innovation. The second shortcoming was the lack of attention given to regional innovation systems. They both became topics that received later research attention, but in hindsight they might have been included in the STPI portfolio.

None of the respondents believed it was wrong for STPI to have concentrated on industrial science and technology policy instruments. There were a few suggestions for additional work to have included agriculture, energy and biomedical sectors. There were many more suggestions as to what should be studied if the project was designed today. These suggestions will be presented in the responses to question nine.

- **Question 2.** Did the project develop any novel methodological approaches for the research? What were they?

  There was a consensus in the replies to this question that stressed the importance of networking. The novelty here was the balance that was obtained between internationally agreed common topics and nationally agreed domestic topics. Most respondents thought that this balance led to some activities that could be compared between countries and other activities that supported individual country science and technology policies.

  This balance led to the effective implementation of another novelty which was the priority given to action-oriented research where strong interaction took place between researchers and policy makers. This issue also came up in responses to other questions.

  One respondent thought that the emphasis on policy instruments enabled a more empirical approach to be taken in the STPI project and this was considered to be very beneficial.

  Another respondent drew attention to the new approaches that were taken to study sectorial science and technology policies and plans. It was this work which led to an understanding of the importance of implicit science and technology policies. Indeed most STPI teams agreed that the distinction between implicit and explicit policies was a major contribution of the project.

  One respondent summed the methodological contributions as: multi country; convergence of various approaches (social science/engineering/economics/planning); combination of different types of reports; and the interaction between all these levels.

- **Question 3.** Networking was an important objective of the project. In your opinion was the interaction between the country teams beneficial? How and why was it beneficial?

  Despite the fact that communication between researchers was far more difficult at the time of the STPI project than it is today, the networking that did take place was considered very beneficial. All those that responded to this question were extremely enthusiastic about the benefits that they had gained from the experiences of the other teams. Several commented that the contacts they had made continued long after the project finished.

  Typical of the comments made were those of Alejandro Nadal who had found the field trips to machine tool plants in Egypt, shipyards in Ulsan, and engineering firms in Delhi, made him appreciate local problems more deeply.

Anil Malhotra had learned from the positive experiments going on in different countries and also learned about failures to avoid.

KunMo Chung thought that networking had been very important for Korea. He had especially learned a lot from the Indian experience with Solid State Switching Mechanisms and CEDOS. This had led him to introduce both to Korea. KunMo Chung himself was appointed the first President of the Korean Power Engineering Corporation. This organization had led Korea to achieve self-reliance in nuclear power. The concept of Implicit and Explicit science and technology policies was spread through Korea by the STPI team.

Ignacio Avalos considered that networking was one of the most positive aspects of the STPI project. It had been very beneficial for Venezuela to compare its approaches with those of other countries. Many of the benefits were realized after the project was finished.

Eduardo Amadeo thought the interaction between different economic, technological and social realities of the time as reflected by different country experiences, together with the benefits of involving different academic experiences all contributed to the benefits derived from networking

Fernando Chaparro was also very positive about the benefits to Colombia. It had enabled Colombia to realize the value of benchmarking and had learned a lot from the experiences of the other STPI partners. He also valued the continuing benefits and cited the case of the introduction of CEDOs into Colombia in 1995, which had been influenced by the experiences of India and Brazil. Also contact with Indian and Venezuelan STPI members have continued to the present day.

José Tavares thought that the interaction with other country teams was highly beneficial. In a world without e-mail, Internet and SKYPE the STPI project provided a unique opportunity to enlarge team members' knowledge on several topics very quickly.

Sergio Barrio commented on the good atmosphere that prevailed among the STPI members and which led to an open exchange of data and rapid diffusion of research results.

Onelia Cardetinni thought that the project had clearly demonstrated the value of South/South linkages, and that this had influenced the attitude of several multilateral organizations.

There can be little doubt that the decision to fund the meetings of team leaders and the technical seminars paid a huge dividend. This not only benefitted the research but also contributed to its policy impact.

- **Question 4.** What were the main contributions to knowledge made as a result of the STPI project? Which of these were country specific and which had broader regional and international significance?

One respondent suggested that a major study would be required to do justice to these questions. However there were enough replies to give some idea of the main contributions to knowledge.

There were several contributions to knowledge that were of international significance. First of all was the recognition of the importance of implicit science and technology policies. These were the policies intended for other economic or fiscal objectives yet which had a major influence on scientific and technological decision making. They were in contrast to the explicit policies specifically designed to achieve scientific and technological objectives. The STPI project demonstrated that not infrequently the implicit policies had greater influence on technological decisions than did the explicit policies.

The second contribution of international significance was the distinction between the supply side policies that influenced the supply of scientific and technological knowledge and the demand side policies that influenced the demand for such knowledge.

A third contribution was the demonstration that science and technology played a critical role in development. Prior to STPI science and technology had been relegated to a secondary role in many developing countries. After STPI it was recognized that science and technology issues had to be placed in a broader economic, social and political context

A fourth contribution that was of international significance was the recognition that science and technology implied much more than research. The work on CEDOs demonstrated the role that engineering and engineering design played in development. Although it was recognized that CEDOs were an important bridge between research and production the STPI project did not devote much attention to the other non-research aspects of technology and development. Earlier work by SPRU for the UN Advisory Committee on Science and Technology for Development had shown that in most countries only about 10% of qualified scientists and engineers actually did research. Science and technology policy should have paid more attention to the activities of the other 90%.

At the local level there were many examples of personal and team learning. In Venezuela it led to a better understanding of how technological learning takes place within enterprises. In Peru it became recognized that the concept of technology strategy was a core issue of agriculture, industry and health. Technology polices effect all aspects of development. In Colombia the understanding of implicit policies played a major role in formulating explicit sectorial science and technology policies. It was also recognized that national experiences couldn't be copied or extrapolated.

In the case of Argentina Eduardo Amadeo had personally benefitted through the recognition that policy instruments could be studied in a systematic way. The concept of studying how incentives operate and generate desired behaviors applies not only to science and technology but also to other areas of policy making. This fact is not always recognized today.

- **Question 5**. An objective of the project was to encourage real time links between researchers and relevant policy makers. To what extent did this occur in the STPI countries? What methods were used to facilitate this interaction? Which proved to be most effective?

  The interaction between researchers and policy makers varied a good deal in the different STPI countries. It was greatest in those countries where STPI team members were at the same time closely involved with the policy making process. This was particularly true in India where Anil Malhotra was a member of the Science Advisory Committee to the Prime Minister. He was also involved in the drafting of the Indian five year Science and Technology Plan. In this he engaged more than a thousand scientists in the process and this gave a sense of ownership to the scientific community.

  Possibility the greatest impact on countries policies came in Macedonia where Nikola Kljusev became the countries first prime minister. Unfortunately Nikola died in 2005 and we were never able to learn how much of what he did in Macedonia could be attributed to his participation in the STPI project.

  In Korea several of the STPI team members went on to become policy makers and implementers and KunMo Chung was twice his countries Minister for Science. Also the project had the strong support from the nation's leaders. Another way in which STPI results impacted on Korean policy was through regular briefing sessions between the countries chief economic adviser and KunMo Chung during the lifetime of the project.

  Many members of the Brazilian STPI team went on to have successful careers in the Brazilian public sector, and became policy makers in the area of science and technology.

  In other countries the STPI team was located within the countries science council that was responsible for drafting science policy. This was the case in Venezuela and Colombia. In the latter country, part of the research was carried out in Colciencias and part was contracted out to researchers based in universities. This helped forge close relations between these academic researchers and policy makers. The STPI project also helped bring about a cultural change in Colciencias. Policy makers changed their attitude to policy research and realized that such research could lead to the identification of practical policy options.

  Several of the STPI researchers in the Andean region went on to work on policy development on science and technology issues in the Andean Pact and the Cartagena Agreement. They were also involved in other collaborative research with researchers from Andean countries after the completion of the STPI project.

  Science Ministers and their advisers from non-STPI countries were exposed to the results of the research through their participation in the STPI dissemination meetings in the Philippines, Sudan, and Senegal. It is difficult to judge whether this exposure had much influence on these other countries policies.

Francisco Sagasti's involvement in the planning of the 1979 UN Vienna Conference on Science and Technology for Development and his negotiating role in the Conference itself enabled him to introduce many of the STPI results to a worldwide audience. Indeed the Group of 77's position at the Conference was based largely on the STPI results.

In some countries such as Mexico there was good interaction between the research team and relevant government departments during the project. However shortly after the project there was a crisis in Mexico and a new government took over with very little concern about science and technology policy. That was Alejandro Nadal's view but Tony Tillett, a keen observer of Mexican affairs, thought otherwise. He believes that over the long term, Alejandro Nadal's STPI report and book that was awarded second prize for the best economic work of the year, has had a considerable impact in Mexico!

Similarly in Argentina, at the beginning of the project there were good exchanges between the team members and policy makers. By the end of the project there had been political changes and such interactions became impossible.

It is noteworthy that the countries where there was greatest policy impact were those in which the team members were themselves deeply involved in formulating policy. Those countries that had least impact were those in which there had been political changes that were not sympathetic to national science and technology policies. But even in those cases later political changes sometimes restored an interest in science and technology and work done during the STPI project became relevant

- **Question 6.** Please provide examples where STPI research quite directly influenced policy at a national level.

Question number four was meant to probe the academic impact of STPI research whereas this question was to assess impact on policy. Fernando's response was the most comprehensive and will be summarized first.

In Colombia STPI created the capacity for Colciencias to think strategically and develop key policy options. This capacity was lacking in most other government agencies and even in the science and technology agencies in other Andean countries. It lasted through the 1980s and 90s but then weakened. It is beginning to come back, but slowly.

STPI also led to the recognition that national policies without policy instruments for their implementation, is useless. The study of implicit policies led Colciencias to develop close collaboration with the main ministries and the business sector as they sought to identify the implicit technology policies for each sector. This in turn influenced the development of science and technology and innovation sectorial plans.

Another STPI characteristic was the international flavor that it gave to Colciencias work. It discovered there was a lot to learn especially from the experiences of Mexico, Argentina and Brazil in Latin America and from India and Korea in Asia.

In Mexico STPI played a significant role in helping the National Registry of Technology Transfer. In India it was the contribution to a better understanding of the role of CEDOs, and feeding ideas into the long term planning for science and technology.

The contribution in Korea included engineering capacity building, horizontal technology transfer, development of the know how in nuclear power generation. STPI also led to the development of the Centre of Excellence project, which played a major role in transforming higher education in Korea

In Venezuela the project showed that the previous Conicit model had been too limited. The process of innovation and development was shown to be much more complex than had been previously thought and required much greater consideration of economic and social factors.

As mentioned in the Argentinean response to the previous question, by the end of the project there was a military dictatorship in that country. This dictatorship impeded the development and use of local science and technology. Researchers were arrested and some went into exile. There was further discussion about the results of STPI in the first decade of the new century, but it has not been possible to assess whether these discussions affected policy.

Peru gave credit to STPI for the recognition that the development of new R&D and innovation financial mechanisms was necessary and important. Sergio stressed the need to integrate S&T policies with industry, trade and economic policies.

- **Question 7.** Please provide examples where the STPI research influenced regional and international positions and policies.

  Although it was easier for most respondents to identify the impact on there own countries there was general agreement that the project had a direct influence on a number of international organizations and other non-STPI countries. Several people pointed to the direct impact that STPI had on the technology policies of the Andean Pact. A specific example was the Andean Pact efforts to develop financial instruments for science and technology that led to the establishment of the Andean Finance Corporation. The results of the STPI project strengthened the case for AFC.

  The STPI impact on Korea was very substantial in defining the Korean model of science, technology and development. To the extent to which other Asian countries adopted the Korean approach it can be speculated that STPI indirectly had an impact on those countries also.

The STPI project clearly had a big impact on the 1979 UN Vienna conference on Science, Technology and Development. This was primarily due to Francisco's involvement as a member of the conference secretariat, and his helping to draft both the Latin American and Group of 77 position papers for the meeting.

- **Question 8.** What influence did participating in the STPI project have on the lives and careers of the participants?

  The short answer to this question is SUBSTANTIAL! There can be few international science and technology policy projects where the participants have had such illustrious careers. For some it was in the academic world where they succeeded. One became Prime Minister of his country. Others became Ministers. Another became the President of a national bank. Yet others went on to hold senior positions in the World Bank and international organizations. Whatever their position all who replied to this question acknowledged the contribution of participating in STPI played in their successes. For some it was transformational. For others it widened their horizons in new and exciting directions. But it was all positive.

  It was not only the team leaders that benefitted. Many of the team members and members of the Field Coordinators office also had illustrious careers. Only a few continued to do research in an academic environment, but just about every one, whether in a university or elsewhere, became involved in the policy making process. For many it was a contribution to their country and for others the contribution was more international.

  What was it that made this project so unique? In part it was its timeliness. It came at a time when it was beginning to be recognized that science and technology policies were not just the domain of scientists. As the Cuzco meeting participants recognized their countries might have excellent policies but unless there was a better understanding of policy instruments the implementation of these policies would be poor. STPI showed a way forward. It was a way that rapidly diffused and it was simply exciting to have been a part of that change in understanding.

  Another benefit was the international networking that developed and which in many cases has gone on over the 40 years since the project began. This networking led to a sense of comradeship which judging from the responses to the questionnaire is still prevalent today.

  Even though in Argentina the project had no immediate impact on policy, it did have a major impact on the professional development of the members of the team. As Eduardo Amadeo wrote: " All of the Argentinean team remember STPI as a cornerstone of their professional careers" This was true whether they stayed as researchers or became involved in the policy process.

- **Question 9.** If the STPI project was being designed today what would be the key issues that it would likely address? How different are these issues to the ones addressed 40 years ago?

This question proved very popular with almost all respondents. It seemed that everyone was aware of the huge changes that have taken place in the world over the past 40 years. Although some of the issues that concerned us then are still with us today there are also a lot of new ones. Forty years ago we were mainly concerned with science and technology policy, now everyone adds innovation policy. Forty years ago most of the STPI participants recognized that innovation policy was implicitly included in our definition of science and technology policy. Now it is made explicit.

Somewhat newer is the concept of systems of innovation. This is often applied to national systems of innovation, but it can also be used for regional systems of innovation or sectorial systems of innovation. Many countries now concentrate on developing policies to enhance their national system of innovation. The term national system of innovation was first used to describe the ways that Japan had taken to strengthen its capability to innovate. Chris Freeman, from SPRU, first coined the phrase in his book published in 1978.

But also in these forty years there have been vast changes in the global economy, which have affected the ways in which science and technology have transformed societies. The concept of globalization has dominated the world economic scene bringing with it strengths and weaknesses in roughly equal measure. Several of the larger developing countries have grown at extraordinary rates. They have transformed themselves into the BRICs mainly through the implementation of their science, technology and innovation policies, and their adoption of open door policies. At the Barbados STPI meeting Gennie Dean presented a paper on science and technology in China. At that time none of us dreamed that over the next forty years China would emerge as one of the largest economies in the world.

But not only has science and technology transformed societies for good it has also contributed to their problems. Environment, pollution, and climate change had all been recognized as problem issues when STPI was established, but they were not considered priority topics. Now they are.

Similarly ICTs, biotechnology, material science and nanotechnologies were just beginning to make their appearance but were not priority topics. Now they are.

It is in the last five years that the world economic crisis has severely affected the well being of many people in both the developed and developing countries. It provides the main background against which any new STPI type project will have to be designed. Many respondents singled out specific background topics as research projects. Others identified the science and technology and innovation policy issues that deserve more research.

In the rest of this section I have picked out several of the latter issues that seem to be of particular interest and importance. Several respondents mentioned many of these topics:

- The science, technology and innovation implications of the present financial and economic crises
- Science and technology as part of the problem and not just part of the solution e.g. genetically modified organisms and climate change.
- How to make science and technology decision-making more transparent and democratic.
- Analysis of latest trends in human resource development for example, university on line courses and the closer integration of teaching and research in research universities.
- The adoption of science and technology by the private sector
- Science Parks and research and innovation clusters.
- Brain migration –in both directions
- New technology based enterprises: national programs; venture tech organizations.
- How to strengthen the links between science and technology activities and productive activities, e.g. Information and technology intelligence capabilities, consulting and engineering design organizations, and agricultural extension
- Novel ways for achieving innovation, e.g. collaboration between enterprises and customers.
- Cross disciplinary synthesis of different S&T disciplines
- Impact of social sciences, humanities and the Arts in commercialization of new innovation and policy initiatives
- Design of strategic views for development of science and technology capabilities with a human face
- Technology assessment taking local and regional environmental factors into account.
- The role of science and technology in promoting human happiness

In a very interesting response Fernando Chaparro describes what happened when he twice had to address this issue in Colombia. The first time was twenty years after the STPI project finished and the second time is now, forty years after the end of STPI. The challenge on both occasions was to design new ST&I policies and policy instruments that responded to major social and economic changes. For example in the mid 90s it was the move from import substitution policies and to the opening up of the market. Today it is the changing global agenda on climate change, the deep economic crisis, and the challenge of sustainable development.

A topic that received no attention in the STPI project but is now beginning to receive quite a lot of attention is the issue of gender, science and development. Strangely only José identified this as an important issue for today's research agenda. I join him in thinking this is an important topic.

- **Question 10**. There were several components to the STPI project. These included: the country teams; the field coordinators office; consultants; IDRC; OAS; and policy makers. Each played different roles, but together they each played a part in the success of the project. In hindsight could these roles have been different so that the project was even more successful?

The consensus view of those who responded to this question was that on the whole the parts played by the different actors were about right. Each element could have had some improvements but there were no key issues that stood out as requiring major reform.

There were a few suggestions for improvement. Alejandro thought that the training component could have been strengthened and suggested that seminars on macroeconomics and industrial organization would have been useful. Anil suggested that the team leaders should have worked full time on the project. Several were only involved part time. Sergio thought that there should have been more resources for communication, and that government institutions should have been involved from the beginning.

- **Question 11.** Norman Girvan from Jamaica was quite critical of the STPI project in a review published in Mazingira issue number eight. His main criticism was that the project gave too much freedom to the individual country teams. It would have been better, he argued, if there had been a theoretical framework agreed before the project began. It would then have been easier to make inter country comparisons at the end of the research. What is your view of this criticism?

  No one agreed with Girvan! Some respondents thought that if the main objective had been academic with the intention of publishing papers then there might have been an element of truth in the Girvan criticism. But the objective was to contribute to development, and the needs of policy makers had priority. This meant that although there was a framework developed at the beginning of the project there was also a good degree of freedom given to the country teams regarding how they worked within the framework. This freedom was a major factor in the success of the project.

  The framework limited the project to the industrial sector and specific industries were also chosen as priority topics for research to make inter-country comparisons possible.

  There was also a view that the state of knowledge on the project topic did not lend itself to formulating theory at the beginning. As Alberto Araoz pointed out the situation reminded him of what Darwin had written about the Beagle expedition "We studied what we could find and then attempted to make sense of it"

  Even though there was freedom given to the country teams there was enough common sense among the researchers that there was very useful discussion and a helpful exchange of experiences.

  So Norman, although I appreciate your writing the article for Mazingira, (I was the editor of this issue) I have to let you know that everyone associated with STPI disagrees with you!

### 1.3. Concluding remarks

The responses to the questionnaire have demonstrated that STPI was a remarkable project. It was remarkable in its contribution to knowledge about science technology and development especially with its high lighting of the difference between implicit and explicit science and technology policies. It was remarkable in its impact on policy in many, but not all, of the participating countries, and it was remarkable in the productive interactions between the country teams that occurred as a result of the built in networking opportunities.

It must be noted that these very positive comments are based primarily on individual STPI member's recollections. They are not based on analysis by impartial historians! A thorough analysis would take a lot of time and money. So this partial analysis will have to suffice for the time being.

We began by questioning whether there are lessons to be learnt by today's researchers, policy makers, consultants, and donors. I think there are but it will be up to the Paracas meeting to decide which are the lessons we want to pass on to the participants of the Lima meeting.

One of the most striking features of the project was the interaction that occurred between researchers and policy makers. In many cases this led to changes in policy and to improved policy implementation. It is worth noting that some of these changes occurred during the lifetime of the project, but other changes took much longer before they were implemented. In some cases the impact only took place after a change in government. Also the evidence about what happened is largely anecdotal. Perhaps a new research project that analyses the link between innovation policy research and policymaking might be designed and funded.

The STPI project was designed to review the policy instruments that were most efficacious in implementing science and technology policies. Participants at the Cuzco meeting wondered if there were handbooks on possible policy instruments for science and technology. Forty years ago we found there were none. What about today? Would it be useful to try to prepare such handbooks? We would of course have to include innovation policy instruments!

This report has focused primarily on the positive lessons derived from the STPI project. There were negative aspects which were mainly of an administrative nature and which led to a few countries being out of phase in the timing of their work. This was the case with Peru because at the beginning of the project IDRC had not yet signed a country agreement with the Peruvian government that permitted IDRC to support research in that country. There were also serious administrative problems that interfered with the work of the Egyptian and Macedonian teams. But overall the positive lessons far outweighed the negative lessons.

## 2. THE SCIENCE AND TECHNOLOGY INSTRUMENTS PROJECT (STPI): 40 YEARS LATER (by Juana R. Kuramoto[20])

### 2.1. Introduction

It has been 40 years since the Science and Technology Policy Instruments Project (STPI) was launched. Its main goal was to examine how best to design and put in practice science and technology policies, and to explore the reasons for the meager growth rates that that underdeveloped countries experienced despite their efforts to pursue industrialization and the implementation of science and technology policies.

The main finding of the project was that the effectiveness of science and technology policy was limited to modify firms' technological behavior. Firms made their technological decisions regardless of the government's policy. The adequacy of these decisions to promote productivity increases depended on the technological capacities accumulated by the firm.

Other important findings relate to the formulation and implementation of ST policy. Among them, that policy implementation is as important as policy formulation. Diligent work to define the adequate policy mix to promote change may be offset by situations that appear during implementation. For example, ST policies may interact with other policies (i.e. implicit) producing unexpected results. Sometimes there is redundancy in the implementation of polices while some other related aspects are left unattended. Or, stakeholders may resist or ignore the implemented policy due to existing conflict of interests.

Many of the findings of the STPI project are still valid 40 years later. The general international context may have changed but the challenges to formulate and implement an effective public policy still remains. Many of the recommendations proposed by this project were based on the identification of certain findings that now have been thoroughly studied and understood.

This essay tries to reflect about the significance of this project 40 years later. The next section presents some background information of the STPI project and resumes their main results. Section 3 discusses the main changes in the world economy and how it affected economic policy formulation. Section 4 discusses the current relevance of the STPI project. It highlights its findings under the light of the current literature on science, technology and innovation, such as innovation systems, technological regimes, technological capabilities and the interaction between macro and microeconomics policies. It also draws attention to some trends in policy formulation and implementation. Finally, Section 5 presents some points of a current agenda formulated with the STPI vision.

[20] Ms. Juana Kuramoto is Associate Researcher at the Grupo de Análisis para el Desarrollo (GRADE) and is currently the Director for Technological Innovation at the Consejo Nacional de Ciencia y Tecnología (CONCYTEC) in Lima, Peru.

## 2.2. The STPI project: background and results

### 2.2.1. Background

The Science and Technology Policy Instruments Project (STPI) was a major initiative launched in 1973 by the International Development Research Centre (IDRC) and the Organization of American States.

The rationale for the project was that after decades of policy intervention trying to strengthen science and technology systems little had been achieved. In many countries the science infrastructure was increased but it had little connection with the productive sector's demand. Thus, the project aimed at exploring policy implementation and figure out the facts that conditioned this poor outcome.

Its objective was to compare the design and implementation of science and technology (S&T) policy in 10 developing countries from Latin America (Argentina, Brazil, Colombia, Mexico, Peru and Venezuela) and from other regions (Egypt, India, Macedonia and South Korea).

The research question was to explore:

> *"[…] how policymaking and policy instruments (independent variables) influence science and technology functions and activities (dependent variables) in the different contexts of underdevelopment."*[21]

Policy instruments are the ways and means used when putting a given policy into practice. They comprise, first, a legal device that embodies the policy in the form of a law, decree or regulation. Second, they include an organizational structure that is put in charge of implementing the policy. Third, the latter implements the policy through a set of operational mechanisms. On the other hand, S&T functions and activities were classified for their effects on the demand side (i.e. technological behavior and decisions in the productive system); the supply side (i.e. activities in the S&T system); and the linkage area (i.e. activities that linked the productive system with sources of S&T).

The project also distinguished three types of independent variables: explicit S&T policy and instruments (i.e. aimed at directly cause an effect on S&T functions and activities); implicit S&T policy and instruments (i.e. aimed at intervening on other areas but have an effect on S&T); and contextual factors." (Sagasti and Araoz, 1976, page 5).

Although the objective was common for all of the participant countries, after a phase of recollecting initial evidence, it was clear that the focus on implementation would reveal differences in the way S&T systems developed, the specific area they focus, the main constraints they faced, etc. Thus, after the analysis of the S&T systems each country team selected the most relevant S&T policies (implicit and explicit) and formulated hypotheses about the characteristics and effects.

---

[21] Italics will be used when citing textually from the STPI documents.

Keeping in mind the close relationship between S&T policies and industrialization, hypotheses were tested at the level of industrial branch (demand), as well as the level of units generating S&T (supply) and the linkage area.

### 2.2.2. Results

The project showed that import substitution industrialization was mostly a reaction to macroeconomic imbalances rather than an explicit development strategy. Deficit in external accounts urged countries to limit imports, promoting domestic industrial production would not only achieve that goal but also create local employment. The path to industrialization was similar in all countries. It began with the substitution of consumer goods and followed, showing substantial differences, with intermediate and capital goods. Nascent industries were dependent of imported technology and foreign financing was a strong means to keep this relationship.

The focus on implementation revealed interesting findings. First, no matter how well formulated is the policy mix, the expected outcomes may differ from the predicted ones, An important source of variation was the influence exerted by implicit policies over the explicit ones.

Second, explicit policies had limited impact on technical change, especially in early stages of industrialization. Firms usually made their technological decision without a consideration of S&T policy instruments. However, instruments directed to increase technological capabilities (i.e. personnel training) were more successful. The latter may be evidence that one important factor in defining the policy mix is the level of development. Limited levels of domestic capabilities in early stages of development may need to be increased before trying to promote more sophisticated S&T activities.

Third, policy implementation was subject to bounded rationality. Policy instruments were designed at a general level and were expected to have the same effect across all industrial branches. Evidence showed that each branch characteristics influenced the direction and speed of technical change.

Fourth, an inadequate policy mix may deliver redundant policy instruments in one policy area while leaving unattended other ones. This implied that policy formulation requires an assessment of existing instruments, both explicit and implicit.

Fifth, it was also found that unperceived loopholes diminished the effectiveness of policy instruments. In addition, some policy instruments required some discretionary power from public officials but there were not clear criteria to exert that power.

Finally, the STPI project showed that the specific context faced by each country defined a unique industrialization path and the features of the different components of the S&T system. In a certain way, evidence collected in this project supported the claim made some years later about the non-prescriptive power of innovation systems.

### 2.3. The changing environment

The findings made by the STPI project were very significant. It showed that policy design and implementation is not a trivial exercise. On the contrary, it does not only require human, financial and infrastructure resources but a continuous learning environment that allows the monitoring of changing conditions and an adequate adaptation.

The latter statement still sounds sensible 40 years later, although major economic, political and social conditions have changed.

#### 2.3.1. Key trends in the world economy

a. Major economic changes

Shift from import substitution to export-led strategy. The STPI project was launched in a time that the import substitution strategy was adopted by most developing countries, although there were signs that such development strategy was reaching its limits. Some countries, like Korea and other Asian ones, were gradually adopting an export-led strategy.

External accounts deficit was one the reasons to adopt an import substitution strategy and, decades later it also became a determinant to abandon it. Savings obtained by local production were offset by the increasing need of importing capital goods and technology to sustain the strategy. In addition, in most countries primary exporting sectors were financing this strategy, however a declining trend in the terms of trade with manufactured products made it difficult to sustain it.

Collateral outcomes of this shortage of domestic savings, were the implementation of short-term economic policies that ended in distorting relatives prices; the increase of external debt; the subordination of state enterprises to government financial needs at the expense of their own survival; the deterioration of the business climate for private investment, among others.

The role of international financial institutions was critical to compel the abandonment of the import substitution strategy. Almost all developing countries were highly indebted and presenting high inflation levels that deteriorated general functioning of their respective economies. During the 1980s, adjustment programs were implemented almost in all developing countries and by the end of the decade a new set of policy prescriptions based on the free functioning of markets became the rule.

These policy prescriptions, known as the Washington Consensus, ruled the economic policy agenda for more than 15 years. They promoted a liberal agenda that limited government intervention and promote the free functioning of markets. Private investment was sought and government investment was reduced to basic infrastructure and the provision of public goods,

Outcomes of these prescriptions were the stabilization of economies and a major change on their economic structures. Privatization processes transferred state-owned enterprises to usually foreign investors, resulting in the modernization of firms and a consequent improvement of efficiency. However, it also resulted in massive unemployment. Privatized firms were mostly in the utilities and the natural resources exploitation sectors.

Promotional measures were launched to attract foreign direct investment (FDI). It was expected that the presence foreign firms would help integrate the economy to global markets. In fact, primary exports increased and most countries recovered their importance as raw materials suppliers. However, the attracted FDI was not a good vehicle to engage in the new global value chains.

Globalization. The agenda of free action of markets and liberalization also had a component of a revalorization of free trade. On the one hand, increasing competition in developed countries make them search for ways to reduce their production costs and expand their markets via foreign direct investment. This also meant a pressure to relax the barriers on trade, both in developed and developing countries. With this favorable environment, multinational companies (MNC) were able to decentralize their production chain.

Asian countries took best advantage of this new economic trend. These countries were attractive not only because of the availability of low cost human capital, but also because of their medium and large markets. In addition, countries like Korea and afterwards the rest of the Asian tigers, adopted an export-led strategy that became beneficial for the relocation of production activities and also allow setting a distribution point to export to other locations.

Technological change also drove globalization via improvements in information technologies, reductions in shipping costs, adoption of "just-in-time" inventory management and flexible production methods. As a result, outsourcing made possible that MNCs shifted part of their activities to unrelated firms. The assembly of a single product may include parts produced all over the world, while having tight control of costs. Thus, giving rise to international value chains. Firms from different countries could engage in the production of a single part, exploiting economies of scale without the need of having large domestic markets. A new strategy of industrialization was available but it required the mastering of production capabilities of all players in the value chain. This did not meant an abandon policies based on the belief of markets as superior resource allocator, but certainly was an indicator that market failures existed in knowledge intensive environments.

b. Changing focus of public policy

Governments have a long tradition of intervening in the economy to promote strategic objectives such as industrialization. Explicit mention to the need of government intervention to support industry is found in Alexander Hamilton's Report on Manufactures presented to the United States House of Representatives in 1791. Hamilton prescribed a series of policy instruments to promote manufacturing that included: (a) protecting duties; (b) prohibitions to rival articles; (c) prohibitions of the exportation of the materials of manufactures; (d) pecuniary bounties; (e) premiums to quality and excellence; (f) the exemption of the materials of manufactures from duty;

(g) drawbacks of the duties which are imposed on the materials of manufactures; (h) the encouragement of new intentions and discoveries at home, and of the introduction into the United States of such as may have been made in other countries; particularly, those which relate to machinery; (i) judicious regulations for the inspection of manufactured commodities; (j) the facilitating of pecuniary remittances from place to place; and (k) the facilitating of the transportation of commodities (Hamilton, 1791).

In the same fashion, Friedrich List's The National System of Political Economy stated that government should protect nascent industries via tariffs: "It may in general be assumed that where any technical industry cannot be established by means of an original protection of forty to sixty per cent and cannot continue to maintain itself under a continued protection of twenty to thirty per cent" (1909, page 32).

These two examples show that government intervention and its paraphernalia were at least discussed and used in developed countries to promote and protect their industries. However, even when the policy instruments might be same apparently there are certain conditions that have to do with specific historical and institutional contexts that contribute to successful implementation.

It is understandable that developing countries tried to replicate these policy prescriptions, especially when they also proved successful in other countries such as Japan. However, it is important to mention that one crucial difference between the role of government intervention in developed and underdeveloped countries is that in the former there was an explicit recognition that private initiative had the most important role and the limits of intervention. Thus, Hamilton mentioned: "it can hardly ever be wise in a government, to attempt to give a direction to the industry of its citizens. This under the quick-sighted guidance of private interest, will, if left to itself, infallibly find its own way to the most profitable employment; and it is by such employment, that the public prosperity will be most effectually promoted. To leave industry to itself, therefore, is, in almost every case, the soundest as well as the simplest policy" (Hamilton, 1871).

As opposed, in underdevelopment countries government intervention was seen not only as a means to promote industrialization but also to control tightly private actors who would not contribute to this goal. In fact, the dependency theory stated that elites accept the norms and values of the industrialized countries and cooperate in maintaining the status quo. Under these circumstances it was reasonable for the government to intervene not only by implementing policy instruments that protected and encouraged domestic industry but also by participating directly in the production of goods and services.

The import substitution strategy was a clear example of the implementation of a myriad of policy instruments and of the establishment of state-owned companies in strategic industries, in which there was no interest of private actors to participate because of the high risks associated, the barriers to entry due to large investments or simply because they were not interested.

Most of Latin American countries pursued this strategy after the Second War World (WWII) but the results have been somehow disappointing: income gaps between these and developed countries did not close and even increased, as well as they were left behind by other regions' underdeveloped countries (Rozenwurcel, 2006). As opposed, in Asian countries, in which the strategy was also applied after the WWII, outcomes were much more positive. Rozenwurcel (2006) stated that the difference rested in a progressive shift to an export-led strategy since the mid 1960s and factors such as the adoption of sound macroeconomic policies, a strong state that not only provided incentives to the private sector but also penalties when it failed to fulfill export goals and a high domestic savings rate. In addition, successful Asian countries stressed the importance of building domestic industrial capacities.

However, the discussion should not be framed only in the comparison of both development strategies. It is important to acknowledge that the inherent complexities of implementing policies will shape the effectiveness of any strategy (Narula, 2002). Some even argue that there is not such a unique import substitution model or an export-led one. In fact, Lall identified different variations of the export-led model followed by Asian countries[22].

In general, the shifts from the import substitution strategy to an export-led one meant a substantial reduction of government intervention. The focus of public policy was directed to enhancing economic efficiency rather than in building capabilities. Some authors indicated that the latter was a risky approach since the new model "withdrew the support structure that allowed firms to internalize the spillovers that derived from international competition" (Narula, 2002, page 11). In fact, some indicated that Latin American countries could not replicate the Asian success story due to: (a) the attenuation of the role of governments; (b) unreasonable expectations from the liberalization of FDI for industrial development; (c) the failure to sustain absorptive capacity; (d) the failure to sequence FDI and domestic capacity in tandem; and (e) the failure to recognize the inertia of transition and coordination failures (Narula, 2002).

The shift in public policy restricted government intervention and neglected the need to formulate policies to build technology capabilities. The assessment of the new model made by Narula (2000), Reinhardt and Peres (2000) and Rozenwurcel (2002) conclude that both the import substitution strategy and the new model implemented in Latin America failed to deliver the expected outcomes of development due to the lack of investment in building domestic technological capabilities.

The disenchantment with the new model became evident after the 2008 crisis. The US and European governments had to intervene drastically in the economy because the crisis in the financial markets spread to other real sector markets. Even when the crisis was not felt in all its magnitude in Latin America, the disappointment came via the meager growth outcomes. A study elaborated by the Inter American Development Bank (IADB), showed that income per capita in Latin America and the Caribbean was almost one-quarter that of the United States in 1960 while today it is only one-sixth (IADB, 2010).

[22] The variations identified by Lall can be reduced to three. First, the Autonomus strategy, deployed by Korea and Taiwan, that aimed at upgrading domestic firms by selective restrictions on FDI and the use of technology imports. Second, the Strategic FDI-dependent Strategy, used by Singapore, aimed at attracting FDI to later upgrade the quality of FDI towards higher value-added activities. Third, the Passive FDI-dependent Strategy, which is similar to the previous one but instead of making purposely effort to upgrade FDI, it relied on market forces. This strategy was pursued by Malaysia, Philippines, Thailand and Indonesia.

Although no alternative model has reached consensus in the international organizations, directly involved governments and the academia, there is a growing agreement that to promote growth and development it is necessary to implement some kind of industrial policy.

c. Global challenges

Since the STPI project was carried out, a series of concerns associated mainly with the impact of industrial activities have now become major global challenges. At this point, solutions will only come from a global concerted action in which all countries are expected to change certain practices and habits. However, even with the pressing demand for these changes, countries are not willing to compromise. The optimistic position that scientific and technological advances will solve for these problems seems no longer feasible.

That is the case of environmental pollution, which was associated to the sites were certain industrial activities took place. Time has passed by and some technology has been developed to abate the impact of such industries (i.e. mining, smelting and refining; chemical production, paper production, etc.), however, the spread of these activities to other countries (usually less advanced) has converted pollution in a global problem. There are major discussions about the right that less developed and emergent countries have to engage in industrial activities as a means for economic development. International conferences were organized to discuss common solutions and to establish compromises from the polluting parties, but the results have been disappointing.

Another major concern is global warming that is a result of an alteration of changes in atmospheric composition. Part of this alteration is associated to the release of carbon dioxide and methane as a result of industrial emissions. Global warming has increased the global temperature by almost 1 centigrade enough to have effects in the rise of the sea level, change the pattern of precipitation, extreme weather effects, among others. The impacts of these climate changes are felt every year in different parts of the world and have terrible consequences to entire populations, usually poor and vulnerable. Foreseeable solutions for this problem include the reduction of greenhouse gases and a series of emission-reducing activities such as energy conservation and increase energy efficiency.

Another major global concern that is emerging is the outcome of scientific and technological advances: genetic modified organisms (GMO). These are organisms that have been altered by genetic engineering. The major uses of GMOs are in the production of new drugs, experimental medicine and agriculture. GMOs generate a lot of controversy. There are ethical concerns about the manipulation of living organisms and the effects they may cause. Another source of concern is that it is impossible to assess the consequences of ingesting GMO food. Additional concerns related to food production are the environmental effects of GMO plants, the proprietary consequences of GMO products that may affect the production of food, the need for regulation, etc. Science and technology advances are ready to be applied but ethical concerns and conflict of interests are halting these developments and the possibilities to produce innovations based on them.

Decades ago, the aforementioned concerns were somehow focalized and although they posed some economic externalities, the responsible parties could be identified clearly (i.e. polluters pay). Their transformation into global concerns is what makes them difficult to handle. They are no longer scientific or technological matters, not even economic ones; they have become global political problems.

Poverty alleviation and social inclusion**.** Although there has been an important reduction of poverty, there are still vast amounts of people living with less than 2 dollars per day. The problem is that such limited income condemns people to other afflictions that impede their development as human beings. The Millennium Development Goals stressed the importance of science and technology to solve the problems these goals tried to solve. So far major advances have been done but still major work has to be done to deliver products and services to attend poor people needs. This is not a new problem, since the 1980s international development organizations are trying to commercialize solutions for these needs, but it seems they don't find the adequate business models to launch affordable goods and services, and as a result, private firms do not perceive the potential of such poor but massive markets. However, some examples, like the microcredit industry, indicate that developing these markets is possible.

d. Changing technological paradigms

Another set of global issues is referred to technologies that could be the base for new technological paradigms. These are biotechnology, information and communication technologies (ICTs) and nanotechnologies. At present, their applications are quite ample and there is still much more room for expansion. Nobody has a clear idea about the direction of their path of development or the kind of changes that may bring to the social, economic and political systems.

Biotechnology. No doubt that biotechnology has massive applications. In medicine, it has an enormous impact from the production of new drugs to human genetic modification that will help to overcome ailments. Societal changes that may derive from these advances range from a longer expectancy of life to the modification of the insurance industry to legal changes with regards to inheritance rights for in-vitro offspring.

In agriculture, the production of more resistant crops will help increase the production of food. However, there are some concerns about the impact these new plants may have in the local livelihoods of poor peasants, as well as the health risks associated with the ingestion of genetically modified plants and animals.

In the field of remediation, biotechnology processes are being developed to remediate polluted sites. The manipulation of organisms can play a major role in the removal of contaminants. Advances in microbiology are offering clues to the evolution of degradation pathways and to the molecular adaptation strategies to changing environmental conditions.

The scope of application of biological engineering includes the manipulation of information, construction of materials, processing of chemicals, production of energy, provision of food, and the enhancement of human health and environment.

Nanotechnology. Nanotechnology opens the possibility to create many new materials and devices with a vast range of applications, such as in medicine, electronics, biomaterials and energy production.

It may allow the production of many high-quality products at very low cost. The image of nanofactories that manipulate individual atoms and machines with organism-like self-replicating abilities, mobility and the ability to consume food are still far from reality. Nanotechnology, together with biotechnology, may change the world as we know. The implications are numerous and uncertain.

The Project on Emerging Nanotechnologies, run by the Woodrow Wilson International Center for Scholars and the Pew Charitable Trusts, estimated that over 1300 manufacturer-identified nanotech products are publicly available.

Information and Communications Technologies. Information and Communications Technologies (ICTs) are nowadays pervasive. They have changed drastically the world. On the one hand, they have increased people's ability to exploit data. Nowadays, decisions can be made taking into account a vast variety of information in just few minutes. On the other, interconnectivity allows to transmit information almost instantaneously. This is allowing that information circulate easily and freely throughout society.

The implications of e-learning to e-government and of using massive information and integrating it are enormous. As opposed to results obtained in the 1980s that showed that ICT did not have a clear impact on productivity growth, recent studies show the contrary. Pilat (2005) reported that different studies found that ICT-using firms tend to have better productivity performance. However, the differences are not homogeneous across all industries. The services sectors seemed to take better advantage of ICTs.

It also seems that ICTs have an enabling role in innovation. Product innovation seems to increase more between 15% and 86% in ICT-using firms, while the percentages range from 62% to 92% in process innovation (Alkas, 2009).

Impact on consumer behavior. New technologies not only are producing new products that increase the product mix available for consumers, but also have generated changes in business models. The result is that it is possible to count with differentiated products at reasonable prices. Consumers are becoming more exigent and are willing to pay a premium for products that satisfy their preferences, as is the case of Starbucks and Apple.

Perez (2005) suggested that a new kind of competition is emerging. Even when recent evidence in global value chains showed a trend towards a localization of commodities segments of manufacturing in Asia and natural resource based industries in Latin America, there is a myriad of other specialized production segments that would be captured by emerging countries in their efforts to upgrade their position in these value chains. This new trend of specialization will combine attributes of standardization and differentiation as well as basic to custom-made attributes.

In this new setting, countries need to invest in capacity building and rely in R&D. For example, it will not be possible to compete in an agriculture market niche without deploying biotechnology to create competitive advantages.

## 2.4. The STPI Project under the light of current approaches to study innovation

One of the striking features of the STPI project is that when one reads the reports and documents produced, it seems that the goals, problems and approaches presented could be stated today.

### 2.4.1. Some of the STPI project findings in the light of the current literature on innovation

The STPI project was formulated when the study of technical change was still in its early stages, and there have been several more recent developments.

a. Innovation systems

The conceptual framework of the STPI project considered the notion that there is a science and technology system that works fulfilling certain functions that contribute to industrialization. The system is made up of firms, which represent the demand side of the system; science and technology institutions, which generate knowledge and put it to the service of firms; and linkage organizations, which act as interface between demand and supply.

The latter configuration is mostly based on the "Sabato triangle" that stated that an effective science and technology system should be formed by the state, in charge of formulation and execution of the policy; the organizations that form the scientific and technological infrastructure and supply technology; and the productive sector that demands technology. As early as 1968, Sabato also stressed the importance of the interactions generated among the vertices of such triangle (Arocena and Sutz, 2002).

However, nowadays the most disseminated framework related to the systemic nature of the generation, adoption, transference, diffusion and use of science, technology and innovation (i.e. knowledge) is the innovation systems concept. Although there are precedents about the concept, such as the one presented above or the early work of Friedrich List, it was Christopher Freeman who first introduced the concept in the late 1980s.

Later work on innovation systems, such as the contributions of Hekkert et al (2007), Johnson (1998), Edquist (2001), Mullin (2002), Bergek et. al. (2006), have stressed the importance of fulfilling certain functions that secure knowledge flows within the system and the generation of value added to the economy. These functions include:

entrepreneurial activities, knowledge generation and diffusion, guidance of search, market formation, resources mobilization and creation of legitimacy. Some advances are being done to measure the effectiveness of each function via a process approach or sequence analysis. The method implies that an event is identified and it is evaluated if it has influenced any of the functions and how in a specific time line (Hekkert et al, 2007).

The STPI project foresaw a set of functions for the science and technology system that were related to the demand (i.e. demand for technology and absorption); to the supply (i.e. production of technology, S&T services and supply of S&T skills); and to the linkage area (i.e. linkage between the S&T and the productive system; and technological transfer, technical cooperation and assistance).

One of the project's findings was that policy instruments do not always deliver the expected results. Some of the explanations provided by the research team were the interaction of implicit and explicit policy instruments; the existence of conflict of interests and firms' decision making processes independent of the policy context. This is understandable under the light of the innovation systems approach. The interaction of actors and the incentives that arise may redefine the conditions for decision-making.

b. Technological regimes

The attention that the STPI project provided to the industrial branch as a unit of analysis was critical to recognize that firms and their related support organizations may have differentiated technological behaviors. In the framework of the project, these behaviors may be influenced by the contextual factors, the characteristics of the branch, the internal structure of the productive unit and the explicit and implicit policies.

The kind of parameters that the teams should collect to define the technological behavior of the firm included: (a) characteristics of the product mix; (b) characteristics of the technology used; (c) origin of the technology used; (d) form in which the technology is acquired; and (e) technical capabilities within the firm.

These parameters resemble the ones used to define technological regimes. A technological regime is "defined in terms of the specific combination of technological opportunity conditions, appropriability conditions, cumulativeness of learning, and nature of the knowledge base" (Clausen, 2004). This concept owes much to the work of Pavitt (1984) who proposed a taxonomy of sectoral patterns of technical change. These patterns became the basis for four differentiated regimes: (a) supplier-dominated, that includes firms from mostly traditional manufacturing such as textiles and agriculture which rely on sources of innovation external to the firm; (b) scale-intensive, that is characterized by mainly large firms producing basic materials and consumer durables. Sources of innovation may be both internal and external to the firm with a medium-level of appropriability; (c) specialized suppliers, conformed by smaller and specialized firms producing technology to be sold into other firms. There is a high level of appropriability due to the tacit nature of the knowledge; and (d) science-based: high-tech firms that rely on R&D from both in-house sources and university research, including industries such as pharmaceuticals and electronics.

Firms in this sector develop new products or processes and have a high degree of appropriability from patents, secrecy, and tacit know-how.

Although the STPI did not develop a systematized typology of industrial branches, it definitely acknowledged that certain attributes had an important effect of the technological behavior of firms. One important feature that was highlighted in the project was the role of market structure in innovation. For example, empirical findings suggested that oligopoly structures inhibited technical change.

c. Technological capabilities

One of the conclusions of the STPI project is that "the development of indigenous S&T capabilities was considered as essential condition for achieving a certain degree of autonomy in decision-making on industrial development. The possibility for a country to control its future industrial evolution and to achieve some self-reliance depends on the capacity to take decisions on technology, to generate technology critical for national development, and to evaluate, absorb, and improve imported technology" (Sagasti, 1978, page 99).

The citation above could be said today without changing a word and it would be completely valid. The critics of the Washington Consensus consistently stated that the economic model derived from it neglected the importance of building capabilities. The model took the market role to an extreme and it was expected that technology transfer and adoption would be enough to build such capabilities. Technology (i.e. knowledge) was seen as any other good that could be purchased in international markets. The rationale was there was no reason to "invent the wheel" again.

However, a vast number of technology-related studies acknowledged, first, that knowledge is not a normal good. It is subject to a lot of uncertainty and it has characteristics of public goods. Thus, it will be subject to market failure and government intervention should be required to secure that society invests on it. Second, technology and knowledge, in general, have explicit and tacit components. The explicit part of technology is articulated and it takes the form of concepts, models, hypotheses, metaphors, and analogies. It can be traded and is incorporated in blueprints, manuals, machines and equipment, and other similar documents and artifacts. As opposed, the tacit part of knowledge requires learning and skills but in a way that cannot be communicated in any direct and codified way.

Learning processes are the mechanisms by which knowledge is transformed in capabilities. There are different forms of learning, the most common being "learning by doing" and "learning by using". The direct experience of the person is required to absorb tacit knowledge. Because tacit knowledge needs to be transferred from one person to another, it requires from social interaction (i.e. learning by interacting).

In the domain of firms, Zahra and George (2002) stated that is necessary of a set of organizational routines and processes to acquire, assimilate, transform and exploit knowledge to produce a dynamic organizational capability.

In the domain of countries, specifically Korea, Bell and Pavitt (1995) claimed that it is necessary to make a distinction between production capacities (i.e. to master production at specific efficiency levels) and technological capabilities (i.e. manage technical change). They mentioned that besides the accumulation of knowledge, skills and experience, it is necessary to provide institutional structures and linkages within firms, among firms and outside firms. In addition, they mention that the specific patterns of technical change should be taken into account to build such capabilities.

Chao, Chen and Wo (2006) stressed the importance of social interaction to build technological capabilities since tacit knowledge is an important component. In analyzing the building of such capabilities in the Taiwanese IT sector, they devised 4 routines that helped learning tacit knowledge. First, imitation: followers learn from the innovators by imitation via subcontracting or outsourcing. Second, replication: innovators are able to systematize (assimilate) their experience and knowledge and then transfer their expertise to the followers. Third, the social network that defines what and how much a follower can learn. Fourth, innovation community: after tacit knowledge is learnt, its growth, evolution and diffusion will depend on the interaction in this community.

From the above, building technological capabilities requires efforts that comprise not only resources and skills but the institutional setting to promote interactions among the different actors. Just like the STPI project, the studies mentioned above showed that, even in the domain of national capabilities, efforts have to be specific to the industrial sector or subsector. Moreover, the routines required to build capabilities involve specific tasks or activities at the plant or firm level.

It is important to mention that policies required for building capabilities must be adequate to the level of development of the country. Kim (2007) proposed a 3-stage model of building technological capabilities based on the Korean experience: (a) duplicative imitation; (b) creative imitation; and (c) innovation. During the first stage capabilities are built through improving education; accessing foreign sources of technology via literature reverse engineering and technical assistance; the creation and nurturing of domestic large firms; and the attraction of foreign talent. These policies were enhanced via an export promotion strategy and by created “crises” that had to be solved on the way.

During the creative imitation stage, capabilities were strengthen through the transfer of more sophisticated technology; the repatriation of human capital; the promotion of corporate research and development; the strengthening of Korean universities and the creation of government research institutions. In this stage, policies were enhanced by learning, by research and by created “crises”.

Finally in the innovation stage, Korean universities began doing basic research; government research institutions became mission-oriented, corporate R&D was intensified and also globalized. and the repatriation of human capital. Policies were enhanced by strengthening competition at the global level and by the continuing of created “crises”.

Experience shows that these policies worked well for Korea, but as the STPI project showed, the effectiveness of such policies depends on various factors that may not be replicable. However, Kim's findings may serve as an initial road map.

Although the STPI project did not cover all the aspects cover by the technological capabilities literature, it certainly recognized that firms need to strengthen their capacities to make better technological decisions, which will also upgrade the technological services demanded to suppliers.

d. Interaction between macro and microeconomic policies

One of the findings of the STPI project was that many of the Latin American countries embarked in an import substitution strategy, not because they devised it as the best one to promote development and growth but because they were trying to adjust their external accounts and control the imports. Another one is that implicit policy instruments, some of them related to macroeconomic goals, may have more impact on the technological behavior of firms than the explicit ones.

Definitely there is no doubt that macroeconomic policy instruments can alter the profitability of certain lines of business, especially in unstable environments or when the incentives are sufficiently attractive. Katz and Stumpo (2001) analyzed the impact of the policy prescriptions derived from the Washington Consensus. They arrived to the conclusion that the prescriptions have altered the industrial structures of the Latin American countries. Liberalization of markets and a framework that promoted international competition have altered the configuration of industrial branches. Many domestic firms went out of market while only the strongest survived, as a result, concentration increased. Articulation among domestic firms have also been altered, the reduction of tariffs for intermediate products have crowded out domestic producers. In some knowledge intensive sectors, like pharmaceuticals, this has meant the abandonment of domestic procurement and a return to intra-firm trade.

### 2.4.2. Innovation focus

In the 1960s and 1970s, most of the work to support science and technology was promoted by international organizations. For example, the United Nations Educational, Scientific and Cultural Organization (UNESCO) urged developing states to take responsibility for promoting science as a means to achieve economic development. UNESCO began actively to assist countries in setting up science policy organizations. It also developed a mission statement to support that role: "the Science Policy Programme of UNESCO is formulated on the basis on the principle that the planning of science policy is indispensable" (Finnemore, 1993, page 583). Outcomes are that around 70% of the member states created science policy organizations in the period 1955-1975. The percentage rose to 84% in the period 1976-1980 (Finnemore, 1993).

Given that attention to the building of science institutional setting, which seems to be based on a linear model of innovation, it is remarkable that the STPI project had a main focus on innovation. In fact, it was acknowledged that economic growth and development is generated in the productive sector and that S&T need to reach and be incorporated in the latter's activities. Special attention was given to the mechanisms of technology transfer as it was seen as a corner stone in the dependent relationship between developed and underdeveloped countries. In addition, the STPI project put special attention to the role of state-owned firms as a vehicle of domestic capacity building.

With the new economic model and the spread of globalization, the liberalization of markets made it simpler for private parties to engage in economic transactions. As a result, many governments stop registering investment inflows of FDI, unless it involved a government party as in the case of the privatization of state-owned companies; as well as all the technology transfer transactions.

The assumption that technology could be transfer easily via FDI and licensing liberated many governments from specific actions to build domestic capacities, especially in countries that had invested little in previous years. It was only on large Latin American countries or countries with an appropriate institutional setting those efforts were maintained. For the rest of the countries, government focused on horizontal policies such as provide funding and support to R&D activities, increase highly specialized human capital and provide support to private innovation.

With regards to the latter, some international organizations that traditionally have supported S&T activities changed the focus of their programs to promote innovation activities in the private sector. For example, the IADB helped set innovation funds for firms in several countries in Latin America. The rationale for this change was that the private sector was responsible for the generation of such capabilities.

However, even considering that innovation is usually performed by private actors, the responsibility of governments is to provide the ecosystem that would make flourish private innovation but few of them achieve this objective. In some countries, where the market oriented model was applied strictly there is the idea that the focus should be to provide support to the private sector.  Extreme positions even suggest that science capacities are not required because the private sector is already connected with the scientific capacity elsewhere.

### 2.4.3. Emphasis on implementation

Emphasis on implementation was the one feature that distinguished the STPI project from other research projects. As it is mentioned in the methodological guidelines, the main goal of the project was not only to prepare a synthesis report, but also to generate knowledge most appropriate to for national policy making.

Most of the research projects on S&T issues, then and now, are focused on making diagnosis about a certain situation (i.e. little scientific or innovation activity performed by domestic actors) and end up prescriptions to overcome it. Very few of them focus on how to do it. In the case of the STPI, governments had already identified the problem and all of them were implementing specific policy instruments. The question was to assess how these instruments were implemented in the different countries that participated and the results they had.

The STPI project defined a policy instrument as "the ways and means used when putting a given policy into practice" and the identification of its constituting parts: a legal device that embodies the policy; (…) an organizational structure that is put in charge of implementing the policy; (…) and a set of operational mechanisms through which the organizational structure actually implements the decisions on a day to day basis".

It was also identified that not all policy instruments have all the required parts. Some lack the legal device but the instrument is implemented coupling the organizational structure and operational mechanisms. Others have no specific organizational structure but the legal device is implemented through existing institutional structures. In other cases, there is no a policy statement but an existing organizational structure decides to take a specific action. Yet other situations imply only having a statement as policy but there is no instrument attached to it.

The STPI reports assessed the different policy instruments found by the countries. The criteria for the assessment include the specificity of the instrument (measured by the number of S&T functions that it covers), its coverage (number of productive units affected by the instrument), and its efficiency (effort-effect analysis), among others. But the final and more important criterion is the effectiveness of the instrument that evaluates if the instrument provokes the desired outcome. Section 2 resumes the main findings from this assessment.

One point of reflection is that the main reports of the project did not summarize the effects of the configurations taken by the policy instruments. From a public administration perspective, it would be worthy to assess how different configurations contribute to the effectiveness of the instruments. Most developing countries did not have enough resources to build up the organizational structures and, probably, even when the operational mechanisms were at place, the lack of resources made it very difficult to implement them. In fact, the reports mentioned the importance of 'policy keepers' that are the responsible ones to actually implement the policy instruments.

The incomplete configuration is of utmost importance given the current prescriptions of maintaining a small government. For example, in countries like Peru, the lack of organizational structures is a persistent problem. In the 1980s, the S&T system suffered from lack of funding that could not maintain the minimum conditions for many organizational structures for an effective functioning. In the 1990s, the re-engineering of government closed some organizations or merged some of them. At the same time, funding to S&T activities remained limited. By the end of the 2000s, with the help of the IADB a US$ 36 million innovation program was approved and had to create its own executive office because there were no adequate capacities to manage a fund of that size in the existing government organizations. However, this office is not permanent because it will operate during the life span of the project.

Another example is referred to the lack of such structures at the regional (subnational) level. Most emerging countries still suffered from centralized government structures and, even, when subnational structures are in place, the innovation system remained fractured.

With regards to the policy instruments that the STPI project identified, many of them are still in place in many countries (see Table 4.3.1). Only those instruments that are directly related to the import substitution strategy, such as control of imports, are not in use. The same occurs with those instruments that exert strong government intervention such as price controls. At present, there are more instruments that involve the participation of the private sector. The increase of the market for innovation has attracted private firms to provide technological services to other firms and even the academia and the government itself.

Table **2.4.3**: **Policy instruments used in the STPI countries**

| **Type of instrument** | **Description** |
|---|---|
| Infrastructure building | ▪ Institution building<br>▪ S&T planning<br>▪ Financing S&T activities<br>▪ Other mechanisms (i.e. import facilities for S&T institutes |
| Regulation of imports | ▪ Import controls<br>▪ Foreign investment controls<br>▪ Registries of licensing agreements<br>▪ Patent system<br>▪ Joint ventures and technology transfer |
| Identification of demand pattern for technology | ▪ Industrial programming<br>▪ Industrial financing mechanisms<br>▪ State purchasing power<br>▪ Fiscal measures<br>▪ Price controls<br>▪ Export promotion measures<br>▪ Other mechanisms |
| Promotion of S&T activities in firms | ▪ Special credit lines<br>▪ Tax incentives<br>▪ Other measures (i.e. administrative facilities for S&T activities in firms |
| Supporting S&T activities | ▪ Technical norms, standards, quality control<br>▪ Technical information systems<br>▪ Manpower training<br>▪ Consulting and engineering activities |

## 2.5. A current agenda formulated with the STPI vision

It is 40 years since the launch of the STPI project. Some of the countries that participated in the project have changed their status from underdeveloped to emerging countries. Despite the labels, the most impressing thing is that countries like Korea and China, though the latter did not participate in the project, have changed completely their productive structure and now they are major producers of high technology goods that are traded all over. As a result, their productivity and income levels have increased dramatically.

Some other countries, like the Latin American ones, have followed a more modest growth path. Most of them are recovering the income levels they had in the 1970s and lost during the 1980s. But, as opposed to their Asian counterparts, Latin American countries' growth was not supported by productivity increases.

Currently almost of countries are conscious that need to incorporate science, technology and innovation in their product mix so as to upgrade and diversify their economies. Many of them have developed plans that guide their actions and are devoting resources to increase their STI efforts. However, most of the time, these plans are not quite connected with the upgrading and diversification of their productive structure. The latter would lead to some kind of industrial or sector oriented policy, which would require two things. On the one hand, it is necessary to devote adequate efforts to build domestic capabilities, both from the government and the corporate side. This means that learning and absorptive capacity need to be enhanced. Although the Asian experience cannot be replicated, different studies provide assessments of what worked and why in these countries. The works of Kim (2000), Lall (2002) and Narula (2002) might be useful in this respect. On the other hand, this connection of the S&T sector with the productive ones requires strengthening governance and coordination mechanisms.

Another consideration is that the efforts to build domestic capabilities must contemplate a global setting. In that respect, foreign direct investment is still one vehicle to absorb technology but efforts should be done to integrate local producers to these firms, as well as participate in global value chains. Little has been done in Latin America to search actively for opportunities of integration in these chains and for a continuous upgrading. Countries need, first, to define strategies to engage in global value chains and, second, to upgrade their position evolving from OEM (original equipment manufacturer) to ODM (original design manufacturer) to finally become (OBM) original brand manufacturer). This transition will obviously require great efforts in building domestic capacities, both in the private and the government sector.

With regards to policy formulation and implementation, it is necessary to fine tune policies to get the private sector involved. In Latin America most of the STI activities are still executed by universities and government institutions. This trend has to be reverted. From improving extension services for small and medium firms to promoting technology transfer and absorptive capacity in medium and large firms will require a large portfolio of policy instruments. In many countries of the region, there is notion of building the innovation ecosystem, that is, a set of policy instruments that contribute from different angles to promote innovation in the private sector.

The innovation system's approach provides a useful framework to define a policy mix that would improve its effectiveness. Table 2.5.1 presents a sample of policy instruments that may be used to enhance each of the functions of the innovation system.

Table 5.1: **Function of innovation systems and selected policy instruments**

| *Function* | *Sample of policy instruments* |
|---|---|
| **Guidance of search** | Plans<br>White papers<br>Priority setting and mission-oriented programs<br>Regulation<br>Taxes<br>Foresight and prospective exercises |
| **Mobilization of resources** | *Human resources*<br>Scholarship programs<br>Strengthening of research capabilities in universities<br>Attraction of talent for research<br>Attraction of talent for firms<br>Fellowship grants<br>Exchange programs<br>*Financial resources*<br>Seed capital<br>Venture capital<br>Credit<br>Guarantees<br>*Complementary assets*<br>Information platforms<br>Promotion of innovation culture<br>Technological infrastructure (laboratories)<br>Adequate business environment<br>Attracting legislation for FDI |
| **Generation of knowledge** | R&D funding<br>Funding for multidisciplinary research<br>Funding for international research projects<br>Research consortia |
| **Diffusion of knowledge** | Access to scientific literature<br>Funding for academic events<br>Technical fairs<br>Demonstration programs<br>Programs to increase absorptive capacity<br>Technology transfer institutions<br>Industrial extension<br>Support for licensing and other technology transfer mechanisms<br>Technology intelligence services<br>Innovation clubs and associations |
| **Entrepreneurial experimentation** | Tax incentives for R&D<br>Subsidies for consulting<br>Subsidies for contract research<br>Technology incubators<br>Technology accelerators<br>Incentives for spin offs<br>Promotion of user-producer interactions<br>Standards setting<br>Quality and metrology infrastructure |
| **Market formation** | Support for market niches<br>Government procurement<br>Value chain support programs<br>Standards setting<br>Regulation |
| **Creation of legitimacy** | Advocacy actions<br>Open government support |

However, defining the policy mix is the first step of implementation. But it requires an adequate definition of the policy problem otherwise it will lead to an inadequate of action. For example, lack of funding for STI activities may be solved by providing funds to universities and firms, but if these actors do not have the capacities to perform them, the availability of resources will not solve the policy problem. This situation can be solved by building information databases of the main actors of the innovation system, and by applying some of the techniques to formulate projects, such as the logic framework.

Second, policy implementation requires a political commitment that is usually translated in adequate funding. For example, plans without funding are just a wishful thinking lists but have no possibility to become a tool to change a situation. A less severe situation is when funding is not provided in adequate amounts, however, it may cause that the impact of such underfunded policy would be negligible.

Third, policy actions are not neutral; they promote change that may be resisted by certain actors. Opposition may take the form of political lobbying against the policy to use administrative red tape to prevent implementation.

Fourth, policy implementation requires focalizing beneficiaries. For example, certain policy instruments meant to benefit smaller or weaker firms or universities but still can be accessed by other kind of actors.

Fifth, policy implementation should include the setting up of a monitoring system. A set of indicators that can control for critical variables in the implementation process, as well as for expected results. Monitoring will allow the early detection of problems and the possibility of make the required changes.

Finally, policy implementation requires impact evaluation. Most of STI policy interventions seek changes in behavior of private actors that lead to the increase of the inputs or outputs in the innovation process (additionality). Impact evaluation methodologies are capable of isolate the effect of the policy with respect to those objectives.

## References

Alkas, H. (2009). "The enabling role of ICT to improve productivity and industrial competitiveness", paper presented at the IIC Telecoms and Media Forum, Brussels, March 25th. Brussels: European Commission. URL: http://es.slideshare.net/stephenmcclelland/the-enabling-role-of-ict-to-improve-productivity-and-industrial-competitiveness

Amsden, A. (1989). Asia's Next Giant: South Korea and Late Industrialization. New York: Oxford University Press.

Arocena, R. and J. Sutz (2002)."Innovation Systems and Developing Countries", DRUID Working Paper No 02-05. Aalborg: Copenhagen Business School, Department of Industrial Economics and Strategy/Aalborg University, Department of Business Studies.

Bell, M. and K. Pavitt (1995). "The development of technological capabilities" in Haque, I. and M. Bell, Trade, Technology, and International Competitiveness, Volume 22. Washington D.C.: The World Bank.

Bergek, A., M. Hekkert, et al. (2006). Functions in innovation systems: a framework for analysing energy systems dynamics and identifying goals for system-building activities by entrepreneurs and policy makers. Workshop on "Innovation on Energy Systems". Oxford.

Clausen, T. (2004). "Technological regimes and Norwegian manufacturing", Paper presented at the DRUID Summer Conference 2004 on Industrial Dynamics, Innovation and Development, Elsinore, Denmark, June 14-16.

De Ferrantis, D.; G. Perry; D. Lederman and W. Maloney (2002). From Natural Resources to the Knowledge Economy. Washington D.C.: The World Bank.

Dunning, C. (2001). "The Eclectic (OLI) Paradigm of International Production: Past, Present and Future", Int. J. of the Economics of Business, Vol. 8, No. 2, 2001, pp. 173-190.

Edquist, C. (2001). The systems of innovation approach and innovation policy: an account of the state of the art. DRUID Conference "National Systems of Innovation, Institutions and Public Policy. Aalborg University.

Finnemore, M. (1993). "International organizations as teaching of norms: the United Nations Educational, Scientific, and Cultural Organization and science policy", International Organization, Vol. 47, No. 4, pp.: 565-587.

Hamilton, A. (1791). "Report on Manufactures" from Annals from Congress. Washington D. C.: House of Representatives. URL: http://www.constitution.org/ah/rpt_manufactures.pdf

Hekkert, M. P., R. A. A. Suurs, et al. (2007). "Functions of Innovation Systems: A new approach for analysing technological change." Technological Forecasting and Social Change 74(4): 413-432.

IADB (2010). The Age of Productivity: Transforming Economies from the Bottom Up. Washington D.C.: Inter American Development Bank.

Katz, J. and G. Stumpo (2001). "Regímenes sectoriales, productividad y competitividad internacional", Revista de la Cepal, No. 75, pp.: 137-159.

Kim, L. (2000). "The dynamics of technological learning in industrialization", Discussion Paper Series No. 2007. Maastricht: Institute for New Technologies – INTECH.

Lall, S. (2002). "Issues and Evidence" in Lall and Urata (eds.) Foreign Direct Investment, Technology Development & Competitiveness: issues and evidence. Cheltenham and Northampton: Edward Elgar.

List, F. (1909). The National System of Political Economy. London: Longmans, Green, and Co. URL: http://www.econlib.org/library/YPDBooks/List/lstNPE26.html#firstpage-bar

Mullin Consulting (2002). Un análisis del sistema peruano de innovación. Lima, Mullin Consulting.

Narula, R. (2002). "Switching from import substitution to the 'New Economic Model' in Latin America: a case of not learning from Asia", MERIT – Infonomics Research Memorandum Series, No. 32. Maastricht: MERIT.

Perez, C. (2005). "Re-specialisation and the Deployment if the ICT Paradigm: an essay on the present challenges of globalization". Cambridge and Sussex Universities. URL: http://www.carlotaperez.org/papers/PEREZ_Respecialisation_and_ICTparadigm.pdf

Reinhardt N. and W. Peres (2000). "Latin America's New economic Model: micro responses and economic restructuring", World Development, Vol. 28, No. 9, pp.: 1543-1566.

Rozenwurcel, G. (2006). "Why Have All Development Strategies Failed in Latin America?", Research Paper No. 2006/12. Helsinki: UNU-WIDER.

Versluysen, E. (1988). "Financial deregulation and the globalization of capital markets, Volume 1", Policy, Planning and Research Department Working Papers No. 40. Washington D.C.: The World Bank.

Zahra and George (2002). "Absorptive capacity: a review, reconceptualization and extension", Academy of Management Review, Vol. 27, No. 2, pp.: 185-203.

## PART III: AFTER STPI AND LOOKING FORWARD

Part III of this report focuses on the post STPI period. The first chapter complements statements on the dissemination of STPI in the late 1970 and the second provides some basic data on how science and technology capabilities evolved in STPI countries during the last four decades, and contains a box contributed by Carlos Contreras. The third chapter is a contribution by Tran Ngoc Ca, who refers to the STPI project as a background to the IDRC-supported review of science and technology policy in Vietnam.

Chapter 4 describes the STPI+40 meetings in Paracas and Lima, and summarizes their main outcomes. Chapter 5 contains contributions by Francisco Sercovich, Alberto Araoz, Monica Salazar and Susan Cozzens with proposals on how to approach science, technology and innovation policy research for development in the future, suggesting topics for research and ways of organizing comparative studies on the subject.

The last chapter contains some brief personal reflections by the former field coordinator of the STPI project and editor of this volume.

## 1. THE DISSEMINATION OF STPI RESULTS (by Francisco Sagasti)

After the main research activities were concluded and the field coordinator's office in Lima was closed at the end of 1976, IDRC decided that dissemination activities should be handled from the Latin American Regional Office, located in Bogotá, Colombia. The dissemination exercise had three components: publication of STPI results, seminars in various developing regions of the world, and support to international institutions involved in science and technology for development. A small dissemination team was assembled in Bogotá to make STPI results available to a wide audience. Two research assistants, one translator and several consultants were engaged to write books, articles and working papers, some of which were translated into Spanish and French. Annex D contains the list of publications that emerged out of this effort.

A second component was the organization of STPI dissemination seminars, aimed at bringing together researchers and policy makers from countries that did not participate in the project. An exploratory meeting was held in Kericho, Kenya, where the format and content of the seminars was tested with participants from Eastern and Southern Africa. The other meetings took place in Khartoum, Sudan, with participants from the Middle East; in Baguio, Philippines, for participants from South and Southeast Asia; and in Fondiugne, Senegal, for participants from West Africa. All seminars were conducted in English, with the exception of that in West Africa, which took place in French. In addition, the Technology Development Unit of the Organization of American States took advantage of several meetings in Latin America to present the results of the STPI project during the late 1970s.

The third component of the dissemination efforts involved feeding in the results of STPI to several international meetings, and particularly to the United Nations Conference on Science and Technology for Development (UNCSTD) that took place in Vienna in August of 1979. The UN General Assembly convened this conference in 1976, and the preparatory process began in earnest in New York just as the dissemination phase of STPI was getting under way. In the general context of negotiations towards a New International Economic Order, the Vienna Conference was seen as a major milestone to reorganize international economic relations on a more equitable basis.

The Vienna Programme of Action, agreed at UNCSTD and endorsed by the United Nations General Assembly in December 1979,[23] aimed at major improvements in the support of developing country initiatives to build science and technology capabilities, and achieved a modest and temporary upgrading in the structure of UN organizations for this purpose. However, the creation of a UN fund for science and technology for development, which was the centerpiece of the Vienna agreement, never took off the ground. The changed political climate of the 1980s, which saw the ascent of economic liberalization policies spearheaded by the United States and United Kingdom

[23] United Nations Yearbook-1979, part one, section 2, chapter X, pp. 633-651, available in http://unyearbook.un.org/unyearbook.html?name=1979index.html; and UN General Assembly resolution /34/218, 19 December 1979, available in http://www.un-documents.net/a34r218.htm

governments, thwarted any effort to expand and enhance international science and technology cooperation initiatives.[24]

As mentioned in the chapter prepared by Geoffrey Oldham in part II of this report, the results of the STPI project continued to exert influence in the participating countries for quite some time. In addition, there were other cases in which the methodology and results of the STPI project influenced policy research activities in various fields and places. For example, several articles and books written by STPI network members made reference to the results of the project,[25] and research on environment and development interventions used the conceptual framework of STPI to examine the relation between explicit and implicit environmental policies.[26] In addition, as reported in the contribution by Tran Ngoc Ca in a following chapter, a science and technology policy review conducted in Vietnam with support from IDRC used concepts derived from STPI. Finally, a recent study sponsored by UNESCO on science, technology and innovation policies in Botswana made use of the conceptual framework developed in STPI for the analysis of policy instruments and policy implementation.[27]

[24] For assessments of the results of the UNCSTD process see: Francisco Sagasti, Reflections on the United Nations Conference on Science and Technology for Development", in Ward Moorehouse (editor), *Third World Panacea or Global Boondoggle?: The UN Conference on Science and Technology for Development Revisited*, Lund, Research Policy Institute, University of Lund, June 1984, available in franciscosagasti.com

[25] See for example: Carlos Contreras, *Transferencia de tecnología a países en desarrollo*, Caracas, Instituto Latinoamericano de Investigaciones Sociales (ILDIS), 1979;Carlos Contreras, "Una ciencia y tecnología para el tercer mundo" *Nueva Sociedad*, 1979, pp. 5–14; Isaías Flit, "Struggling for self-reliance in Science and Technology: the Peruvian case – ITINTEC" *Development Dialogue*, 1979, no. 1. pp. 39–45; Francisco Sagasti, *Financing the development of science and technology in the third world*. New York: UNITAR, 1979; Francisco Sagasti, "National science and technology policies for development: a comparative analysis", in J. Ramesh (Ed.), *Mobilizing technology for world development*, New York: Pergamon Press, 1979, pp. 162–173; Francisco Sagasti, *Technology, planning, and self-reliant development, A Latin American view*. New York: Praeger, 1979; Francisco Sagasti, *Ciencia, tecnología y desarrollo latinoamericano*. México DF: Fondo de Cultura Económica, 1981; and Francisco Sagasti, "Science and Technology Policy Research Some Lessons of Experience," presentation made at the *25th Anniversary Conference of the Science Policy Research Unit (SPRU) of the University of Sussex*, Falmer, Brighton, Sussex, 1991, available in franciscosagasti.com

[26] Silvia Charpentier and Jessica Hidalgo, *Políticas Ambientales en el Perú*, Lima, FORO Nacional Internacional-Agenda: PERÚ, 1999.

[27] UNESCO, *Mapping Research and Innovation in the Republic of Botswana*, GO-SPIN Country Profiles in Science, Technology and Innovation Policy, Paris, 2013.

## 2. A RETROSPECTIVE LOOK AT THE STPI COUNTRIES (By Francisco Sagasti and Carlos Contreras)

### 2.1. The growth of scientific and technological capacity in STPI countries

To appreciate what happened to the science and technology capabilities of STPI countries in the four decades after the research was conducted, it is useful to examine some indicators. Table 1 shows data from the World Bank for research and development expenditures as a percentage of Gross Domestic Product, researcher per million inhabitants, scientific and technical publications, high technology exports and patent applications by residents. The values of these indicators are quite suggestive, and allow an appreciation of the differential performance of the STPI countries in science and technology over time.

With few exceptions in some indicators, all STPI countries show improvement. With the exception of Colombia and Macedonia, all countries show increases in research and development expenditures, most at a steady or slow pace, with the exception of the Republic of Korea whose research and development expenditures were rather high even in 1980 and soared to 3.74 percent of GDP in 2010, more than tripling that of Brazil, the country with the second highest value for this indicator in the later year. The number of researchers per million inhabitants also grew at a steady pace in most STPI countries, but between 1990 and 2010 it more than doubled in the Republic of Korea, to reach nearly 5,500 researchers per million inhabitants, five times as large as that of Argentina.

All STPI countries increased their scientific and technological publications, most at a modest rate, but between 1980 and 2010 Brazil's scientific articles increased eightfold, those of Mexico six times, those of Argentina quadrupled, and those of India nearly doubled. Yet, South Korean science and technology publications increased 130 times in the three decades from 1980 to 2010, to reach more than 22,200 scientific papers. A similar pattern can be appreciated with regards to high technology exports and patent applications by resident, for which the South Korean figures (131,805) vastly exceed those of India (8,853) and Brazil (2,705), the second and third countries for the value of this indicator.

These significant differences in the performance of science and technology activities are the result of complex factors at work, but the case of the Republic of Korea stands out as an exception. During the coordinating committee meeting in Seoul, and during the visits of the field coordinator in the 1970s, it was possible to appreciate the single-mindedness and determination of country authorities to make science and technology capabilities a cornerstone of their development efforts.

It was not possible to conduct field research in China, but a study done by Genevieve Dean on the basis of her doctoral dissertation (supervised by Geoffrey Oldham), together with subsequent visits to Beijing by Geoffrey Oldham and myself, allowed appreciating a similar degree of commitment to scientific and technological development in this country. The continental size of China and the huge amount of resources at the disposal of the state allowed it to make a swift dash and increase its capabilities to become one of the world's scientific leaders in the first decades of the 21st century.

TABLE 1: **Evolution of science and technology capacity in STPI countries**

| | Indicators | 1980 | 1990 | 2000 | 2010 |
|---|---|---|---|---|---|
| **Argentina** | *R&D expenditure (% of GDP)* | - | 0.42(f) | 0.44 | 0.62 |
| | *Researchers in R&D (per million people)* | - | 694.50 (g) | 715.39 | 1,091.22 (n) |
| | *Scientific and technical journal articles* | 892(a) | 1,627 | 2,846 | 3,655(n) |
| | *High-technology exports (million current US$)* | - | 255.89(c) | 797.07 | 1,648.29 |
| | *Patent applications, residents* | 1,269 | 955 | 1,062 | 801(k) |
| **Brazil** | *R&D expenditure (% of GDP)* | - | - | 1.02 | 1.16 |
| | *Researchers in R&D (per million people)* | - | - | 423.53 | 703.72 |
| | *Scientific and technical journal articles* | 1,438(a) | 2,374 | 6,407 | 12,306(n) |
| | *High-technology exports (million current US$)* | - | 1,053.13 | 5,990.41 | 8,121.87 |
| | *Patent applications, residents* | 2,149 | 2,389 | 3,080 | 2,705 |
| **Colombia** | *R&D expenditure (% of GDP)* | - | 0.30(f) | 0.11 | 0.19 |
| | *Researchers in R&D (per million people)* | - | 71.89(f) | 100.87 | 160.87 (n) |
| | *Scientific and technical journal articles* | - | 122 | 332 | 608(n) |
| | *High-technology exports (million current US$)* | - | 126.54 (b) | 330.56 | 425.24 |
| | *Patent applications, residents* | 43 | 85(b) | 75 | 133 |
| **Egypt** | *R&D expenditure (% of GDP)* | - | 0.21(f) | 0.19 | 0.40 |
| | *Researchers in R&D (per million people)* | - | - | - | 420.44(n) |
| | *Scientific and technical journal articles* | 1,060(a) | 1,254 | 1,433 | 2,247(n) |
| | *High-technology exports (million current US$)* | - | 5.58(e) | 5.59 | 96.23 |
| | *Patent applications, residents* | 76 | 278 | 534 | 605 |
| **India** | *R&D expenditure (% of GDP)* | - | 0.63(f) | 0.75 | 0.76(j) |
| | *Researchers in R&D (per million people)* | - | 151.98(f) | 110.01 | 135.81(i) |
| | *Scientific and technical journal articles* | 11,725(a) | 9,200 | 10,276 | 19,917(n) |
| | *High-technology exports (million current US$)* | - | 497.83 | 2,062.49 | 10,086.63 |
| | *Patent applications, residents* | 1,207 | 1,147 | 2,206 | 8,853 |

*Notes:* (a) 1981; (b) 1991; (c) 1992; (d) 1993; (e) 1994; (f) 1996; (g) 1997; (h) 2004; (i) 2005; (j) 2007; (k) 2008; (n) 2009; (m) 2011.
Source: World Bank

TABLE 1: **Evolution of science and technology capacity in STPI countries**
(continued)

| | Indicators | 1980 | 1990 | 2000 | 2010 |
|---|---|---|---|---|---|
| **Korea, Rep.** | *R&D expenditure (% of GDP)* | - | 2.42(f) | 2.30 | 3.74 |
| | *Researchers in R&D (per million people)* | - | 2,212.10(f) | 2,356.50 | 5,481.49 |
| | *Scientific and technical journal articles* | 168(a) | 1,170 | 9,572 | 22,271(n) |
| | *High-technology exports (million current US$)* | - | 10,936.00 | 54,332.60 | 121,478.14 |
| | *Patent applications, residents* | 1,241 | 9,082 | 72,831 | 131,805 |
| **Macedonia** | *R&D expenditure (% of GDP)* | - | - | 0.44 | 0.23(k) |
| | *Researchers in R&D (per million people)* | - | 617.25(g) | 659.50 | 471.61 (k) |
| | *Scientific and technical journal articles* | - | 0 | 56 | 57(n) |
| | *High-technology exports (million current US$)* | - | 14.04(e) | 11.41 | 123.41(m) |
| | *Patent applications, residents* | - | 78(d) | 71 | 27 |
| **Mexico** | *R&D expenditure (% of GDP)* | - | 0.31(f) | 0.37 | 0.48 |
| | *Researchers in R&D (per million people)* | - | 211.96(f) | 222.37 | 383.57 (n) |
| | *Scientific and technical journal articles* | 648(a) | 1,038 | 2,971 | 4,128(n) |
| | *High-technology exports (million current US$)* | - | 962.21 | 31,174.47 | 37,657.29 |
| | *Patent applications, residents* | 704 | 661 | 431 | 951 |
| **Peru** | *R&D expenditure (% of GDP)* | - | - | 0.11 | 0.15(h) |
| | *Researchers in R&D (per million people)* | - | - | - | - |
| | *Scientific and technical journal articles* | - | 77 | 79 | 159(n) |
| | *High-technology exports (million current US$)* | - | 7.27(c) | 50.83 | 252.42 |
| | *Patent applications, residents* | 82 | 49 | 40 | 39 |
| **Venezuela** | *R&D expenditure (% of GDP)* | - | - | - | - |
| | *Researchers in R&D (per million people)* | - | - | 61.40 | 182.64(n) |
| | *Scientific and technical journal articles* | - | 314 | 516 | 354(n) |
| | *High-technology exports (million current US$)* | - | 73.69 | 81.59 | 145.23 |
| | *Patent applications, residents* | 236 | 262 | 56 | 33(m) |

*Notes*: (a) 1981; (b) 1991; (c) 1992; (d) 1993; (e) 1994; (f) 1996; (g) 1997; (h) 2004; (i) 2005; (j) 2007; (k) 2008; (n) 2009; (m) 2011
Source: World Bank

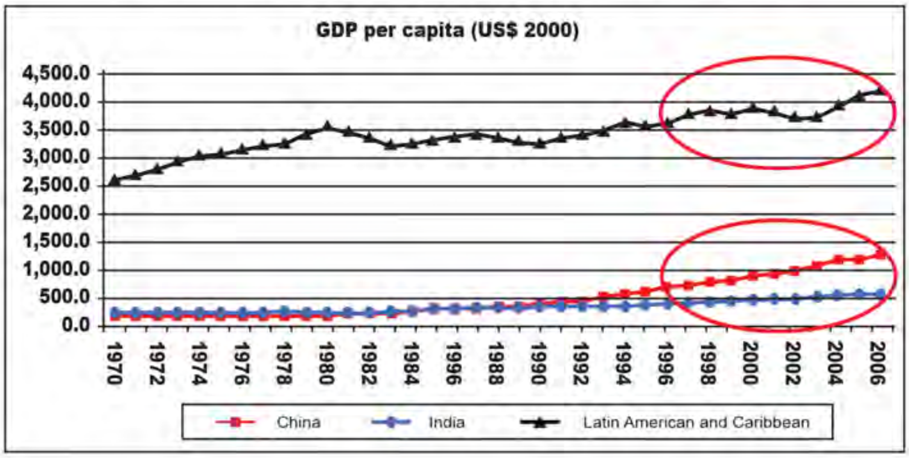
## 2.2. The differential growth and research and development performance of Latin American and Asian countries

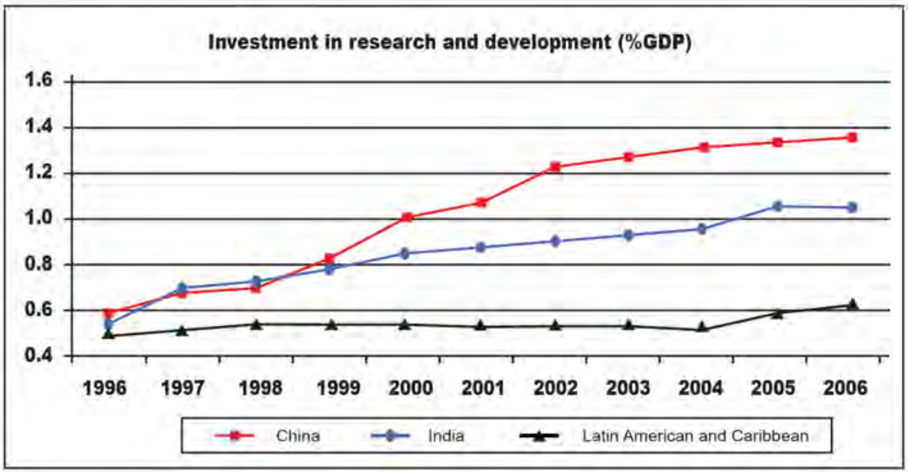
It is worth examining the striking differences in economic performance of three Asian countries and the Latin American region in the light of resource allocations to research and development over time. The Indian and South Korean teams, and the China STPI, report made it clear governments in these countries gave top priority to scientific and technological development starting in the mid-1970s. While aggregate data for Latin America masks significant differences between countries, they nevertheless allow drawing some general conclusions.

Comparing the levels of income per capita with the investments in science and technology as a percentage of GDP during the last four decades, it is possible to appreciate a stark contrast regarding the situations of India and China on one side, and that of Latin America on the other. Latin America had a much higher GDP per capita than China and India during the last few decades, particularly between 1996 and 2006. However, during this period India and China invested, on average, more than double in research and development as a percentage of their GDP (Figure 4), and the average economic rates of growth during this period were 9.74 percent for China and 5.65 percent for India, in comparison to the 2.85 percent for Latin America as a whole.

Between 1977 and 1986, the Republic of Korea had a GDP per capita similar to that of Latin America between 1998 and 2006; yet it invested a larger and growing percentage of its GDP in research, which in 1985 was more than double that of Latin America in 2006 (Figure 5). The average annual rate of economic growth for the Republic of Korea has been consistently greater than those of Latin America during the last several decades: between 1977 and 2008, these rates were 6.53 percent for the former and 2.99 percent for the latter. Even though it is not possible to establish a simple causal relation between investments in science, technology, and innovation on the one hand, and economic growth on the other, since the 1960s political leaders in Korea have been keenly aware that science and technology capabilities were essential for accelerating and sustaining development.

FIGURE 4: **Gap between the GDP *per capita and investments in research and development*: China, India and Latin America**
(In constant 2000 US dollars and percentage of GDP)

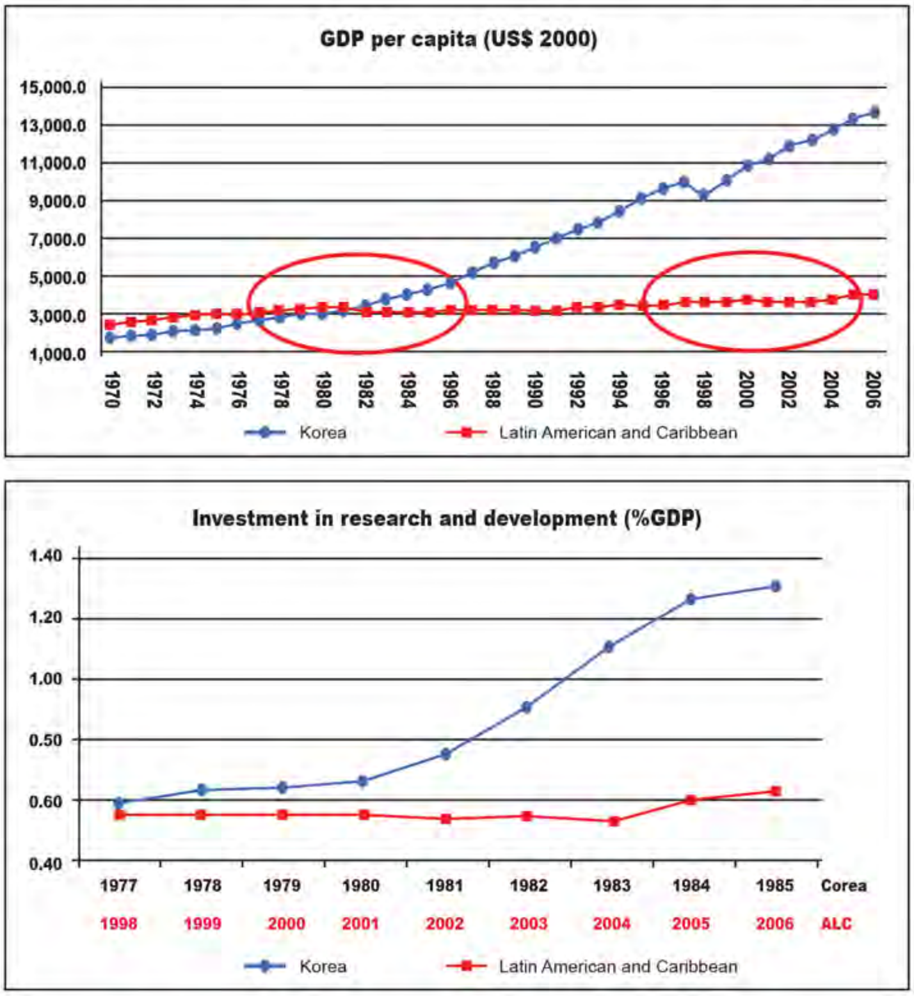



Source: World Bank, *World Development Indicators*, various years. Taken from F. Sagasti, *Ciencia, Tecnología, Innovación. Políticas para América Latina* (second edition), Lima/México, Fondo de Cultura Económica, 2013.

There is no common reason for the divergence between ideas and practice in science, technology, and innovation policies in a region as diverse as Latin America. Some explanations point to a cultural heritage that did not value the practical use of scientific and technological knowledge; an excessive dependence on foreign investment for capital and technology; variations of the "natural resources curse" that kept the region as an exporter of easy-to-extract raw materials with low knowledge content; and political upheavals that set back efforts to create and consolidate science, technology and innovation capacities.

FIGURE 5: **Gap between GDP *per capita* and investments in research and development: The Republic of Korea and Latin America**
(In 2000 constant US$ dollars and percentage of GDP)




Source: World Bank, *World Development Indicators*, various years. Taken from F. Sagasti, *Ciencia, Tecnología, Innovación. Políticas para América Latina* (second edition), Lima/México, Fondo de Cultura Económica, 2013.

The indifference of political leaders and the ineffectiveness of public policies also loom as likely explanations. It is sobering to realize that countries like South Korea and India, which had the same access to the results of STPI research as Latin American countries, apparently made much better use of the lessons learned on science and technology policy design and implementation. In the following box, Carlos Contreras points out some additional factors that may have contributed to the differential development paths of STPI countries.

## BOX: Forty years of contextual factors in science and technology development: A Latin American Perspective (by Carlos Contreras)

When the STPI project began in 1973, several Latin American countries were committed to promote scientific and technological development, which was considered as a foundation for self-sustained, stable, diversified and autonomous economic and social development. Their efforts were supported by international institutions, such as the Andean Pact and the Latin American Free Trade Association, both of them associated with economic integration, and also by the United Nations Conference on Trade and Development (UNCTAD), which championed the cause of free but regulated international trade. The Latin American Economic System (SELA) joined later this group of institutions.

Several intergovernmental conferences —the Group of 77 meeting in Lima in 1971, which grouped all developing countries, and UNCTAD III in Santiago de Chile in 1972, gave strong support to policies for the development of national science and technology capabilities. In addition, the Group of 77 and the group of Non-Aligned Countries proposed to the United Nations General Assembly a charter for a New International Economic Order, which was adopted in 1974.

However, this favorable context for developing country efforts to build up their science and technology capabilities was radically altered in the 1980s. The advent of militantly conservative governments in the United States and the United Kingdom led to the imposition of neoliberal economic policies, and a withdrawal of support for international cooperation initiatives to strengthen science and technology capabilities in developing countries. An example of this new adverse mood were the Uruguay Round of negotiations of the General Agreement on Trade and Tariffs, which ended in 1996 with poor results for achieving fair treatment of developing countries. The GATT was replaced by the World Trade Organization (WTO) and, twenty-seven years after the Uruguay Round began, the failed Doha Round has not achieved a full liberalization of trade in agricultural products, which are still subsidized by developed countries and provide unfair advantages to them in detriment of developing countries.

In addition, the Agreement on Trade–Related Intellectual Property Rights (TRIPS) established when the WTO was founded, introduced a series of restrictions which limit the scope for science and technology policy initiatives in developing countries. Moreover, there are the problems generated by financial liberalization, which led to financial speculation and crisis in developed countries, whose effects are most difficult to control in developing regions.

Facing an adverse international context in the 1980s, some of the STPI countries, in particular Brazil, Korea and India, avoided liberalization excesses and managed to keep a regulated market system, while at the same time persevering in the efforts to develop their science and technology capabilities. This allowed them to perform better than the other STPI countries that were not able to do so, particularly in Latin America. In this region, the full impact of the Washington Consensus led to economic stabilization and growth following the “lost decade”, but with high levels of income concentration, inequality of opportunities, poverty and social exclusion, and also with increasing reliance on commodity exports that make Latin American countries vulnerable to international market shocks. This situation did not favor efforts to build up science and technology capabilities in most Latin American countries.

The experience of the last four decades since the STPI project began suggests Latin American countries need to diversify their economy, and to move into more complex and technology intensive sectors. Latin America should explore new areas of economic activity that involve the region as a whole; international cooperation will be necessary to achieve the critical mass required for success in science and technology capacity building, and in creating engineering design capabilities. New bi- or multi-national infrastructure projects, joint initiatives in advanced technology fields, and collaboration in the sustainable use of natural resources are some of the areas in which it would be possible to work together, and which could drive efforts leading to scientific and technological development.

## 3. STPI: FROM A PROJECT TO THE IMPACT AND SOME THOUGHTS FOR THE FUTURE IN VIETNAM (by Tran Ngoc Ca) [28]

### 3.1. The IDRC Review of Science and Technology Policy in Vietnam

The STPI project that the workshop commemorates today is a starting point (as the IDRC history itself) for helping developing countries in upgrading their knowledge, experience and capabilities in science, technology and innovation policy. Its impact and influences go beyond the countries where the project started. This note tries to provide an example how the first idea of STPI project was spearheaded into other countries and studies by IDRC efforts.

In 1996, Vietnam is in the middle of the exercise to draft a science and technology strategy for the country until 2010. In January 1997, Dr. Pham Gia Khiem, then Minister for Science, Technology and Environment (later became Deputy Prime Minister) has met Dr. Keith Bezanson, then President of the IDRC and on behalf of the Vietnamese government, asked IDRC and the Canadian International Development Agency (CIDA) to conduct an S&T policy review, along the broad lines of an approach pioneered by the Organization for Economic Co-operation and Development, as adapted by IDRC.

The central feature of an S&T policy review is that it attempts to capture and distil the experiences, assessments, and views held of national policy and to engage in dialogue (to provide a mirror) about those experiences and experiences from other parts of the world. Certainly, STPI and previously done China study by IDRC have strong imprint on the design of Vietnamese study. In September 1997 the international review team spent 3 weeks in Viet Nam, conducting the review. The international review consisted of 6 members: Keith Bezanson, Geoff Oldham, Jan Annerstedt, Francisco Sagasti, Dennis Hopper, and Kun Mo Chung. In addition, other two experts have been invited to provide additional support. Jack Smith from National Research Council of Canada provided a training course on methodology for strategy making, and Martin Fransman from Edinburgh University gave experiences of some East and Southeast Asian economies in science, technology and innovation policy.

During the visit, the review team met with some 70 organizations, institutions, departments, firms, and associations and some 320 Vietnamese S&T policymakers, policy implementers, and people affected by the policies. The government appointed the National Institute for Science and Technology Policy and Strategy Studies (NISTPASS) under the then Ministry of Science, Technology and Environment (now Ministry of Science and Technology) to be the Vietnamese counterpart in the review.

### 3.2. Recommendations of the review

In addition to the general report and its unquestionable impact on the knowledge and information input for Vietnamese policy making process, the Review report

[28] NISTPASS and National Council for Science and Technology Policy, 39 Tran Hung Dao, Hanoi, Vietnam; email: tnca@most.gov.vn; tranngocca@gmail.com

specifically put out 16 specific recommendations on various aspects of the Vietnamese science, technology and innovation system. Despite some minor difficulties with dissemination of the report, overall, all recommendations have been turned into implemented actions and had great impact on changing STI policy landscape in Vietnam, as we can see in attached Appendix.

As we can see, most recommendations of the IDRC Review report have got into practice. It would be unfair to conclude that all changes and actions in STI policy in Vietnam have stemmed from the recommendations of the IDRC Review. But it would be safe to say that most of the recommendations have contributed positively into the process of designing new policy measures for promoting science; technology and innovation in the country. These recommendations have found a strong resonance from the community of Vietnamese policy makers. The practice of policy making for science and technology in Vietnam just evolved along the direction pinpointed in the Review. Most importantly, there is seen a strong shift from science and technology policy to innovation policy with emphasis placed on the enterprises, especially SME which are the central to any productive sectors in Vietnam.

Following this, IDRC supported another review on international cooperation in science and technology (ICST). In 2002-2004, the Department for International Relations of the Ministry of S&T has asked IDRC to support with their attempt to design strategy for developing international cooperation and integration in science and technology (ICST). This is to serve other important policies to be adopted by the government. To deal with this task, a task force has been set up and drafted the structure of the report, which in fact looks at the issue from different aspects. These aspects indeed are important components of the innovation policy itself, such as human resources, financing, linkage with and support to enterprises, change of S&T management mechanism, link with FDI and ODA activities, etc. Once again, IDRC experiences have been studied, with support of some IDRC invited experts like Stephen McGurk, Lan Xue and Caroline Wagner and as such, they served as both the catalyst and input in terms of content for ICST study.

In the same vein, during 2000-2001, under UNIDO/UNDP project, Geoffrey Oldham and Keith Bezanson together with author of this note have prepared together another study for science, technology and industry strategy for Vietnam, as one component of overall development strategy until 2010-2015. This continued process of working together created an unique opportunity for capacity building in Vietnam on STI policy making.

### 3.3. Conclusion and some thoughts for the future

Experiences of Vietnam in creating and relying on various internationally backed reviews teams for science, technology and innovation policy show that these activities are very useful for the country in the policy making process. It provided background information, new knowledge on basic concepts, updating on latest trends, and most importantly, provided the analytical tool and framework.

However, the way these review have been responded to, studied, accepted, and diffused may not be the same in every societies and countries. Depending on the policy window, on the specific context and on the cultural circumstances of each country, the recommendations of the reviews may have been adopted, appreciated to different extent and in various forms. Experiences show that it takes time for the society like Vietnam to absorb the new vision suggested by external experts (National System of Innovation is one of such examples) and turned them into own action by the local efforts. Without this slow, but firm, "policy assimilation" attempt to make changes could be short lived. International partner organizations should take this into account and ready to accept some kind of policy time lag.

In addition, having macro review probably is not enough for having a profound impact and lasting change. To turn the recommendations aimed at the macro level into something more substantial and concrete at the micro level, more specific experiments and studies could be useful. This is an area where organizations like IDRC could pay more attention. There could be two layers of the assistance: the macro review and the action programs/projects aiming at more specific targets as components of the review.

It is no doubt that IDRC activities and STPI project, as its first attempt of review type, are very useful and influential for a country like Vietnam. STPI, in that case went beyond Latin America, and beyond countries involved in the beginning of this project. It became an endless process that students of STI policy studies should carry on forward.

ANNEX: **IDRC Review for Vietnam: recommendations and implementation**

**Suggestion 1**. A possible fast track for improving coherence in S&T policy. The dialogue of the government and private sector, representatives of international organizations, such as the World Bank and the Asian Development Bank, UNDP, other donors and MNC have been held from time to time (in a format of Private Sector Forum) to discuss mainly economic issues, including sometime issue like knowledge based economy.

**Suggestion 2.** To conduct an independent and brief review of Vietnam's four high-tech research programs. Ministry of Science and Technology oversees about 8 state research programs and four techno-economic programs on high tech areas such as information technology, biotechnology, new material and automation. These programs have been reviewed from time to time, including that by some outside MOST reviewers.

**Suggestion 3.** Revision of S&T Law. The Law has been promulgated in 2000 with some changes adopted in the last minutes. As any legal document, the Law still caused some debates and arguments. But the core essence of the Law is indeed the liberation of the creativity of the science and technology community. Many other Laws have been in place since then, such as Technology Transfer Law, IP Law and High Law.

**Suggestion 4.** Accelerating S&T reform to build Center of Excellence. The new policy is adopted as exact as recommended by the Review, although with a different name. The government decided to set up 16 state key laboratories with concentrated investment and call for submission from all over the country.

**Suggestion 5.** Possible measures to address the problem of an aging scientific community. A scholarship program funded by the state budget to send a large number of young student to study in top universities overseas has been implemented.

**Suggestion 6.** A Vietnam Science and Engineering Foundation. The National Foundation for Science and Technology Development (NAFOSTED) has been proposed and come into the operation by the end of 2003, with initial endowment fund is 14 million USD, with annual review. Another National Technology Innovation Foundation (NATIF) just has been set up with endowment of US$50 million.

**Suggestion 7**. Measures to facilitate acquisition and assimilation of technologies. Many measures have been revised regularly to attract more technologies via foreign investment. Training component and management skills have been paid more and more attention. These measures generally were taken care of by MPI and other production ministries, under the recommendations of MOST.

**Suggestion 8.** Constructing S&T policy innovation policy. The concept of NSI was first officially introduced into Vietnam in the Review report. Many team and other task forces drafting S&T strategy, vision have been familiarized with the concept and tried to find ways to adapt this to Vietnamese situation. Firms increasingly became a central factor in all policy measures for S&T.

**Suggestion 9.** Including issue of international collaboration in a long-term S&T strategy. The whole new set of various policies and agencies were created to promote international cooperation and integration in S&T.

**Suggestion 10**. Paying more attention to the issue of women's participation rate in S&T. In every government agencies, science and technology organizations were set up a committee for the progress of women, with the top managers (Directors) usually to be the chair.

**Suggestion 11.** To set up a Vietnamese techno-management program. Some universities have set up their own programs on technology management, or close to MBA style with some components of technology management. Still, no university or training organization is specifically designing the program with structure and content similar to that recommended by IDRC Review. More recently, the Ministry of S&T begins techno-management activities under the new national program of technology innovation.

**Suggestion 12**. Some instruments to consider in economic transformation. Agricultural sector became one of the top priorities in the S&T activity. A special state research program on S&T supporting models for agriculture, rural and mountainous areas has been implemented for several years now.

**Suggestion 13**. Removal of impediments to widespread use of the Internet. A lot of new policies and ICT laws/regulations have been introduced to speed up the process of using ICT as both economic sector and enabler of the socio-economic development of the country. The establishment of the new Ministry for Information and Communication (MIC), regular reduction of connection fees for telephone and Internet services are among these measures and much better infrastructure.

**Suggestion 14**. A pilot program to bring IT to communities in the Mekong Delta has been implemented via many concrete efforts.

**Suggestion 15.** Streamlining criteria for decisions on high-tech parks. Together with S&T based agriculture, the government put high-tech development in general and high-tech park in particular as one of the top priorities. New measures to promote high-tech park practice in Vietnam, and learning experiences of other countries are in place with two high tech parks (Hanoi and HoChiMinh City) in operation and the third one being created in Danang.

**Suggestion 16**. Creating an observatory for S&T and innovation. Although there is no such a S&T observatory, the idea of detecting trends of S&T development and implication for Vietnam are getting more and more attention from the stakeholders. Foresight is recommended by NISTPASS (with creation of a new department in the institute) to MOST as one of the most effective toll to shape the future and priority setting for all S1T, innovation activity. This concept got positive responses from relevant partners and with support of UNIDO, in 2011-2012 NISTPASS has conducted Foresight for new Vietnam STI Strategy until 2020.

## References


Bezanson, K. Oldham, G. and Tran Ngoc Ca. (2001). Science, technology and industry strategy for Vietnam. Hanoi: UNDP/MPI.

Bezanzon et al (1998). Vietnam at the Crossroad. Review of science and technology policy. IDRC.

Lan Xue (2004, April). Report to IDRC on Vietnam Roundtable Conferences on ICST.

Law of Science and Technology. (2003). Hanoi: National Political Publisher.

McGurk, S. (2004) Vietnam: International Cooperation in Biosciences.

MOST (2004). Report on state research programs 1996-2000. Hanoi.

Wagner, C. & Acharya, T. (2006). Biotechnology and International Collaboration. A Strategy for Viet Nam.

Wagner, C. (2004) Vietnam in the network of global science.

## 4. THE STPI+40 EVENTS

After some extensive planning and a postponement due to unforeseen circumstances, the events to mark the fortieth anniversary of the STPI project took place in Paracas and Lima, Peru during August 2-7, 2013. The first meeting gathered the original members of the STPI network, although two of them, Anil Malhotra and José Tavares, could not attend in person. The second meeting involved the participation of active STI policy researchers and policy makers and IDRC representatives. (See Annex D for a list of participants and biographical notes on the members of the STPI network).

### 4.1. The Paracas meeting of STPI network members

The Paracas meeting was the first reunion of STPI country coordinators, members of the field coordinator's office and consultants in more than three decades. Even though some network members had remained in contact intermittently, there had not been an opportunity to meet in person, exchange views and compare notes on the way science, technology and innovation had evolved in their countries and the world after the STPI project. This meeting provided an opportunity to renew friendships, discuss substantive science and technology policy issues, and reflect on what to transmit to the new generations of researchers and policy makers in this field.

Several plenary and working group sessions were held in Paracas, and all participants gave video interviews on their experience with STPI and their subsequent professional careers.[29] While it is not possible to summarize the richness and depth of the conversations and debates that took place, it was decided to prepare a statement directed to the new generation of science, technology and innovation policy researchers and decision makers. This statement consists of a preamble based on contributions by Francisco Sercovich, and a summary of the main issues identified during the conversations prepared by Francisco Sagasti.

[29] These video interviews are available in http://kind-cind.org/blogstpi/?lang=en

## BOX 2: Science and Technology Policy Research and Implementation: A Statement by the Members of the STPI Network (1973-1976)

*This statement is addressed to the national and international science, technology and innovation (STI) policy and development community at large. We have met in Paracas, Peru, to assess what we have learned since we carried out the original STPI project forty years ago.*

*Our deliberations led us to conclude that focused efforts at capitalizing on experience in the design and implementation of science, technology and innovation policy instruments across countries can show clear benefits and be most useful. The extent to which this learning actually translates into social gains strongly depends on leadership as well as on political, institutional and context-specific factors.*

*Looking back, the context and the challenges we currently face in this domain, as compared to those we addressed originally, differ quite sharply.*

*First, we currently perceive a heightened sense of urgency in the social and environmental domains, which often imposes agonizing trade-offs to STI-related policy decisions. Implicit in this, there is an acute sense of the ethical dilemmas involved.*

*Second, we live in a much more turbulent and unpredictable global economy, which poses a premium on policy adaptation and learning attributes. In turn, these depend on the quality of the capabilities and institutions involved in the STI policy cycle, including their ability to generate consensus and motivate public/private/academic cooperation.*

*Third, issues such as human wellbeing, community development, democratic choices, environmental impact and world poverty now figure prominently among the criteria for designing and implementing science, technology and innovation policies. This is not just an ethical imperative, but increasingly a matter of survival.*

*Finally, we now know, even more than forty years ago, that science, technology and innovation policies, appropriately placed in the context of broader development policies and strategies, have the potential to substantially enhance the welfare of developing societies. However, this requires a deep understanding of the conditions that affect the design and implementation of science, technology and innovation policies.*

*With this idea in mind, we identified five general themes that, in our collective view, should be considered by STI policy researchers and policy makers in the first decades of the twenty-first century.*

***i. Understand the times we are living in***

*The world has changed significantly during the last four decades. Globalization has made it futile to think of STI policies at just the national level. It demands an explicit consideration of the constraints and opportunities offered by the new highly interconnected global context. In particular, it requires examining the role of the international financial system, trade liberalization agreements and intellectual property rights in constraining national STI policies and determining the room for maneuver of national policy-making.*

*We are experiencing a worldwide transition towards knowledge societies, in which science, technology and innovation have become a major determinant of social and economic progress. The capacity to understand, generate, assimilate and utilize scientific and technological knowledge has become a key development factor. Science-based technologies now dominate the scene in communications, energy, manufacturing, agriculture, transport, health and education, among other fields. Their rapid advance, together with the acceleration of the rate of expansion of knowledge and an unequal distribution of science and technology capacities, are posing new challenges for international governance and for the fair distribution of the benefits of scientific and technological progress. Disruptive technologies are changing the structure and location of international production and service activities, and require significant efforts to at least understand the way in which they will alter the future and the prospects for developing countries.*

*Climate change, biodiversity loss, deforestation, desertification and pollution, together with urbanization and massive changes in land use, are manifestation of the emergence of a new anthropocene era. There is growing imbalance between the impact of human activities and the regenerative capacity of natural ecosystems supporting them. New approaches to knowledge generation and utilization are required to address environmental sustainability at the local, national, regional, international and global levels. In the coming decades, science and technology should be fully enlisted at the service of environmental sustainability.*

*The times we are living in require much higher, even unprecedented, degrees of political commitment and government effectiveness. We have learned that the national political context —in particular the commitment of political leaders to science and technology— is crucial for the success of development initiatives. Long-term vision and plans, stability and continuity, adequate human and financial resources, effective government and adequate institutions are some of the conditions we have found necessary to realize the potential contribution of science and technology to development. We believe the same applies at the regional, international and global levels, and while aware of the constraints faced in the transition from the national to higher levels of governance, the magnitude of the supranational challenges we face demands our best efforts to succeed and avoid the dire negative consequences of failure to act in concert.*

*ii.* ***Adopt an ethical perspective on science and technology issues***

*The unprecedented situation we face poses a new range of ethical challenges and dilemmas. A firm commitment and orientation toward inclusive and sustainable human development should be the bedrock of approaches to STI policy design and implementation. Yet, we acknowledge there will be tradeoffs and difficult choices to be made in defining priorities, allocating resources and implementing polices and decisions. There are no ready-made answers to these dilemmas. A sense of individual and collective responsibility, firmly anchored in human values and human rights, must inform those involved in science, technology and innovation of policy making and implementation.*

*Among other things, this obliges to assess the contours and limits of the policy space, identifying and judging policy options, determining their viability, and making ethical decisions that consider second order and long-term consequences. In this light, STI policy researchers and policy makers should not shy away from politics and political issues, but ground proposals on the best available evidence and engage politicians knowingly with an ethical perspective.*

*We urge to avoid voluntarism and be aware of the crucial role of the state in developing science, technology and innovation capabilities. State institutions should represent the collective interest and exercise leadership in mobilizing knowledge to promote inclusive and sustainable human development. But realism requires acknowledging there are different actors in the public, private, civil society and academic sectors, each with their own interests and objectives. Policy research and advice should aim at coherence and coordination between these differing perspectives, but keeping in mind the wellbeing of society as a whole and being ready to assume personal responsibility for choices and actions. The same applies at the supranational level, where there is an even more urgent need for the convergence of views and initiative to face global problems.*

***iii. Approach science, technology and innovation policies as a joint learning exercise***

*Policy research and policy making in complex fields are both art and science, but above all they should be learning exercises. The magnitude of challenges, the rapid pace of change, and the critical consequences of science, technology and innovation policy decisions require open minds, timely information, continuous adaptation, and an intuitive grasp of political, cultural and social factors. Policy researchers and decision makers should cast their nets wide, and learn from the experience of others —but keep in mind there are no ready-made solutions: what works at one time in a given context does not necessarily work elsewhere or at other times. A willingness to experiment and learn from mistakes is essential in STI policy design and implementation.*

*Reliable data and evidence should go hand in hand with rigorous intellectual and conceptual frameworks to appreciate science, technology and innovation policy issues. These should inform joint public, private, academic and civil society initiatives to define priorities, establish sequences and deploy political capital. The different logics of policy research, design and implementation, and the various objectives of the actors involved in these activities, should be explicitly acknowledged, assessing and incorporating the long-term consequences and indirect effects of decisions in science, technology and innovation. Awareness of the impact of implicit policies is essential, and this requires a broad framing of STI policy design and implementation. Monitoring and evaluation play a crucial role in the STI policy process, and should be factored in at an early stage.*

*Ideological rigidities and polarization should be avoided. Labels and adjectives that disqualify different opinions are to be eschewed in STI policy research, design and implementation. Multiple perspectives and openness to alternative views should be welcome, accompanied by a willingness to challenge conventional wisdom. We have learned that success in science, technology and innovation policies is often the result of doing things differently, of going against the grain and persisting in "errors" that defy established habits of thought.*

*iv. Science, technology and innovation policies require teamwork*

*Knowledgeable and qualified professionals in science, technology and innovation policies are indispensable in the design and implementation of STI policies. Education and training programs in this field should be instituted and advantage taken of opportunities for international collaboration. STI policy research and implementation teams should be organized with interpersonal relations based on trust and mutual support, to ensure they can work together in difficult times and under challenging conditions.*

*Build networks of stakeholders and interested persons in science, technology and innovation issues, and take care to develop constituencies that can offer political support. Adopt democratic practices and focus on problems of interest to stakeholders and team members, and remember there is no limit to what can be achieved, provided others take credit for it. Engage in extensive consultations, listen attentively and build consensus, but avoid the least common denominator and be ready to take decisions that alienate some team members and stakeholders. To the extent possible, ensure you have the political support to back up and implement decisions.*

*Employ extensively the new telecommunications and information technologies that were not available forty years ago, when the STPI project was carried out. These can provide the means to maintain contact with team members and stakeholders and gauge their views and opinions, but be aware they can also distract and make you lose focus.*

*v. Consider the time dimension and location of science, technology and innovation policy research*

*The lags in policy research, design and implementation are often considerable and need to be taken into account. Policy research frequently becomes an ongoing task, to be carried out concurrently with policy design and implementation. A delicate balance should be achieved between generating rigorous evidence and providing timely advice. Certainty is an illusion in policy research, but premature conclusions should be avoided. It is also necessary to acknowledge tradeoffs in policy scope and timing, and that short-term compromises may be necessary to keep policies on track for the long term.*

*Persistence and determination are required to adopt a long-term perspective in STI policy research, and to wait for the proper time and circumstances for introducing policy initiatives. We are fully aware this begs the question of how to determine "proper time", but have learned there is no substitute for experience, intuition, personal judgment, and even luck.*

*Academic, government and independent settings have their advantages and limitations to conduct policy-oriented STI research. There is no ideal location for this type of activity, but the extremes of splendid academic isolation and of public policy rationalization should be consciously avoided. This presents a dilemma between maintaining intellectual freedom and being above the political fray on the one hand, and securing access to decision makers and influencing the policy process on the other. There are no easy ways out of this dilemma, and while a long-term view may help placing these issues in perspective, ease navigating tradeoffs and avoid compromising independence, we should be aware that illusion and self-deception lurk always in the shadows of policy research and could lead us astray.*

* * *

*These are some of the conclusions and suggestions we arrived at in Paracas, Peru, forty years after we first embarked in an ambitious effort to improve science and technology policy design and implementation in our countries. We hope they are of use to the current and next generation of STI policy researchers and policy-makers.*

## 4.2. The Lima STPI+40 meeting

The Paracas meeting was followed by a larger gathering in Lima, with researchers currently active in science, technology and innovation policy, and with policy and decision makers who have responsibilities in national and international organizations in related areas. The objective of the second meeting was to reflect collectively on future directions for STI policy research in the light of the experience of the STPI project and what has happened during the last four decades in this field.

The Lima meeting began with a presentation by Geoffrey Oldham on half a century of science and technology policy research, and how the STPI project fit in the evolution of research in this field, and then Juana Kuramoto described the main changes in the context for science, technology and innovation since the STPI research was carried out, and explored some implications for the future. Both presentations were based on papers commissioned for the STPI+40 events. Following this, Francisco Sagasti gave a brief description of the STPI project approach, methodology, organization and results, before summarizing the statement agreed by STPI network members in Paracas (see preceding section).

Numerous interventions, presentations discussions and debates ensued during the two days of the Lima STPI+40 meeting. Several participants contributed written statements, some of which are in the following chapters, and the points made by other participants have been integrated into the brief summary of the following section. No attempt was made to forge consensus or reach agreement on each and every point discussed. Interventions reflected the rich diversity of views and experience that has been characteristic of science and technology policy research since the beginning of this field of study. Consequently, the summary below just lists the main points that emerged and issues discussed, without attempting to offer conclusions.

## 4.3. Approaches, issues and priorities for science, technology and innovation (STI) policy research, design and implementation forty years after STPI

The STPI project had a major impact on policy making in several of the participating countries, on the professional careers researchers and policy makers that participated in it, on their personal development and on the creation of a long-lasting network of colleagues and friends. This was largely due to the shared concern to build science and technology capabilities for development, the way the research was approached as a collective learning exercise, and the frequent meetings that helped to establish personal rapport, mutual respect and an appreciation for each other's work.

The STPI experience and numerous examples mentioned during the Lima meeting indicate that research in this field has affected policy making in significant ways, and contributed to improve performance in building up and utilizing science and technology capabilities in developing countries. Skepticism on the impact of science, technology and innovation policy research is clearly not warranted. Yet, it is also clear that success in this field depends, not only on a combination of vision, knowledge, determination and political will, but also on favorable national and international contexts for science and technology capacity building initiatives, on appropriate timing to exploit emerging opportunities, and on a good measure of luck. Efforts at the national level should be complemented with initiatives to understand context, and appreciate the room for maneuver it offers for STI policy design and implementation.

New challenges for science, technology and innovation have emerged in the 21$^{st}$ century, it was suggested that humanity is experiencing a change of epoch in which the ecosystems that support life have been irreversibly modifies. While these increasingly global challenges are becoming pervasive, daunting and urgent, the capacity to act collectively at the international level has diminished noticeably during the last few decades. The future of humanity appears rather uncertain in the absence of political will and institutional arrangements to jointly address emerging global challenges.

Against this background, contributions to the Lima STPI+40 debates can be organized into three groups: changing context and emerging responses, novel approaches to STI research, and reflections on the way forward.

### 4.3.1. Changing context and emerging responses

Discussions placed emphasis on several new features of the context for STI policies and policy instruments. Among them there are the shifts in international power relations, the emergence of major global problems and concerns, the greater diversity and heterogeneity of countries and regions, and the growing gap between the rich and the poor, all of which place new demands on science, technology and innovation capabilities. The disparities in capabilities between wealthy countries and powerful corporations on one side, and poor countries and grass roots organizations on the other side, are creating a huge gap in their capacities to generate and utilize scientific and technological knowledge. This was seen as a challenge that required collective action at the international level.

It was also acknowledged that there are now more actors in the STI policy and decision space, and that governments are no longer the only, or even the main, actor. There is the rise of public-private-academic partnerships, in which the three actors now have equal footing, and the increased interconnection and interdependence of STI issues and decisions that make it impossible to view actors in isolation. The increasingly complex relations between competitive and collaborative behavior of firms and corporations has changed the dynamics of innovation, giving rise to pre-competitive research and manufacturing alliances in many industrial sectors, but that not preclude fierce market struggles at the end product stage. There are also pressures for increasing citizen participation and democratic practices in matters of science and technology, for there is growing militant opposition to research that may eventually have health implications.

At the same time, a growing number of complex problems escape national jurisdictions and require governance and institutional arrangements that do not exist at present. This is particularly the case for the provision of international public goods, for which only a limited number of ad hoc arrangements appear to be in place. Moreover, a mixture of complacency, anxiety and alarm characterizes the attitude of many world leaders, who display far less appetite for international initiatives than in decades past, while the capacity for multilateral and concerted action has been severely diminished. In many societies this has been accompanied by a greater emphasis on personal advancement, which has led to highlight entrepreneurship and the innovative spirit of individuals, but at the price of diminishing solidarity and lessening concern for others, which undermines the appetite for joint and collective undertakings.

Nonetheless, new ethical imperatives are beginning to be recognized, including that of the survival of the human species in vastly altered ecosystems, partly as a result of climate change, deforestation, desertification and pollution, among other phenomena resulting from human activity. This is altering the roles of experts and citizens, opening spaces for citizen participation in science and technology policy debates, such as that on the perils and advantages of genetically modified organisms, the importance of biodiversity, and the need for climate change mitigation and adaptation initiatives. New information and communications technologies facilitate the participation of citizens and give exposure to their views. There also intimations that, should some of the major possible changes anticipated in the 21$^{st}$ century come to pass, the concept of development and the idea of progress will have to be redefined for all: not only for developing countries, but for rich countries and for humanity as a whole.

Against this background, some responses and STI issues are becoming more visible. These include: greater priority given to innovation at the firm, region, country and international levels, and especially technological innovation; initiatives to look back in time and reassess past policy responses to development problems an issues, such as the role of the state, rural and territorial development, education and the transmission of knowledge; and an appreciation of historical perspectives and learning from mistakes and successes.

New themes and areas for policy studies have also emerged, including the role of science, technology and innovation in the service sectors, including those supporting economic agents (logistics, commerce, finance and business information), as well as public services (security, water and sanitation, health, and education) and those that straddle the private and public sectors (food, energy, transport, elderly care). Attention is also being paid to the growing role of creative industries (visual arts, design, performing arts, cinema, entertainment, on-line gaming), which have become a source of economic growth and employment. While information and communications technologies play a key support role in these activities, it appears that social innovations (organization, mobilization, participation, social networks, virtual communities, petition drives and various other forms of collective action) are growing in importance.

The territorial scope of innovation systems, which are no longer seen as solely “national”, is another emerging research issue, with growing emphasis on their local, regional, sectorial, distributed and outsourced components that escape the action of national policy making. Furthermore, there is increasing awareness of the limits to the influence and impact of STI policies considered on their own, and of the need for policy coherence and coordination between explicit and implicit policies.

The recognition that persistent poverty and lack of opportunity, which together with growing inequalities in wealth, income and opportunity, limit severely the possibility of human beings achieving their full potential, was deemed a key subject for STI policy research to address. Topics such as knowledge and innovation for inclusive and sustainable development, frugal innovations for the bottom of the pyramid, knowledge and livelihoods for the poor in the informal sector, and the recovery and upgrading of traditional knowledge and technology, were seen as worthy of attention and support in this regard.

Another set of issues making their way into the STI policy research agenda refer to the needs of future generations, environmental sustainability and the long-term impact of current economic decisions. There is growing interest in questions such as: what should be the appropriate discount rate for events whose costs and consequences will take place in the future? What is the impact of macroeconomic policies on capacity building in science and technology? How does the international financial system constraint the policy space for responding to emerging challenges?

### 4.3.2. Novel approaches to STPI policy research

It was recognized that approaches to policy research have evolved over time, not only with regard to shifts in the issues under examination, but also because changes in the way policy research is conducted, and STI policies are designed and implemented. Many side conversations and exchanges took place during the Lima STPI+40 meeting, and among the issues that were raised it is possible to highlight the following issues.

First, there appear to be a new emphasis on recovering past experience with the design and implementation of science and technology policies, and on recognizing the importance of assimilating the lessons of the past. The renewed emphasis on productivity improvements, which hark back to efforts made during the 1960s in Europe, North America, Japan and several developing countries, is one example (a second one is the STPI+40 exercise reported here).

Second, an emphasis on mapping the policy space and ascertain the proper place and aims of STI policies and policy instruments in the 21$^{st}$ century, particularly as globalization, increased interactions and more complex economic systems make it necessary to embed the development of science, technology and innovation capabilities in more fluid and rapidly changing contexts.

Third, in comparison to the situation when the STPI project was carried out, there is a broader range of policy instruments and ways of influencing the behavior of actors in the science, technology and innovation system. These include new forms of venture capital to finance technological experimentation, various means of supporting entrepreneurship in new areas of economic activity, diverse mechanisms to develop highly specialized scientists and engineers (distance education, sandwich programs, fellowships and facilities for recovering émigrés), and the use of advances in information technology to establish virtual laboratories that facilitate international research cooperation, among many others.

Fourth, new ways of exercising policy influence have emerged, including participatory technology assessments, joint public-private partnerships, structured interactions between experts and citizens, social media campaigns, and South-South cooperation programs. Fifth, gender issues in science and technology have acquired more importance and figure prominently in most policy research, design and implementation.

Finally, there is a need to examine the fundamental changes that humanity is experiencing in the first decades of the 21st century from a science, technology and innovation perspective. This requires a renewal of conceptual frameworks that are no longer adequate to interpret the human predicament, a thorough examination of the social consequences of scientific and technological advances, an assessment of the real possibilities and limits of providing scientific and technological responses to problems that were generated by science and technology itself, and the elaboration of rigorous and fruitful narratives that make sense of the origins and main features of the turbulent times we are living in, and that capable of pointing ways to the future.

### 4.3.3. Reflections on the way forward

A few signposts on how to move forward in STI policy research emerged during the STPI+40 deliberations that took place in Lima. Following on the issues raised in the preceding section, the importance of devising frameworks and narratives that can guide the search for responses to emerging trends, situations and challenges was deemed highly important.

This may require abandoning established habits of thought regarding the role of actors in STI policy design and implementation, such as deemphasizing the role of government and paying more attention to citizen movements, grassroots organizations, international civil society and, last but not least, large transnational corporations. It also requires the full incorporation of social innovation into the design of STI policies, which demands initiatives to make scientific and technological knowledge accessible and understandable to citizens at large, providing scientific and technological information and advice to government at all levels, and making science and technology an integral part of education

Deliberate attempts at influencing and changing values, attitudes, behavior and, eventually, institutions, to engage, motivate and generate citizen enthusiasm to support science, technology and innovation, should be an integral component of STI policy research. The new information and communications technologies have an enormous potential to assist in this endeavor, and STI policy research initiatives should use them extensively at all stages of the research process.

# 5. LOOKING FORWARD: THE NEXT 40 YEARS IN SCIENCE, TECHNOLOGY AND INNOVATION POLICY RESEARCH

During the two events that took place in Paracas and Lima, the first with former members of the STPI network and the second with additional active science and technology policy research specialists, there were a number of ideas and proposals to carry forward the type of research that was carried out in STPI. This chapter includes three proposals on this subject, made by Francisco Sercovich, Alberto Aráoz, and by Sussan Cozzens and Monica Salazar.

## 5.1. STPI+40 post-Paracas/Lima reflections (by Francisco Sercovich)

What follows contains some reflections on how best to take advantage of the lessons learned from the STPI project for the benefit of subsequent efforts in the Science, Technology and Innovation policy field.[30]

In view of the nature of the matter at hand, some methodological remarks merit precedence.

Slow, painstaking long-term progress notwithstanding, the transfer of lessons learned over time and across countries in social sciences still poses major methodological puzzles, hurdles and question marks.

The very nature of social processes, with their variegated dynamic, multidimensional and idiosyncratic human and institutional attributes often turns attempts at extrapolation, projection, drawing of analogies and transfer of experience into rather tentative exercises at best and will-o'-the-wisp at worst. This is largely the case however massive the amount of information gathered and regardless how rigorous and sophisticated the variable controls and statistical methods resorted to are. And it applies particularly to lessons learned relating to policy simply because, in order to succeed, policies need to make the ability to accommodate highly specific, changing situations one of their key, uniquely configured, attributes.

Still, within the constraints imposed by the need to apply utmost caution whenever dealing with such matters, social sciences can —and actually do, to some extent— draw profitably upon learned lessons over time and across space, including those relating to Science, Technology and Innovation policy.

One important corollary of the above is that, when engaging in such kind of exercises, there is little choice but to reinterpret assumed lessons learned strictly and rigorously from the perspective of the situation to which such lessons are intended to be applied – rather than vice versa. More specifically, this means that all key nuances of that situation need to be duly mastered and factored-in as a pre-condition for the ensuing analytic/interpretative process. This entails stringent standards relating to the levels of specificity within which the results arrived at need to be circumscribed.

[30] This note should be seen as complementary to my July 2013 contribution to the Paracas/Lima meeting "Some thoughts on STPI + 40: emerging issues and topics", reproduced with minor amendments in the following section.

Attempting to take advantage of what has been learned from an applied research project carried out in the past submits plenty of methodological dilemmas of this kind, which are only augmented by a four decades-long temporal gap. This in no way belittles the significance of such cases where the experience gained during the project has had some impact on subsequent developments in specific countries, particularly thanks to the research/policy-making interfaces through individuals who participated in the original project and subsequently played a role as policy-makers and, more indirectly, also through other individuals that, having participated in the original project, capitalized on the ensuing experience in their subsequent research work, especially in other multi-country projects (see next section), and their respective impact on policy-making. Be as it might, the need remains, among other things, to take due stock of subsequent lessons learned, of changes in the relevant circumstances and of emerging trends during the intervening period.[31]

With the benefit of having been involved in its preparation, a review of the Paracas statement (see section 4.1) reveals in my view not only awareness of the above points, but also a largely implicit, inescapable, decision to rely on the accumulated collective experience and acumen of those who participated in the original exercise and were able to attend the Paracas and Lima meetings in August 2-7, 2013, as opposed to a detailed, nuanced and protracted stock-taking of lessons learned as a result of such exercise from the perspective of today. In other words, the ability to answer to the question: what have we learned during the last forty years which is of use today necessarily rests on our collective STPI and post-STPI experience, which could only have been codified during a meeting by resorting to a considerable effort of synthesis. My perception is that this has been a valid and appropriate shortcut, given the circumstances.[32]

Thus, such an approach has entailed a trade-off, namely, an attempt at getting across a major and meaningful synthesis as opposed to a rigorous bridging of the conceptual and historical distances between what was learned then, on the one hand, and what we know today and current challenges, on the other. The second alternative (the following section points in this direction) would have implied a more ambitious and systematic effort –, which was beyond what was feasible at the time. An effort that would have permitted tracing, reassessing and extending the imprints left by the STPI project and upshot thereof in light of current predicaments with a view to enriching the ongoing STI policy debate in a more disaggregated and specific way.

In sum, the outcome of efforts at capitalizing on experience in the design, implementation, monitoring and evaluation of Science, Technology and Innovation policy instruments across countries and over time can be expected to lead, and to some extent, has actually led, to valuable externalities. Nevertheless, it is my considered view that progress in this particular field during the last four decades still leaves much to be desired.

---

[31] This effort needs to avoid casual/selective/descriptive approaches, be systematic and focused, and take stock of the most directly relevant experiences and contributions during the intervening period from the perspective of today. In addition, currently it is possible and necessary to adopt a more thoroughly multi-disciplinary approach than was the case in the past.

[32] Post-STPI experience includes that relating to the vast richness of the catching-up processes that have taken place since the 1980s and to the nature of system-wide learning processes, among others (see the following section).

### 5.2. Some thoughts on STPI + 40 emerging issues and topics (by Francisco Sercovich)[33]

Since the 1970s, when the STPI project was conceived and carried out, tectonic changes have taken place in Science, Technology and Innovation (STI) policy theorizing, practice and research. These changes are still ongoing — at a breathtaking pace. Along with them, we have witnessed, inter alia, the emergence of new global priorities, major shifts in the international and regional distribution of economic power, hubris about the 'end of history', a 'lost decade' in Latin America, successful national catching-up strategies by late industrialisers in South East Asia, the rise of pervasive uncertainty and turbulence as a new norm in the global economy and the realization of a central trilemma about the possibility of reconciling two, but not three, of the following: national sovereignty, democracy and global integration.[34]

In what follows I first account very succinctly for just a few among the former (see references at the end for further details), to then conclude with a reflection about some of the latter.

#### 5.2.1. New challenges in STI policy theorizing, practice and research

a. STI policy impact-assessment

Quasi-experimental micro-econometric methods have emerged as the 'gold-standard' for the evaluation of the impact of STI policy programs. Input- and output-additionality studies have become the methodological template for assessing the effectiveness, efficiency and transparency of STI policy management. The weaknesses of this approach are being nuanced by emerging concepts such as that of behavioral-additionality, which is still to become fully operationalized empirically. Problems with these approaches remain with respect to the unit of analysis, the relevant time-frame, the capturing of the micro-dynamic phenomena underlying learning processes and the linkage with strategic priorities and with policy learning (reference 9).

[33] My post-STPI association with the IDRC includes their sponsorship of a research fellowship at Harvard (see Sercovich, 1980) as well as their support for my research papers Sercovich (1989), (1990) and (2008).

[34] To avoid lengthening the list unduly l would just mention, in passing that, whilst in the 1960s projections anticipated that the USSR was poised to overtake the U.S. within a few decades, in the 1980s the rise of Japan to global dominance seemed all but inevitable. These precedents notwithstanding, China's current ascent to the status of largest world economy appears firmly grounded (for instance, it's poised to add more than 50 million science and engineering graduates to its workforce from now to 2030), although question marks remain on the outcome of current efforts by Chinese policy-makers to 'rebalance' China's pattern of growth', which eventually might trigger a 'lost decade' for China, meaning 'lackluster' rates of growth of around 6 – 7 per cent per year. Currently, Chinese policy-makers are struggling to attain a 7.5 per cent growth rate in 1914.

b. Policy learning

Policy-making in general and STI policy-making in particular need to draw on a relentless scrutiny of policies as an essential ingredient. Though this may appear a truism, it does happen that ex-post policy impact assessment exercises are often carried out just for the sake of meeting formal requirements or legitimizing specific programs —with limited, if any, effects on policy learning. Such exercises rely on highly restrictive assumptions and suffer notorious shortcomings that confine their usefulness for actual STI policy-making and, a fortiori, for strategy making. No doubt, policy learning does occur heuristically anyway, so that an evolution can be traced, for instance, in shifts from horizontal to focused policies and in the progressive refinement of policy instruments through learning by doing. Yet, this progress has hardly been systematized and even less used for subsequent, methodical policy development. The still rather undeveloped state of the concept of policy learning itself and its attributes, vouch for this (reference 8).

c. Integrating the various dimensions of learning

The morphing of the original Sabato triangle into a full-fledged conceptualization of the innovation system concept has giving rise to a reassessment of the concept of interactive and networked learning processes. Along these lines, progress is taking place towards an integration of the various dimensions and tracks of social learning: namely, firm specific, institutional/systemic and policy learning. This approach is being operationalized for STI and for infant industry development policy purposes (Ibid).

d. Integrating STI and industrial development policies

The grounds for this integration are being paved by means of the progressive substitution of heuristic, experimental strategies that factor-in limited information and uncertainties by means of conjectural, conditional approaches, for the simple algorithms from conventional economics that used to inform policies in the past. This entails a growing understanding of the role of structural change and the need for a provident allocation of resources to innovative development as keys to industrial development. Thus, the ability to generate discontinuities by means of transformations in domains such as those of the mastering of knowledge, innovative capability promotion and human resource development have become the necessary underpinnings of successful industrial strategies, which are often implemented by means of 'second-best', unconventional policies (reference 7).

e. Technological learning: from the 'whats' to the 'hows'

Largely through myriad case studies carried out since STPI a lot has been learned about the micro-dynamics of technological learning as well as about the factors that bear upon it, with significant implications for the design and management of STI strategies and policy instruments. This progress has had its ebbs and flows. Thus, for instance, at first efforts focused on developing (functional) taxonomies of technological capabilities —such as the definition of innovative capabilities proper as opposed to those relating of investment or production capabilities. Progress towards grasping the intricacies of technological learning, especially the causal chains involved and the outcomes from it has been much slower to accrue —and is still ongoing, both conceptually and empirically (references 8 and 9).

f. Institutional learning

Along with firm-specific technological (including organizational) learning and policy learning, institutional learning (i.e., learning by decentralized public and private non-market institutions) constitutes a third essential component of the system-wide learning triad underpinning the evolution of innovation systems. Alas, like with policy learning, institutional learning has been underemphasized so far in the literature. Further efforts are needed to come to a full appreciation and integration of this dimension of learning in order to advance towards a richer understanding of STI policies (references 7 and 8) .

g. Role of the state and of the private sector

The prior dichotomy, either/or, view of the role of the public and the private sectors in economic development in general, and STI development in particular, has been succeeded by a more nuanced interpretation. One of the key lessons from the recent successful experiences at catching-up innovation systems involves the realization of the vital joint, complementary, strategic and dynamic roles played by both sectors, respectively, in the development of the domestic knowledge system. This strategic partnership between the public and private sector, in turn, is one of the keys to ensuring the success of catching-up policies whilst shortening the time required for them to come to fruition. As the historical record shows, this includes record rates of growth in the supply of university graduates, particularly in natural sciences and engineering (most relevant to technology absorption), high priority to speeding up technological learning, incremental innovation and domestic knowledge diffusion by means of institutional Innovations and fostering personnel and technological knowledge flows among research laboratories, universities and the private sector to bridge imbalances in the supply and demand of scientific, technological and entrepreneurial skills, promote competence building and foster efficiency gains.

These strategies often relied on a covenant between the state and the private sector whereby the state subsidized technological learning and orchestrated the levers —financial, external, fiscal, regulatory, institutional— conducive to the effective exploitation of the outputs of such learning for production aimed at world markets, while the private sector achieved sustainable standards of technology mastery and international competitiveness through augmented research and development, innovation and training efforts. Clear and effective rules applied so that the goals sought were achieved within specific timeframes.

Notwithstanding the above, great diversity's observed in actual catching-up experience, with actual policy focus ranging from domestic small and medium-sized enterprise development (Taiwan) to fostering chaebols (South Korea), from indirect state incentive orchestration (South Korea) to "market socialism" (China) and from heavy reliance on foreign direct investment (China, Brazil) to arm's length technology deals with multinational corporations (Taiwan), including various blends in-between. Commonalities include a capability-building focused strategy, the subsidization of domestic learning processes and the promotion of domestic entrepreneurship and export-orientation, along with episodes of import-substitution, which for the most part, when successful, were turned into export-oriented ventures and, when unsuccessful, were phased out. As mentioned, the key to such policies lies in the building and strengthening of domestic knowledge systems and the promotion of an internationally competitive private sector capable of embarking upon sustainable Innovation trajectories. Without domestic absorption and innovative capabilities, little if any advantage can be taken of International knowledge flows, either through foreign direct investment or otherwise. Infant industry development policies are naturally-not paradoxically-fully consistent with outward integration (references 6 and 10).

h. Growing role of the upper educational system in catching-up

The central role of evolving domestic knowledge systems in catching-up processes entails growing demands on the higher educational system to become vital agents of knowledge flows both across borders and domestically in their dual role as providers of knowledge and of qualified human resources. However, adapting the culture and routines of universities, along with those of other institutions (like those relating to training, intellectual property rights, regulations, standards, etc.) to play a pro-active role in evolving domestic innovations systems often entails painful and often protracted habit-changing and social-learning intensive periods. These processes cannot be left outside the scope of STI policies (reference 8).

i. Implicit and explicit policies

The increasing differentiation, specialization and deepening of STI policy instruments such as those relating to innovation financing, government procurement, networking, start-up financing, etc., have divested the attention from this distinction —first introduced by Amilcar Herrera. However, it remains highly relevant to understanding, for instance, the policy-mediated relationships between the economic cycle and STI capability building under conditions of high uncertainty. The current crisis in the Euro-zone is throwing this issue into sharp relief.

j. Intellectual Property Rights

Although specific 'flexibilities' by way of exceptions largely offset the strictures imposed on developing countries by the World Trade Organization's 1995 Treaty on Trade Related Intellectual Property Rights (TRIPS) in the specific case of health, later regional and bilateral free trade and investment agreements, in turn, more than countervailed what those flexibilities sought to alleviate. Because of a bias towards the bilateralization of TRIPs-plus negotiations, in their efforts to promote their innovative capabilities and performance late industrialisers face nowadays what probably is the toughest global intellectual property rights environment ever (lets notice, in passim, that this affects even an advanced country like Canada, which has so far pursued an independent track in this regard). This situation poses exacting demands on the design and management of adept STI policy-instruments along with those relating to complementary trade and industrial policies (reference 4).

k. Technological platforms, sectorial funds and public goods

The progressive passage from horizontal to more focused STI policies, including such instruments as technological platforms and sectorial funds calls for a reassessment of the role of (largely sector-specific) public goods in fostering innovation system-wide and strategic capability building. In this context, public goods can be regarded as a pivotal dimension for the effective implementation of strategic public policy guidelines. As the provision of public and semi-public goods comes largely associated to their consumption, this perspective entails integrating all stakeholders in an inclusive approach towards STI policy, since those goods with higher public knowledge content entail greater potential for social dissemination (reference 5).

l. Emerging new global map of innovation

A new global map of innovation is emerging as a result of the growth of integrated global value chains, growing vertical specialization, the spread of STI activities by multinationals beyond their home bases, the narrowing gap between tradable and non-tradable activities and the mobilization of innovative capabilities in emerging countries. This entails new constraints, challenges and opportunities for developing countries at large.

### 5.2.2. Looking forward: final comment

The spectacular rise of China has brought important dividends to the developing world and Latin America in particular (with some intra-regional variations). Whether the countries of the region have made the best of these dividends, however, is a matter for controversy. No doubt, elucidating how best to deal with the impact of the cyclical behavior of the economy on STI policies still poses a pressing assignment to the region.

Allocation of resources to STI probably suffers more from volatility, and the ensuing uncertainties, than from slow growth. As already mentioned, structural imbalances suggest that world economy is poised to slow growth for most of what remains of this decade and beyond. This, per se, may not bode that bad for STI activity, but volatility and major macroeconomic mal-adjustments are another matter, as shown by the recent experience of non-core European countries. Thus, the way economic policy authorities in the key countries manage the adjustment to the current mismatches in the world economy, either through painful recessions (as has recently been the case in Europe) or by means of more moderate, nuanced and fine-tuned therapies, will be key for STI performance.

In addition to valuable lessons, China growth miracle has brought about tangible benefits, such as a sharply beneficial change in terms of trade and in export earnings thanks to expanding trade and soaring commodity prices (particularly those from exports of minerals followed by foodstuffs, animal feed and processed primary products). While in 1990 China was placed just seventeenth on the list of Latin American export destinations, by 2011 it had become the first export market for Brazil, Chile and Peru, and second for Argentina, Cuba, Uruguay, Colombia and Venezuela (all in all, as much as three fourths of recent Latin American growth can be attributed to commodity exports). On the downside, however, a parallel process of 're-primarization' of the region has been observed, which relates to the commodity export boom coupled with tough competition from China's manufactures. Whilst raw materials accounted for 52 per cent of regional exports during the early 1980s, this share went down to 20 per cent by the late 1990s, only to rebound to 40 per cent by 2009.

On top of the mixed legacy of the past decade (with some positive social indicators), Latin America currently faces stronger headwinds than tailwinds. This includes a low growth cycle for the global economy as a whole, and China in particular (see footnote 35 above), further falls in industry's labor absorption capacity, the accentuation of the enclave-inducing impact of global value chains, tougher competition in manufactures and mounting social tensions.

The recent golden age of catching-up and growth miracles is probably over. Is the mixed blessing of China's turbo-charged growth coming to an end? Will China's economic adjustment provoke adverse shocks to developing countries, particularly those heavily reliant on non-food commodities? These are open questions, subject to uncertain prospects. However, they must be tackled through bold public policies, including STI policies. These need to feature an increasing strategic orientation.

Are we witnessing a classic case of 'middle-income trap'? I doubt it. Although China has made great strides in catching-up, its productivity gap with the technology leaders is still considerable (as is, indeed, that of the Latin American countries, whose catching-up processes have stagnated). Productivity differences are probably not more decisive in settling the question about China's growth prospects than macroeconomic imbalances and labor-market/demographic variables. In addition, we know that capital per worker is far for accounting for productivity growth, since it neglects the incidence of technological capabilities and institutional change.

* * *

The STPI project was a pioneering one in various respects and probably ahead of its time. An ex-post evaluation cannot neglect drawing on the experience from later analogous multi-national projects (which, in turn, drew on the STPI), such as the World Bank/Inter-American Development Bank project on Technological Capabilities, and the Economic Commission for Latin America/Inter-American Development Bank/International Development Research Centre project on Science and Technology (in all of which I had the fortune of participating).

**References**

1. Sercovich, F. (1980): State-Owned Enterprises and Dynamic Comparative Advantages in the World Petrochemical Industry: the Case of Commodity Olefins in Brazil", University de Harvard, Cambridge

2. ………..……..(1989): Interactive Learning, University/Industry Links and Institutional Innovations" Revista del Derecho Industrial, No 31, enero-abril, pp.119-133 (in Spanish)

3. ………………..and M. Leopold (1990): Developing Countries and the 'New Biotechnology': Market Entry and International Competition", IDRC, Ottawa

4. ………………..(2008.a): Free Trade Agreements, Intellectual Property Rights y Catching-Up: Policy dimensions from a Latin American perspective (in Spanish), ECLAC. http://www.cepal.org/publicaciones/xml/1/33521/L865.pdf

5. ……………..…(2008.b): Fondos Sectoriales, Plataformas Tecnológicas y Bienes Públicos, Ministry of Science, Technology and Innovation, unpublished manuscript, Buenos Aires (in Spanish)

6. ………………..(2011): Knowledge, FDI and Catching-Up Strategies, Columbia University, http://www.vcc.columbia.edu/content/knowledge-fdi-and-catching-strategies

7. ………………..(2012): Towards the Integration of Industrial Development and Innovation Policies – Some Pending Issues, Presentation at COLCIENCIAS/TECNOS, Bogota, 14 June, 2012 (in Spanish)

8. ………………..and Teubal M. (forthcoming, a): An Evolutionary View of the Infant Industry Argument, Technology Assessment and Strategic Management Journal, London

9. ………………..(forthcoming. b) Dynamic Additionality, Ministry of Science, Technology and Innovation, Buenos Aires (in Spanish)

10. Magarinos, C., Long Yongtu and F. Sercovich (2003), China and the World Trade Organisation: The Birth of a new Catching-Up Strategy, Palgrave MacMillan, London

### 5.3. STPI Cooperation Network A Preliminary Proposal (by Alberto Araoz)

As a sequel to the work on the original STPI project and its present Review Meeting, a proposal is made for the formation of an institutional network on Science, Technology and Innovation Policy Instruments (STIPIN) to host a continual collaboration on this subject.

#### 5.3.1. The need for revisiting STPI

Four decades after the STPI Project took place, many different things have emerged as our STPI field has evolved with world-changing developments, new problems and new approaches. If an STPI Project should be programmed now, it would have to incorporate many new aspects and issues.

It is interesting to notice that, beyond isolated instances, there has not been a strong enough effort to establish interchanges among the STPI original participants. Networking has not been organized; newcomers to the game have generally proceeded on their own. The present STPI+40 review meeting is an excellent effort to remedy this, but only at this moment in time. What happens after it?

A new STPI Project, with Innovation included, may not be feasible even when conducted using the new ITC tools that were not available before. But even so, what would we do in the future to keep up with new issues and new ways of tackling them?

We would like to suggest that a dynamic and fertile approach would be to create a cooperation system among the old STPI participants and others that may want to join. This solution would allow a systematic updating of the subject in respect of changing challenges and the responses to them as practiced by the participating countries, and other countries as well.

There are numerous advantages in creating a cooperation network among a number of scientific and technological institutions of similar characteristics around the subject of policy instruments for Science, Technology and Innovation. The network —which may be called Science, Technology and Innovation Policy Instruments Network, or STIPIN for short — would allow the member institutions to profit from each other's experience, exchange scientific personnel, carry out collaborative research and other activities, and negotiate jointly with Foundations and International Organizations interested in promoting and funding STIPI-related activities. It would help them to collaborate on a number of STIPI aspects, and to participate in a joint learning effort, at a time when a single such institution of small to moderate size (as is usually the case in many emerging economies) finds it increasingly difficult to keep up to date and to pursue and maintain an expertise in those fields of work, particularly when rapidly developing new technologies are involved.

### 5.3.2. Structuring a new research effort on science and technology policy implementation

Following previous research by the present author (1), the main elements in the network would be:

- Nodes
- Nucleus
- Links
- Flows
- Joint Activities
- Objectives
- Funding

Let us review them briefly.

***Nodes.*** These are the institutions that would make up the network. They may assume different characteristics, but in general would have a special interest and responsibility in policy instruments for R&D, technology, innovation and technological services. An operational definition of what would constitute an eligible member institution should be established beforehand, and the candidate members should comply with it. A survey should be carried out to identify the likely candidates before attempting to constitute the network. The number of members from different countries would vary according to the country's size and the stage of its development.

***Nucleus.*** Is the central unit of the network, in charge of promoting and coordinating the activities carried out within the network. This could be organized, as a Secretariat, which would be independent of the nodes but would report to a Board made up of the latter's representatives. An Advisory Council with outside members (drawn from industry, universities, international organizations, etc.) could be constituted to assist the Secretariat and the Network in the general strategies to be followed. The Secretariat should be small, with very few professionals under fixed-term contracts (to avoid creating a bureaucracy). Whenever necessary it would employ consultants to develop projects, carry out joint activities, etc. It should operate flexibly, but at the same time enjoy a good measure of institutional stability. This may be obtained by attaching it to an international or a first rate national institution. In this way it could be provided with a chief officer (or Secretary) and supporting staff, initially hired for a limited number of years, and budgetary resources covering structural costs during that period.

The Secretariat would actively organize and promote various types of flows between the nodes, and joint activities among them. It should be prepared to help member institutions in their development and improvement, for instance by organizing technical and training programs for them. It would also engage in activities relating to information, training, technical meetings and consultations on different aspects of STI, relations with outside institutions, funding possibilities, and so on.

***Links.*** These are the links between the nodes, or channels through which flows would take place. A smooth circulation of flows depends on stable and reliable links. The establishment of such links is one of the more important tasks the nucleus should undertake at the time the network is created. They would include e-mail, teleconferencing, websites (particularly giving access to databases and information resources), newsletters and bulletins, periodic meetings, formal consultation mechanisms, and informal personal contacts of different types.

***Flows.*** These are the flows circulating through the network, between the nucleus and the nodes, and between the nodes themselves. Such flows would include principally information and intelligence on knowledge resources, social and economic subjects, legislation, specific experiences, etc. Many of these flows will originate within the network, often as a result of joint activities. There may be significant flows coming from the outside, captured by the nucleus or any of the nodes, which would be circulated throughout the network.

Flows would also include human resources that circulate between the constituents of the network for purposes of scientific exchanges, training, joint activities and so on. Financial flows should also be included in this list.

***Joint Activities***. Joint activities are undertaken by two or more members of the network, such as collaborative research projects, technology monitoring and assessment, training courses, and the formulation of common policies and courses of action (for instance for joint action at the international level).

These activities may be set up and carried out as joint projects, which should be carefully prepared by the participating nodes with assistance from the Secretariat. Such projects should be adequately funded, from sources other than the regular budget of the network. A joint project will constitute a temporary cooperation network around a single topic, and will generate intense flows between the participating nodes. Most research will be policy research and this may be of a multidisciplinary nature, needing the participation of several disciplines including economists, social scientists, lawyers, etc.

***Objectives***. A set of clear long-term objectives should be carefully spelled out when designing the network and should gain the agreement of the founding members. It should be possible to modify them when other institutions join the network or when circumstances change. Short-term tactical objectives to guide activities in the network should be adopted at the periodic meetings (annual or biennial) of the Board, and would normally be expressed in a work program for the coming period. This may be drafted by the Secretariat on the basis of suggestions by the nodes.

As suggested by S. Barrio (2), human development and happiness is in the final analysis our objective and this could be adopted as the overarching objective for STIPIN.

***Funding***. This includes the financial resources for the Secretariat and of the activities to be carried out in the network. The importance of this element should not be minimized, since the smooth and efficient functioning of the network depends on it. Multiannual budgets should be prepared and financial resources gathered; projects and joint activities should not be started if specific funding is not assured. An important source of funding would be the member institutions themselves, which should contribute a membership fee and cover part (sometimes all) of their own expenses in activities in which they participate. Other sources would be international and bilateral cooperation agencies and various foundations.

## BOX: New aspects and issues relating to science, technology and innovation policy instruments

As Avalos points out (3), the situation today is completely different in almost all aspects than what it was 40 years ago. The globalized Knowledge Society establishes very different parameters —political, economic, ecologic, ethical— to think and approach the issues of science, technology and innovation.

The present author has indicated (4) that things have changed very much in recent years, to a large extent due to the great advances in information technology, communications technology, materials science, robotics, biotechnology, pharmacodynamics, nanotechnology, etc. There has almost been a paradigm change in our subject matter. To take an example: it has recently been suggested that 3-D printing manufacturing technologies will bring about a new industrial revolution that will determine which countries will prosper and which won't, since in many cases products will not be exported but only their design, through the Internet, as the country of destination will carry out local production with 3-D printers. Such a situation will put a further premium on quality education and S&T development (5).

Meaningful research in science, technology and innovation policy for developing countries and its instruments would have to incorporate many issues that were not critical 40 years ago. For instance:

- New Instruments and Institutions for the development and utilization of Human Resources for Science, Technology and Innovation, such as (1) New Avenues for Human Resources Development in Higher Education, especially the use of on-line university courses, which is now expanding rapidly, and the close joining of teaching and research in Research Universities; (2) Science Parks and Research-Innovation Clusters; (3) International Brain Migration, to developed countries for training and gathering experience, and back to developing countries for S, T and Innovation activities.
- Creation and Support of New Technology-Based Enterprises, through (1) National Programs, including those sponsored by the EMPRETEC Program at the United Nations; (2) Venture Capital institutions and activities; (3) Crowd-Funding schemes.
- Strengthening of institutions and programs that link science/technology activities and productive activities, such as (1) Information and Technical Intelligence capabilities; (2) Consulting and Engineering; (3) Agricultural Extension.
- Novel ways of achieving innovation, such as: (1) Collaborative work between enterprises and their customers; (2) Innovations from Users of technology; (3) "Frugal" innovation.

To the above list, we may add:

- The expected change in global work force demographics: populations are rapidly aging in some countries (US, Western Europe, Japan, China) while other countries (India, Latin America, Africa) brim with young people needing education and training for the modern world.
- Cultural factors regarding innovation: there is a need to introduce and expand a Culture of Innovation in emerging countries. A suggestion has been submitted to the present meeting regarding the utilization of the intellectual diaspora for such a purpose (6).

Other aspects that were mentioned by STPI+40 participants are:

- Technology assessment (2)
- Implications of the "economics of the commons" – educational, soil, environmental and health issues. (2)
- Heavier emphasis on the cross-disciplinary synthesis of different scientific and technological disciplines, systems engineering approach in the broad sense, analysis and utilization of the effects of social sciences, humanities and arts in commercialization process of new innovation and policy initiatives. (7)
- Climate change (8)
- Social and environmental sustainability. Regarding the latter, climate change and biodiversity loss in particular. How to arrest this process of environmental deterioration and reorient the world's economies in a path of sustainability (9)
- Instruments to foster the adoption of S&T by the private sector (10)

### 5.3.3. Concluding remarks

STIPIN should ultimately become a true cooperation system. This would require several conditions to be met:

- Clearly defined long term objectives that are shared by the member institutes;
- Firm and stable links among the latter;
- Intense circulation of flows so that systemic relationships are established through them;
- The sharing of flows originating from the outside;
- Joint activities carried out with sufficient continuity.

If these conditions are obtained, and the network acquires systemic characteristics, there will be a much higher probability that the efforts and resources assigned to cooperation among institutions working on S, T and I policy and its instruments will produce high returns, through a significant improvement of the efficiency and impact of the member institutions.

A feasibility study should be prepared before constituting the network. This study should indicate whether the network is viable from the technical, political and financial points of view, and should provide an initial design as well as a preliminary budget for at least three years of operation. If the findings are positive, a meeting could take place with the participation of candidate members and interested supporting institutions, in order to discuss such findings and, if all goes well, launch the network.

**Endnotes and References**

A. Araoz, "Nuevas modalidades de cooperación técnica en América Latina", Comercio Exterior, Mexico, September 1981

S. Barrios, reply to Prof. Oldham's Questionnaire, 2013

I. Avalos, reply to Prof. Oldham's Questionnaire, 2013

A. Araoz, reply to Prof. Oldham's Questionnaire, 2013

La Nacion, Buenos Aires, 26 July 2013

A. Araoz and Z. Karani Araoz, "The Intellectual Diaspora as an Instrument to Develop Innovation Capabilities in Emerging Economies", STPI 40-year Review Meeting, Lima, August 2013

Kun-Mo Chung, reply to Prof. Oldham's Questionnaire, 2013

A. Malhotra, reply to Prof. Oldham's Questionnaire, 2013

J. Tavares de Araujo Jr., reply to Prof. Oldham's Questionnaire, 2013

E. Amadeo, reply to Prof. Oldham's Questionnaire, 2013

### 5.4. Research Network on Science, Technology and Innovation Policies in the Americas – STIPA (by Monica Salazar and Susan Cozzens)[35]

#### 5.4.1. What?

A new academic network on science, technology and innovation policies for researchers, programs, institutes and universities in the Americas. Any person in these categories is welcome to join us.

#### 5.4.2. Why?

Science, technology and innovation policies are the result of interactions between multiple actors in local, national and international knowledge systems. Academics from different disciplines in the Americas have studies the dynamics of science, technology and innovation policies and made valuable contributions that require a specific platform for their dissemination. The STIPA network offers a space to consolidate fundamental research questions regarding the design and implementation policies in this field. Through an academic exchange between young and experienced senior researchers working individually or in institutions, STIPA aims at consolidating a dedicated space to integrate the accumulated knowledge emerging from science, technology and innovation policies in the Americas region.

#### 5.4.3. How?

The American continent is sufficiently large and diverse, with different cultures and languages, distinct models of innovation systems, and diverse traditions in the design and implementation of science and technology policies, all of which require new thinking and new research frameworks to improve the quality of results. STIPA will offer opportunities to advance in activities such as:

- Academic events to discuss recent progress in science, technology and innovation policies.
- Postgraduate education and training (list of programs, summer schools for doctoral students, online shared courses, conferences for young researchers).
- Advise to doctoral students in the field of science, technology and innovation policies.
- Dissemination of scientific publications produced by researchers in the Americas.
- Design and fund raising for joint research projects.

---

[35] At the STPI+40 meeting Monica Salazar and Susan Cozzens to organize a comparative research network to study science, technology and innovation policies in the Americas. A formal proposal to establish this network was subsequently made at a conference on "Science, Technology and Innovation Policies in the Americas", held in Atlanta in September 2013. This section is based on the Spanish version of the brochure prepared to launch the network.

- Relations with similar networks in other places, such as EU-SPRI, or those related to LALICS, ESOCITE and ALTEC, among others.
- Network activities to improve the transfer of academic knowledge to policy makers.

Considering the large size of the American continent, STPI could divide the development of its activities according to geographical nodes. Interested members of the network will define these nodes.

Administrative arrangement will be discussed among participants. For example, should membership be institutional or individual? Should there be contributions to support administrative services?

#### 5.4.4. Who?

The STIPA initiative is promoted by the Technology Policy and Assessment Center (TPAC) of Georgia Tech in Atlanta, and by the Colombian Observatory of Science and Technology (OCyT) in Bogotá. Other promoters and national champions are welcome. For additional information please contact Sussan Cozzens at scozzens@gatech.edu, or Monica Salazar at msalazar@ocyt.org.co. See also: www.stipamericas.net.

## 6. CONCLUDING REMARKS AND PERSONAL POSTSCRIPT (by Francisco Sagasti)

This report has taken a retrospective look at the Science and Technology Policy Instruments (STPI) project forty years after it began, and more than three decades after it was completed and its results began to be implemented. The STPI+40 events of 2013 allowed to examine the impact of the research, review the varying fortunes of efforts to build science and technology capabilities in the participating countries, examine what we have learned over four decades and assess what does this imply for the future.

Before closing this report, some personal comments may be in order. The STPI project had a profound impact on my professional career and personal life. It opened unusual learning opportunities, allowed me to make lasting friendships that enriched my life, put me in contact with leading science and technology policy experts from all over the world, and made demands that vastly increased my intellectual, managerial and professional abilities.

I was a PhD student at the University of Pennsylvania when, in late 1968, at the suggestion of Dr. Alberto Giesecke Matto, the president of the newly created Peruvian National Research Council, I decided to do my dissertation on science and technology planning using Peru as a case study. He put me in contact with Máximo Halty Carrere, who was spearheading science and technology policy studies and advice at the Organization of American States (OAS) in Washington DC. Following a short consulting assignment with Halty's unit at the OAS, a research contract between the Management Science Center of the University of Pennsylvania and the Department of Scientific Affairs of the OAS provided support for my dissertation.

After completing my dissertation I joined the OAS as a staff member and worked on several studies, some of which were done in collaboration with the Science Policy Research Unit (SPRU) at Sussex University. In this way I got to know Geoffrey Oldham and Christopher Freeman, the founders of SPRU, and Charles Cooper, one of its leading researchers. Geoffrey Oldham was also director of the science and technology policy program at the Canadian International Development Research Centre (IDRC) in Ottawa. During my time at the OAS I participated actively in the team developing the Andean Pact Common Technology Policy, worked in the preparation of papers for an OECD-OAS meeting to compare approaches to science and technology policy design, and prepared a background report for the IDRC-OAS project identification meeting held in Barbados that originated the STPI project.

When the project was launched in 1973, I was appointed STPI field coordinator based in Lima. At the same time, I became advisor to Alberto Jiménez de Lucio, Minister of Industry, Trade and Integration and to the President of the National Research Council, as well as vice-Chairman of Board of the Peruvian Industrial Technology Institute. The combination of international comparative research, advisory responsibilities and policy making functions provided me with a unique opportunity to understand the complexities of designing and implementing science and technology policies.

After completing the research in the STPI project at the end of 1976, the dissemination phase was managed from Bogotá, where the IDRC Latin American Regional Office was located. I moved to Bogotá for three years in early 1977 and assembled a small team to organize publications, events and provide advice to various international institutions and government agencies (see chapter 1 of Part III of this report).

One of the important dissemination activities involved making available the results of the STPI project to the various agencies involved in the preparatory process for the United Nations Conference on Science and Technology for Development (UNCSTD) held in Vienna in August 1979. Developing countries in the Group of 77 adopted a militant stance during the preparatory negotiations, seeking to obtain concessions from developed countries to support the development of science and technology capabilities. UNCSTD was the last of the major United Nations Conferences of the 1970s, which took place when proposals for a "New International Economic Order" occupied center stage on the international scene.

In 1978-1979 was seconded by IDRC to assist the Peruvian delegation, the Group of 77, the Andean Pact Secretariat, the UN Economic Commission for Latin America, and the UNCSTD Secretariat in the preparation of their position papers for the conference. Difficulties and conflicts between the UNCSTD Secretariat and other units in the United Nations system marred the negotiations and led to delays in the preparation of the background documents. My main task at the UNCSTD Secretariat was to revise and rewrite the concept paper prepared as background the Vienna conference,[36] which provided an opportunity for feeding the results of STPI into the preparatory process.

As member of the Peruvian delegation at the conference in late August 1979, I was directly involved in the negotiations that led to the Vienna Program of Action on Science and Technology for Development. This program contained recommendations for building science and technology capabilities, dealing with technology imports, organizing international cooperation programs, and for restructuring the United Nations machinery for science and technology with the creation of a UN Center for Science and Technology for Development. Several findings of the STPI project that made their way to the UNCSTD Secretariat concept paper were incorporated in the Vienna Program of Action. One of the main demands of developing countries had been the creation of a financing system for science and technology for development, and the agreement included provisions to set up an expert group to design the financing system, as well as the immediate creation of a US$250 million interim fund that would be temporarily managed by the United Nations Development Program.

The political context for United Nations initiatives changed radically in the 1980s. The elections of Ronald Reagan in the United States and Margaret Thatcher in United Kingdom opened up a period in which economic liberalization policies, a reduction of state intervention and a much more limited role for international organizations became the new norm. There was no chance for agreement reached in Vienna to be put in practice in the new context, and the interim fund languished and eventually disappeared. The UN Center for Science and Technology for Development was abolished a few years after its creation, and science and technology issues all but disappeared from the international development scene.

[36] See: United Nations, *Science and technology and the concept of development, consolidated discussion paper prepared by the Secretary - General of the conference*. New York/Vienna: United Nations, 1979 (available in http://kind-cind.org/blogstpi/?page_id=83 STPI+40 webpage).

The disappointment and frustration that followed these developments were tempered by my decision to return to Peru in 1980. Together with Claudio Herzka and Helan Jaworsky, we founded the Group of Análisis for Development (GRADE) a think tank that has had a most distinguished track record. The lessons I learned in STPI figured prominently in the design of GRADE and its research program, and the first grant we obtained was provided by IDRC. Not surprisingly, science and technology policy research was one of the topics on which GRADE has worked during its more than three decades of existence.

I subsequently taught at the University of Pennsylvania during 1986-1987, and was later recruited by David Hopper, World Bank vice-President and former IDRC President, to become chief of the newly established strategic planning division of the World Bank in late 1987. I and returned to Lima in 1992 to create, with Max Hernández, FORO Nacional Internacional, a think-link-act tank that has been actively involved in democratic governance, development strategies and futures research. Now under the direction of Mario Bazán, FORO Nacional Internacional has become one of the leading Peruvian institutions working on science and technology policy institutions. While doing all of this this, in the 1990s and 2000s I became an advisor to Keith Bezanson, the president of IDRC, and later joined the IDRC Board of Governors for more than a decade.

By the time the STPI+40 gatherings took place. I had worked in science, technology and innovation policy issues during four and a half decades. These events made me to look back at what we did in the STPI project, examining what we expected would happen as a result of our work. They also allowed me to reflect on what have I learned about public policy design and implementation in fields as complex as science, technology and innovation for development.

Trying to avoid repeating what has been said in the preceding chapters, I would like to focus on just one lesson of experience, which has been reinforced by discussions with STPI network members in Paracas and Lima: the success or failure of science and technology policy initiatives is largely determined by a combination of political, technical and management factors.

First, it is essential to have the full commitment and support of political leaders at the highest level, and also the backing of leading business and academic personalities. This sounds banal, but experience has shown that indifference or lukewarm commitment to science and technology has been the rule in most developing countries. Capacity building in this field is a slow process, whose results are seen only in the long term, and immediate political gains and visible impact must be foregone for the sake of what appear to be rather uncertain outcomes. Understandably, politicians view with suspicion ventures that do not provide near term political advantages, and are reluctant to invest political capital and scarce resources in what the see as dubious initiatives. Politicians that combine conviction with the capacity to act in science, technology and innovation matters are few and far in between.

This places science and technology policy makers in an awkward position: should they wait for an enlightened leader to emerge, keeping their policy weapons ready for when he or she appears? Or, should they adopt guerrilla warfare tactics, using every small opportunity to advance piecemeal the cause of science and technology, hoping for an unlikely victory at some distant time? During the time of the STPI project and in the years after I have learned that both approaches are required. Bold proposals for building science and technology capabilities need to be prepared and be ready should opportunities arise, while actively engaging in specific activities that improve the situation, at least partially.

A paradoxical mindset is necessary for at least a modicum of success, for there is a need to integrate what appear contradictory stances: radical incrementalism and strategic opportunism. A radical vision in which science and technology provide the foundation for development efforts must be combined with incremental steps for advancing steadily towards it. A strategic perspective for institution building, priority identification and resource allocation must be combined with an opportunistic stance, seeking to take advantage of every possible circumstance to improve science and technology capabilities.

Second, a thorough understanding of the complexities of science and technology policy design and implementation is essential. Unfortunately, ignorance is all too common in a field that has established its legitimacy only a few decades ago. Scientific researchers, university professors, professional engineers, public administrators and businessmen often think that qualifications and experience in their own fields make them natural science and technology policy makers. In the years since the STPI project was carried out, I have frequently come across government officials and political appointees who do not consider it necessary to engage professionals in science and technology policy. Worse, as there is a dearth of such professionals in most developing countries, they could hot hire them even if there was the willingness to do so.

There is an urgent need to train researchers, policy makers and managers that understand what science, technology and innovation policies for development are all about. Ignorance of these matters is most dangerous, especially at a time when science and technology have become key in the knowledge society of the twenty-first century. This calls for establishing graduate degree programs in science and technology policy, technology management, research administration and similar fields; for creating short courses, conferences and professional events to enable continuous learning; and for supporting research institutions in this field.

Third, managerial competence is required to make things happen on the ground. Political commitment and policy knowledge are not sufficient to ensure success in mobilizing science and technology for development. This places a premium on the capacity to manage complex public policy undertakings in the rather unstable and bureaucratic administrative settings of most developing countries. STPI project findings made us aware that cumbersome regulations, excessive discretionary power, overlapping policy instruments and convoluted interactions between explicit and implicit policies, coupled with institutional inertia, risk avoidance and lack of incentives for public servants, make the design and implementation of science and technology policies a difficult proposition.

The inherent uncertainty involved in most science, technology and innovation activities, whose results cannot be know for sure in advance, mean that most government officials in developing countries find them difficult to handle. They usually face penalties for failure but no rewards for success, which makes them reluctant to take risky decisions that could harm their careers. Identifying and recruiting public servants who know how government agencies work, are interested in science and technology issues, and are willing to take risks is a high priority task.

Four decades of work in the field of science, technology and innovation policy have also taught me that success in policy design and implementation demands team effort, a supporting network of stakeholders, and empowering leadership. This is the only way in which the unusual combination of political commitment and acumen, substantive knowledge and understanding of policy issues, and administrative and managerial capabilities can be brought together.

The experience and lessons learned in the STPI project have had a profound impact on the way I have approached all the research and policymaking tasks I have been involved in. The STPI+40 events in Paracas and Lima in August 2013 brought this, once again, clearly to mind. I am most grateful to Geoffrey Oldham, Máximo Halty and those who made the STPI project possible, and to the friends and colleagues who taught me so many things during the early stages of my professional career.

**ANNEXES**

Institutes and Countries Participating in the STPI Project

| | |
|---|---|
| Argentina | Secretaria Ejecutiva del Consejo Latinoamericano de Ciencias Sociales (CLACSO)<br>Country Coordinator: Eduardo Amadeo |
| Brazil | Financiadora de Estudos e Projetos (FINEP)<br>Country Coordinator: Fabio Erber (until September 1974) and José Tavares |
| Colombia | Fondo Colombiano de Investigaciones Cientificas y Proyectos Especiales "Francisco José de Caldas" (COLCIENCIAS)<br>Country Coordinator: Fernando Chaparro |
| Egypt | Academy of Scientific Research and Technology<br>Country Coordinator: Adel Sabet (until July 1975) and Ahmed Gamal Abdel Samie |
| India | National Committee on Science and Technology<br>Country Coordinator: Anil Malhotra (until July 1975) and S.K. Subramanian (until March 1976) |
| South Korea | The Korea Advanced Institute of Science (KAIS)<br>Country Coordinator: KunMo Chung |
| Mexico | El Colegio de Mexico<br>Country Coordinator: Alejandro Nadal |
| Peru | Instituto Nacional de Planificación (INP)<br>Country Coordinator: Enrique Estremadoyro (Until February 1975) and Fernando Otero.<br>Technical Directors: Fernando Gonzales Vigil (until February 1975) and Roberto Wangeman |
| Venezuela | Consejo Nacional de Investigaciones Cientificas y Tecnologicas (CONICIT)<br>Country Coordinator: Dulce de Uzcategui (until July 1974) and Ignacio Avalos |
| Yugoslavia (Macedonia) | Faculty of Economics, University of Skopje<br>Country Coordinator: Nikola Kljusev |

Source: Francisco Sagasti, Science and technology for development: main comparative report of the Science and Technology Policy Instruments Project. Ottawa, Ont., IDRC, 1978. p. 102.

Chronology of the International Component of the STPI Project

| | |
|---|---|
| February 1971 | Initial idea put forward at a meeting of Latin American science policy organizations in Lima and Cuzco, Peru. |
| January 1972 | Meeting at the Science Policy Research Unit, Sussex University, to discuss project identification report commissioned by IDRC. |
| August/November 1972 | Feasibility studies carried out in Peru and Argentina sponsored by OAS. |
| January 1973 | Project identification meeting convened at Barbados by IDRC. Project proposal prepared by participants. |
| June 1973 | IDRC Board of Governors approves funding of international component and of some country proposals. |
| June/December 1973 | Country teams established. |
| August 1973 | Field coordinator appointed and first meeting of the coordinating committee, Rio de Janeiro, Brazil. |
| October 1973 | Field coordinator's office established in Lima, Peru. |
| December 1973 | IDRC Board of Governors approves funding of the rest of country proposals. |
| January 1974 | Working meeting held in Lima to discuss methodological guidelines. |
| April 1974 | Field coordinator's office staff appointed. |
| May 1974 | Second coordinating committee meeting held in Mexico City. |
| November/December 1974 | Third coordinating committee meeting held in Cairo, Egypt. |
| April 1975 | Working meeting on technology transfer held in Ohrid, Macedonia (Yugoslavia). |
| May 1975 | Working meeting on science and technology planning held in Villa de Leyva, Colombia. |
| July 1975 | Fourth coordinating committee meeting held in Seoul, South Korea. Discussion started on procedures for drafting comparative reports. |
| August 1975 | Working meeting on state enterprises and technology policies held in Buenos Aires, Argentina. |
| November 1975 | Working meeting on consulting and engineering design organizations held in Naiguatá, Venezuela. |
| December 1975 | Extension of the international component agreed by IDRC. |
| January 1976 | Fifth coordinating committee meeting held in New Delhi, India. Agenda and procedures for Sussex workshop agreed. |
| June/July 1976 | Sussex workshop held to prepare drafts of main comparative report and review other reports for publication. Editorial Committee appointed. |
| December 1976 | Field coordinator's office closed down. Field research concluded. |
| January 1977/April 1978 | Preparation of STPI comparative reports and meeting of the Editorial Committee to revise the material prepared by the field coordinator. |

Source: Francisco Sagasti, Science and technology for development: main comparative report of the Science and Technology Policy Instruments Project. Ottawa, Ont., IDRC, 1978. p. 103.

**STPI publications prepared during dissemination phase**

(Note: this list does not consider the reports produced by the STPI teams)


Main reports

- Dean, G. C. (1979). Science and technology for development : technology policy and industrialization in the People's Republic of China. Ottawa: IDRC.
- Sagasti, F. (1978a). Ciencia y tecnología para el desarrollo : informe comparativo central del Proyecto sobre Instrumentos de Política Científica y Tecnológica. Ottawa: IDRC.
- Sagasti, F. (1978b). Science and technology for development : main comparative report of the Science and Technology Policy Instruments Project. Ottawa: IDRC.
- Sagasti, F., & Aráoz, A. (1975a). Estudios de los instrumentos de política científica y tecnológica en países de menor desarrollo: pautas metodológicas para el proyecto de IPCT. Ottawa: IDRC
- Sagasti, F., & Aráoz, A. (1975b). Science and technology policy implementation in less - developed countries : methodological guidelines for the STPI project. Ottawa: IDRC.
- Sagasti, F., & Aráoz, A. (Eds.). (1979). Science and technology for development : planning in the STPI countries.

STPI modules

- Aráoz, A. (1980a). Science and technology for development : policy instruments to build up an infrastructure for the generation of technology. Ottawa: IDRC.
- Aráoz, A. (1980b). Science and technology for development : present situation of science and technology in the STPI countries. Ottawa: IDRC.
- Barrio, S. (1980). Science and technology for development : policy instruments to define the pattern of demand for technology. Ottawa: IDRC.
- Cardettini, O., Sagasti, F., Garrido Lecca, G., & Gonzalez Vigil, F. (1980). Science and technology for development : the evolution of industry in STPI countries. Ottawa: IDRC.
- Sagasti, F. (1980a). Policy instruments to promote the performance of S and T activities in industrial enterprises. Ottawa: IDRC.
- Sagasti, F. (1980b). Science and technology for development : a review of schools of thought on science, technology, development, and technical change. Ottawa: IDRC.

- Sagasti, F. (1980c). Science and Technology for development : the evolution of science and technology in STPI countries. Ottawa: IDRC.

- Science and Technology Policy Instruments Project. (1980). Science and technology for development : policy instruments for the regulation of technology imports. Ottawa: IDRC.

- Sercovich, F. (1980a). Science and technology for development : case studies on technological change. Ottawa: IDRC.

- Sercovich, F. (1980b). Science and technology for development : technical changes in industrial branches. Ottawa: IDRC.

- Sercovich, F. (1980c). Science and technology for development : technology behavior of industrial enterprises. Ottawa: IDRC.

- Tillett, A. D., Barrio, S., & Chung, K. (1980). Science and technology for development : policy instruments for the support of industrial science and technology activities. Ottawa: IDRC.

STPI working papers

- Amadeo, E. P. (1982). Instrumentos de política científica y tecnológica en Argentina : una síntesis de Proyecto STPI. IDRC. Manuscript reports / IDRC 36s.

- Amadeo, E. P., Fernández, R. F., & Morales, F. (1982). Argentine's machine tool sector. Ottawa. Manuscript reports / IDRC 35e.

- Barrio, S. (1981). Rol de los bancos en la comercialización de tecnología. IDRC. Manuscript reports / IDRC 38.

- Contreras Q., C., Sercovich, F., Malhotra, A., & Nadal Egea, A. (1980). Technology transfer in developing countries. IDRC. Manuscript reports / IDRC 23.

- Malhotra, A. K. (1980). Consulting and design engineering capabilities in developing countries. IDRC. Manuscript reports / IDRC 22.

- Oldham, G., Cardettini, O., & Halty-Carrère, M. (1980). Science and technology policy and development. IDRC. Manuscript reports / IDRC 21.

- Oszlak, O., Cavarozzi, M., & Sonnino, S. (1982). INTI y el desarrollo tecnológico en la industria Argentina. IDRC. Manuscript reports / IDRC 34s.

- Universidade de Brasília, Versiani, F. R., & Bastos, V. L. (1982). Brazilian machine tool industry : patterns of technological transfer and the role of the government. IDRC. Manuscript reports / IDRC 37e.

- Villanueva, M. (1981). Comportamiento tecnológico de las empresas mixtas en la industria petroquímica. IDRC. Manuscript reports / IDRC 39s.

STPI-related publications and reports

- Contreras Q., Carlos. 1979. Transferencia De Tecnología a Países En Desarrollo. Caracas: Instituto Latinoamericano de Investigaciones Sociales – ILDIS.

- Halty-Carrere, Maximo. 1979. Technological Development Strategies for Developing Countries: a Review for Policy Makers. Montreal: Institute for Research on Public Policy.

- United Nations Advisory Committee on Science and Technology for Development. 1989. "Science, Technology and Development: The Imperative of Social Innovation: a Declaration of Present and Former Members of the Advisory Committee on Science and Technology for Development on the Occasion of the Tenth Anniversary of the Vienna Programme of Action."

- United Nations Preparatory Committee for the United Nations Conference on Science and Technology for Development. 1979. "Science and Technology and the Concept of Development: Consolidated Paper Related to the Discussion of Items 4, 5 and 6 of the Provisional Agenda of the Conference Prepared by the Secretary General of the Conference." In United Nations Conference on Science and Technology for Development. A/CONF.81/PC/37.

- Halty-Carrere, Maximo. 1986. Estrategias De Desarrollo Tecnológico Para Países En Desarrollo. México D.F.: El Colegio de México.

## Annex D

## List of participants with STPI+40 event

*STPI network members*

**Eduardo Amadeo**

*STPI coordinator for Argentina.*

*Argentinean politician from Justicialist Party. He studied Economics at Catholic University of Buenos Aires (UBA). He has been elected to Congress as a representative for the province of Buenos Aires. He served as president of Banco de la Provincia de Buenos Aires between 1987-1991, Secretary of Social Development of Argentina between 1994-1998 and Argentine Ambassador to the United States between 2002-2003. He was deputy chief of the Cabinet of Ministers and spokesperson for President Eduardo Duhalde. In 2003 he was Chief of Staff of the Common Market Council of Southern Common Market (Mercosur). Specialized in social policy he is working to support public institutions willing to improve the administration of their social resources through the Social Observatory Foundation.*

**Alberto Aráoz**

*Consultant for STPI.*

*Alberto Araoz is currently a Senior Associate of Managing Across Cultures, an international corporate collaboration consulting firm. In recent years he was Visiting Scholar at MIT, the Fletcher School at Tufts University and the College of Management, University of Massachusetts, Boston. In 1998-92 he was Deputy Director-General of UNIDO, the United Nations Industrial Development Organization, in charge of Technology and Investment, with responsibility for technical cooperation for developing countries as well as overseeing three major projects, the Latin American Network of Microelectronics (REMLA), the International Centre for Science and High Technology (ICS), and the International Centre for Genetic Engineering and Biotechnology (ICGEB). He was previously Vice President of the National Institute of Industrial Technology of Argentina and Senior Adviser on Science and Technology at the Bank of the Province of Buenos Aires. He has authored a number of publications including several books.*

**Ignacio Ávalos**

*STPI Coordinator for Venezuela*

*A sociologist from the Central University of Venezuela, specialized in Science, Technology and Innovation Policies. He is the director of the Association for Technological Innovation (INNOVAVEN) in Venezuela, a professor at the Central University of Venezuela, the director of the Non-profit pro-democratic organization Observador Electoral Venezolano (OVC) and biweekly columnist for the Venezuelan newspaper El Nacional. He is former president of the International Council for Scientific and Technological Research (CONICIT) in Venezuela, and board member of the National Electoral Council. As a consultant he has worked with a number of national and international organizations and authored numerous publications.*

## Sergio Barrio Tarnawiecki

*Consultant of the STPI Field Coordination Office*

*Consultant, trained as an economist at the Université de Paris (La Sorbonne, IEDES), Master on Democracy and Education in Values at the University of Barcelona. He has done research and policy design in the field of science and technology policies since 1967 at the OECD, DSA, at SPRU, Sussex University, at the Andean Pact, Cartagena Agreement, now Andean Community, at the CONICYT in Venezuela and has been a member of the STPI team. He was honoured with a First Prize in an essay he wrote on the human rights issue. He has rendered services as a consultant for a number of international organizations such as UNIDO, CAF, and for NGO such as CARE, KALLPA, and has been a teacher at postgraduate master courses at the UCV in Venezuela, and UNI and UNSMP Lima, Perú. He is the author of a number of publications in the field of Science and Technology and humanistic issues.*

## Onelia Cardettini

*Member of the STPI Field Coordination Office*

*Onelia Cardettini was co-Head of the Department of Environment and Municipal Administrator in Mitrovica at the United Nations Interim Administration Mission in Kosovo (UNMIK). Previously, she has worked as Regional Director at the Organization for Security and Co-operation in Europe (OSCE), in Tuzla and Croatia. In the STPI project she co-authored "Science and Technology for Development, The Evolution of Industry in STPI Countries", and "Science and Technology Policy and Development".*

## Fernando Chaparro

*STPI Coordinator for Colombia*

*Fernando Chaparro holds an M.A. and Ph.D. degrees in sociology from Princeton University (N.J., USA). Currently he is Adviser in Strategic Planning and in Knowledge Management practices at the Universidad Central in Bogotá, Colombia and member of the "Consejo Asesor" of ANECA in Spain (National Accreditation Agency of Spain), and of the "Consejo Superior" of the Universidad Nacional de Colombia. He has been General Director of the Colombian Agricultural Research Corporation (CORPOICA); Director General of COLCIENCIAS; Executive Secretary of the Global Forum on Agricultural Research (GFAR) based in Rome, Italy; and Regional Director for Latin America and the Caribbean of IDRC of Canada. He has been Chairman of the Board of Trustees of the "International Center for Tropical Agriculture"; Chairman of the Board of the Latin American Agricultural Technology Fund (FONTAGRO); Chairman of the Steering Committee of the Global Forum on Agricultural Research (GFAR); and Chairman of the National Accreditation Council (CNA) of Colombia. He has written several articles and books on issues related to research policy, technological development and innovation dynamics.*

## KunMo Chung

*STPI Coordinator for Korea*

*Dr. KunMo Chung is an internationally known energy engineer and science policy specialist. He served twice as Minister of Science and Technology in the South Korean government. Professor Chung also served as President and CEO of the Korean Academy of Science and Technology. Dr. Chung was formerly President of Korea Power Engineering Company and has served as Chairman and CEO of the Korea Science and Engineering Foundation. Currently, Dr. Chung is Distinguished Invited Professor at Ajou University in Korea and Distinguished Research Professor at George Mason University in Virginia, USA. He also serves as Advisor to Korea Electric Power Corporation.*

## Carlos Contreras

*Member of the STPI Field Coordination Office*

Carlos Contreras Quina is a lawyer and independent consultant. He is director of the Forum's Latin America 2010 and visiting professor in the Master of Latin American Studies offered by the Casa de America and Universidad Complutense de Madrid, and the University of Extremadura. He has been Executive Secretary of the South American Peace Security and Democracy Commission, and Coordinator of the Analytical Committee of the Financial Systems for Science and Technology for Development at United Nations. He was in charge of the implementation of the Technological Information Network for Latin America by UNCTAD, GENEVA. He is a member of the Advisory Board of the magazine Quorum, at the University of Alcalá de Henares, Spain and author of several articles and essays and books. He has been coordinator of "América Latina en el Siglo XXI. De la esperanza a la equidad." Fondo de Cultura Económica.

## Mauricio de María y Campos

*STPI Co-coordinator for Mexico*

Mauricio de María y Campos obtained a BA Degree in Economics at the Mexican National Autonomous University and a Masters Degree of Arts in Economic Development at Sussex University. He currently is Director of Instituto de Investigaciones sobre Desarrollo Sustentable y Equidad Social (IIDSES) at Universidad Iberoamericana, member of and former president of Mexican Council on Foreign Relation (COMEXI), member of Center of International Negotiations Studies (CAENI) y and member of Tepoztlán Center. He is the former Director-General of the United Nations Industrial Development Organization (UNIDO) and former Mexican Ambassador to South Africa.

## Alejandro Nadal

*STPI Co-coordinator for Mexico*

Alejandro Nadal holds a B.A. in Law from the National Autonomous University of Mexico and a Ph.D. in Economics from the University of Paris X (Nanterre). Alejandro Nadal is a professor and researcher at El Colegio de México, where he researches on comparative economic theory and economics of technological change. He is journalist on economics and sustainability in La Jornada, one of Mexico's leading national newspapers. He was chair of the Collaborative Research Competition and visiting scholar of the John D. and Caherine T. MacArthur Foundation. He has carried out research on macroeconomics, general equilibrium theory, technological change, nuclear weapons and sustainable resource management. He is member of the editorial board of a number of journals, and has written several articles and book chapters.

## Geoffrey Oldham

*Former Director of the Science and Technology Policy Programme at IDRC*

Honorary Professor with Science and Technology Policy Research Unit (SPRU) at the University of Sussex, United Kingdom. He was a member of the team which designed and drafted the Act of the Canadian Parliament which established the International Development Research Centre. He directed the Centre's Science and Technology Policy Programme for ten years and served as Science Adviser to the President of IDRC from 1992 to 1996. He was chairman of the UN Advisory Committee on Science and Technology for Development and the UK delegate to the UN Commission on Science and Technology for Development. He was an adviser to China's Minister of Science and Technology from 1997 to 2000.

## Francisco Sagasti

*Director of the STPI Field Coordination Office*

*Francisco Sagasti is senior researcher and former Director of FORO Nacional Internacional, member of the International Institute for Environment and Development (IIED) board and the advisory council of the Lemelson foundation, and advisor of international and Peruvian organizations. He has been Chairman of the Board of the Science and Technology Program at the Prime Minister's Office in Peru, member of the Board of Governors of the Canadian Center for International Development Research (IDRC), founder and former Executive Director of GRADE, a Peruvian think-tank. He has also been Chief of Strategic Planning at the World Bank, Chairman of the United Nations Advisory Committee on Science and Technology, visiting professor at the Wharton School of the University of Pennsylvania, the Instituto de Empresa in Madrid, and the University for Peace in Costa Rica. He has published many books and academic papers, and has produced a TV series on development issues.*

## Francisco Sercovich

*STPI Consultant*

*Francisco C. Sercovich holds a Ph.D. in Economics, University of Sussex, U.K. and a Master in Political Economy, University of Buenos Aires, Argentina. His recent and current positions include: Senior Advisor, Ministry of STI, Argentina; Professor, University of Buenos Aires; Fulbright Scholar; Visiting Scholar, Universities of Harvard and Columbia, U.S.; Visiting Professor, Universities of Quebec in Montreal, Canada, and Hofstra, U.S.; Director of Policy Research and Senior Advisor on Policies to the Director-General, UNIDO; Director, Industrial Development Reports, UNIDO; Chair, Task Force on Economic Development, United Nations Inter-Agency High Level Committee on Programmes; Member of the UN's Millennium Project's Expert Group and Task Force on STI. He has published numerous books and articles in refereed journals including: F.C. Sercovich et al., Competition and the World Economy, Edward Elgar, 1999, U.K.; China and the W.T.O. – The Birth of a New Catching-up Strategy (with collaborators), Palgrave Macmillan, 2002, U.K.*

## José Távares

*STPI Coordinator for Brazil*

*José Távares holds a PhD in Economics from the University of London. He is director of Centro de Estudos de Integração e Desenvolvimento (CINDES) and has been Secretary of the Brazilian Chamber of Foreign Trade (CAMEX) and consultant for international organizations such as the World Bank, Inter-American Development Bank (IADB), Organization of American States (OAS), Economic Commission for Latin America and the Caribbean (ECLAC), Caribbean Community (CARICOM), United Nations Industrial Development Organization (UNIDO), among others*

## *José Roberto Wangeman Silva*

*STPI Coordinator for Peru*

*An economist from the Pacific University of Peru, with a Master's Studies in Development Planning from the American Graduate School in Economics (ESCOLATINA, Chile). He has professional experience working with government agencies in national and industrial planning, the Corporation of Promotion of the Production (CORFO, Chile) and the Institute of National Planning (INP, Peru). He has consulted and trained NGOs on how to promote the development of rural and industrial self-management organizations (CIDIAG, Peru). During the past twenty-four years he has worked as an independent consultant, developing advisor and trainer in strategic planning, design, monitoring, evaluation and systematization of development projects on the topics of: rural development, environment, indigenous issues, intercultural and bilingual education, and gender and human rights—in general projects funded by European cooperation agencies and multilateral institutions.*

S&T policy researchers and policy-makers

Alejandro Afuso (Peru)
Belén Baptista (Uruguay)
Mario Bazán (Peru)
Tran Ngoc Ca (Vietnam)
Rafael Castillo (Peru)
Susan Cozzens (United States)
Gustavo Crespi (Argentina)
Isaías Flit (Peru)
Marco Kamiya (Venezuela)
Claudio Herzka (Peru)
Juana Kuramoto (Peru)
Erika Kraemer-Mbula (South Africa)
Xue Lan (China)
Modesto Montoya (Peru)
Tavinder Nijhawan (Canada)
Paul O'Brien (Peru)
Ben Petrazzini (Canada)
Zoraida Portillo (Peru)
Mónica Salazar (Colombia)
Amitav Rath (Canada)
Fernando Villarán (Peru)

# Annex E

## STPI+40 Events Day by Day Program

40$^{TH}$ ANNIVERSARY OF THE SCIENCE AND TECHNOLOGY POLICY INSTRUMENTS PROJECT MEETING

Paracas, Peru. August, 3$^{rd}$ and 4$^{th}$ ,2013.

Lima, Peru. August, 5$^{th}$ to 7$^{th}$,2013.

**DAY BY DAY PROGRAM**

(Revised July 31, 2013)

STPI+40

Looking back to move forward

***FIRST PART OF THE EVENT***

HOTEL BAHÍA DE PARACAS

Paracas, Peru. August, 3rd and 4th, 2013.

| DAY 1 | Saturday, August 3rd 2013*(For members of the original STPI network only)* | |
|---|---|---|
| | *Summary: Travel to Paracas , initial session, individual interviews, inaugural dinner* | |
| **Time** | **Activity** | **Notes** |
| **9:00 – 12:30** | Travel to Paracas by bus. | The bus will pick you up from the Hotel Sol de Oro. One member of FORO Nacional Internacional will meet you at the hotel lobby. The bus will depart on time to Paracas (no later than 9:30am) so be sure to take all your belongings with you and have everything ready to go |
| **12:30 – 13:30** | Registration at the hotel Bahia de Paracas | |
| **13:30 - 15:30** | Lunch and informal discussion | |
| **15:30 – 16:30** | • Initial presentation and informal guided discussions to extract lessons from the experience of STPI national teams<br>• Individual video interviews | Chair: F. Sagasti<br>Video interviews coordinated by M. Bazán |
| **16:30 - 17:00** | Coffee Break | |
| **17:00 – 18:00** | • Informal discussions on the experience of STPI national teams and international implications<br>• Individual video interviews | Chair: F. Sagasti<br>Video interviews coordinated by M. Bazán |
| **18:00 – 20:00** | Personal time | |
| **20:00 – 21:30** | Inaugural dinner: remarks by G. Oldham, F. Sagasti and T. Nijhawan | |

HOTEL BAHÍA DE PARACAS. Paracas, Peru

| DAY 2 | **Sunday, August 4th 2013*(For members of the original STPI network only)*** | |
|---|---|---|
| *Summary: STPI lessons, experience and impacts in participating countries, Contemporary S&T Policy issues in the light of what was learnt in the STPI Project* | | |
| **Time** | **Activity** | **Notes** |
| **8:30 – 10:00** | Working session:<br>*The STPI Project – lessons of experience …* | Chair: F. Sagasti |
| **10:00 - 10:15** | Coffee Break | |
| **10:15 - 11:30** | *…and impact in participating countries and at the international level.* | Chair: M. Bazán |
| **11:30 – 13:30** | Paracas Tour (Optional, Individual arrangements) | |
| **13:30 – 14:30** | Lunch | |
| **15:30 - 17:00** | Working session:<br>*Contemporary science and technology policy issues in the light of what was learnt in the STPI project* | Chair: F. Sagasti<br>Video link by Skype with Anil Malhotra and Jose Tavares |
| **17:00 – 17:15** | Coffee Break | |
| **17:15 - 19:00** | Working session:<br>*Lessons for the current and future generations of policy researchers* | Chair: G. Oldham<br>Video link by Skype with Anil Malhotra and Jose Tavares |
| **20:00 – 21:30** | Dinner | |

## SECOND PART OF THE EVENT

SOL DE ORO HOTEL AND SUITES. Lima, Peru.

| DAY 3 | Monday, August 5th 2013 | |
|---|---|---|
| *Summary: Former STPI network members travel from Paracas to Lima, participants registration, inaugural lunch, introduction to the STPI Project and its results, general discussion, reception with Peruvian authorities* | | |
| **Time** | **Activity** | **Notes** |
| **8:30 – 12:00** | Travel to Lima from Paracas | |
| **12:00 – 13:00** | Registration at the Sol de Oro Hotel & Suites | |
| **13:00 – 14:30** | Lunch at the hotel for international guests | |
| **14:30 – 16:00** | Opening session:<br>*"Six decades of S&T policy research "*<br>• Keynote speech by Dr. Geoffrey Oldham<br>• Comments by: K. Chung, A. Nadal, X. Lan | Chair F. Sagasti |
| **16:00 – 16:15** | Coffee Break | |
| **16:15 – 18:15** | Working session 2:<br>*The STPI project: approach, organization and results*<br>• Francisco Sagasti,<br>• Comments by M. María Campos, O. Cardettini, F. Chaparro.<br>*The STPI project: forty years later*<br>• Juana Kuramoto<br>• Comments by A. Nadal, A. Araoz, M. Kamiya<br>• General discussion | Chair M. Bazán |
| **19:00 – 19:15** | | Meet at the hotel Lobby to take the shuttle bus to the reception |
| **19:30 – 21:00** | Reception with national S&T Authorities | Spouses are welcome to come |
| **21:00** | Return to the hotel | |

SOL DE ORO HOTEL AND SUITES. Lima, Peru.

| DAY 4 | Tuesday, August 6TH 2013 | |
|---|---|---|
| *Summary: International context and implications for S&T policy, current S&T Policy Research, 21st century S&T Innovation Policies in the light of the STPI experience, issues for the next 40ty years in ST Policy and cultural activity* | | |
| **Time** | **Activity** | **Notes** |
| **9:00 – 10:30** | Working session 3:<br>*The New International context of S&T policy:*<br>• Lead interventions A.Rath, S.Barrio, C.Contreras, F. Sercovich, B, Petrazzini(six minutes each)<br>• General discussion | Chair F. Sagasti |
| **10:30 – 11:00** | Coffee Break | |
| **11:00 - 13:00** | Working session 4:<br>*Current S&T Policy Research issues and prospects*<br>• Lead interventions S. Cozzens, G. Crespi, M. Salazar, T. Ngoc Ca, E. Kramer (six minutes each)<br>• General discussion | Chair M. Bazán |
| **13:00 – 14:30** | Lunch at the hotel for international guest | |
| **14:30 – 15:00** | Break | |
| **15:00 – 16:30** | Working session 5:<br>*21st century S&T Innovation Policies in the light of the STPI experience*<br>• Panel with STPI country coordinators | Chair F. Sagasti |
| **16:30 – 16:45** | Coffee Break | |
| **16:45 – 18:00** | Working session 6:<br>*Issues and research issues for the next 40 years in S&T Policy*<br>• Open discussion | Chair G. Oldham |
| **18:00 – 18:30** | Transport leaves toLarco Herrera Museum | Will meet at the hotel lobby at 6:00pm to take the bus to the Larco Museum, Spouses are welcome to come |
| **19:00 – 20:15** | Larco Herrera Museum of Anthropology and Archeology | |
| **20:15 - 21:30** | Dinner at the Café del Museo Restaurant | |
| **21:30** | Return to the Hotel | |

SOL DE ORO HOTEL AND SUITES. Lima, Peru.

| DAY 5 | Wednesday, August 7TH 2013 | |
|---|---|---|
| *Summary: International context and implications for S&T policy researchers, future agenda for next 40 years and cultural activity* | | |
| **Time** | **Activity** | **Notes** |
| **9:00 – 10:15** | Working session 7:<br>*Identification of science, technology and innovation research priorities*<br>• Lead interventions J.Kuramoto, S.Cozzens, G.Crespi, X.Lan, A. Araoz (six minutes each)<br>• Open discussion | Chair M. Oldham |
| **10:15 – 10:30** | Coffee break | |
| **10:30 - 12:00** | Concluding session:<br>*Summary, conclusions and follow up initiatives*<br>• Francisco Sagasti and Geoffrey Oldham<br>• Comments by T. Nijhawan/B.Petrazzini | |
| **12:30 - 16:00** | Farewell lunch at Francisco Sagasti's house | Will meet at the hotel lobby at 12:30 to take the bus to Francisco Sagasti´s house. Participants leaving Peru today are advice to check out from the hotel early morning and leave their luggage at the hotel lockers, or take it with them to Francisco´s house to go directly from Francisco´s House to the airport. |
| End of the event | | |

FORO Nacional Internacional

STPI+40

Looking back to move forward

# LOOKING BACK TO MOVE FORWARD

**A forty-year retrospective of the Science and Technology Policy Instruments (STPI) project**