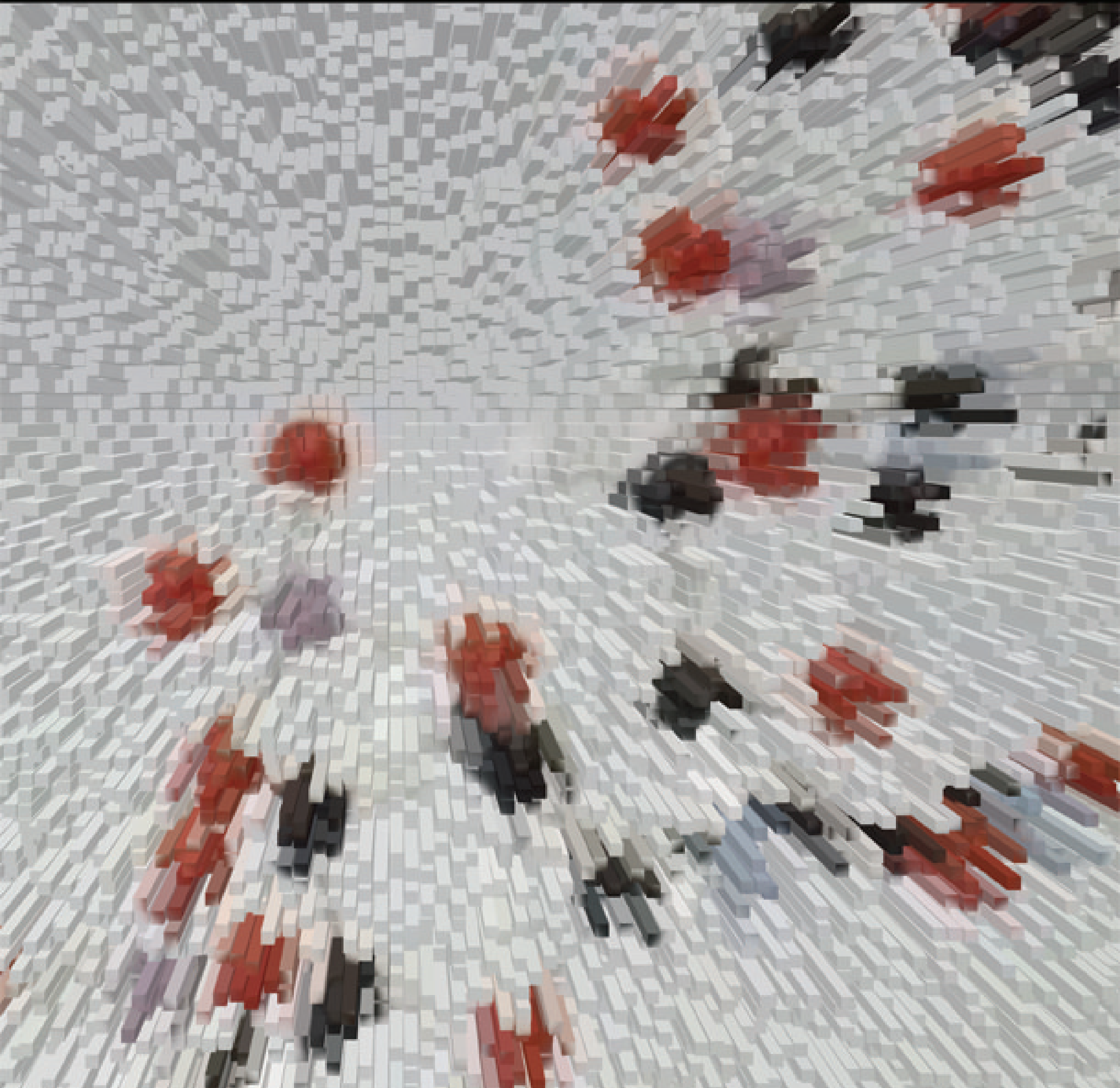
Science, Technology, Engineering and Innovation for Development

A vision for the Americas in the Twenty First Century



Organization of American States
Office of Education, Science and Technology

Science, Technology, Engineering and Innovation for Development

A Vision for the Americas in the Twenty First Century

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A Vision for the Americas in the Twenty First Century

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Preface to the Second Edition

The unprecedented advances of scientific and technological knowledge of the last centuries continue to accelerate, with great potential to improve the quality of life of the world's population and with profound implications for the global economy. Experience through the years has demonstrated that it is unthinkable to separate a nation's socioeconomic and cultural development from its advances in or use of science and technology to solve major problems.

Despite these immense possibilities, only a fraction of the global population has benefited from the advances of science and technology and improvements in living standards. Increasing worldwide poverty, which affects 1.3 billion people today, evidences that current development strategies have not achieved the expected results. For this reason, it is crucial that all countries, large and small, rich and poor, take advantage of science, technology and innovation as fundamental elements for their development strategies, poverty reduction and the construction of a Knowledge Society.

This publication entitled "Science, Technology, Engineering and Innovation for Development: A Vision for the Americas in the Twenty First Century" was prepared with the input and collaboration of distinguished scientists, experts and government officials from the Americas. It aims to contribute in the formulation of this new approach, focused on capacity building, which if developed and strengthened in our countries will greatly favor their advancement, position and integration to the world.

The development and maintenance of a national science and technology capacity will allow our countries to be more than just consumers of other nations' technological exports and allow citizens to actively improve their own situation and social and economic well-being. A country that does not recognize this, as well as the importance of investing in its science and technology capacity, required in the Knowledge Society, will find itself lagging behind in the race for progress.

For this reason, and given that the Fourth Summit of the Americas will take place soon in Mar del Plata, I consider that this a timely occasion to present you with the second edition of this publication. I am sure that, considering the crosscutting nature of science, technology and innovation, the recommendations and thoughts presented here will help the member states in the formulation of their national development policies and strategies, with emphasis on capacity building for creating decent work, fighting poverty and strengthening democratic governance, all of which are central themes of the Fourth Summit of the Americas.

José Miguel Insulza
Secretary General
Organization of American States

Washington, D.C., October 24, 2005

Preface to the First Edition

In our time, science, technology, engineering, and innovation play a fundamental role in the creation of wealth, economic growth and the improvement of the quality of life for all citizens of the Americas. These areas are engines of integral development. They generate employment and well-being through innovation and the commercialization of new products and services; they help reduce poverty, improve education, health, nutrition, and trade; and are essential for building new capacities required in the 21st century.

Through the Summit of the Americas Process, our Heads of State and Government have promoted and encouraged the development of science and technology and its inclusion as a crosscutting dimension of development strategies in the countries of the hemisphere. As the Technical Secretariat of numerous sector-specific projects and within the framework of the Inter-American Council for Integral Development (CIDI), the General Secretariat of the Organization of American States (OAS) is organizing the First Meeting of Ministers and High Authorities of Science and Technology to be held in Lima, Peru, in November 2004.

Since the last meeting of high-level science and technology authorities which took place more than eight years ago, with the support of the member states and the Inter-American Committee on Science and Technology (COMCYT), the OAS Office of Education, Science and Technology (OEST) has organized a series of technical workshops to identify and analyze hemispheric priorities in this area. The result of this work has been compiled in this publication, which we present to the member states with the hope that it may prove to be a useful contribution to the design and formulation of new policies in science and technology.

The OAS has played a historic role in supporting sector-specific efforts that are contributing to a comprehensive integration process in the hemisphere. The human spirit that characterizes our region can never be confined to finite endeavors. We trust that this publication will provide valuable input and serve as a catalyst for new initiatives in science, technology, engineering, and innovation.

Luigi R. Einaudi
Acting Secretary General
Organization of American States

Washington, D.C., October 18, 2004

Acknowledgments

The Office of Education, Science and Technology (OEST) of the Organization of American States (OAS) expresses its gratitude to the experts of the Americas who participated in the hemispheric workshops carried out within the Project in Hemispheric Cooperation in the Development of Science and Technology Policy. Their knowledge, experience, and vision provided the main elements for the discussion and the formulation of policies and strategies for the Hemisphere in the priority areas of science and technology addressed during the workshops.

The OEST also expresses its deepest appreciation to the Secretariat of Science, Technology and Productive Innovation (SECYT) of Argentina; the Foundation for Science and Technology (FUNDACYT) of Ecuador; the Museum of Astronomy and Related Sciences (MAST) and the Ministry of Science and Technology of Brazil; and the National Commission on Science and Technology (NCST) of Jamaica for their important contributions in the organization and development of the hemispheric workshops. The support of the National Science Foundation of the United States is also acknowledged.

The OEST is also grateful to the member countries of the OAS and the delegates of the Inter-American Committee on Science and Technology (COMCYT) for their encouragement and support.

Although this document reflects the discussions that took place in all the events mentioned in this introduction, the responsibility for writing this final version has rested with the Office of Education, Science and Technology of the OAS. We hope that we were able to be faithful to the ideas and proposals that were expressed during this process.

Alice Abreu
Director
Office of Education, Science and Technology
Organization of American States

Washington, D.C., October 18, 2004

Introduction

“To strengthen democracy, create prosperity and realize human potential, our Governments will [in the area of science and technology]: Promote the popularization of science and technology necessary to advance the establishment and consolidation of a scientific culture in the region; and stimulate the development of science and technology for regional connectivity through information and communications technologies essential for building knowledge-based societies; support the development of high-level human capital for the development of science and technology research and innovation that would encourage the strengthening of the agricultural, industrial, commercial and business sectors as well as the sustainability of the environment; and promote, with the support of existing cooperation mechanisms, the development of the regional program of science and technology indicators. . . ”

Quebec Plan of Action, Third Summit of the Americas, December 2001

“. . . We agree that scientific and technological research and development plays an important role in creating and sustaining productive economies. We will continue to formulate policies and guidelines that support public and private research associations and promote their interaction with the productive sectors, taking into account the requirements and objectives of our countries. We will continue to enhance investments in the area of science and technology, with the participation of the private sector and the support of multilateral organizations. Accordingly, we will strive to improve effective and equitable access to, and transfer of, technology. We will also redouble our efforts to encourage our universities and higher institutions of science and technology to multiply and strengthen the links among them, and deepen basic and applied research. In all of these undertakings, we commit to the protection of intellectual property in accordance with both national laws and international agreements. . . . In an endeavor to close the digital divide, both within and between our countries, we are committed to the Declaration of Principles of the World Summit on the Information Society, and the continued implementation of the Agenda for Connectivity in the Americas and Plan of Action of Quito. We therefore reaffirm our commitment to build a people-centered, inclusive, and development-oriented information society, inspired by objectives of social inclusion, poverty reduction, and progress in the framework of balanced economic and social development.”

Declaration of Nuevo León, Special Summit of the Americas, Monterrey, Mexico, January 2004

General Frame of Reference

Within the new Process of the Summit of the Americas, from the First Summit held in Miami, Florida, in 1994 to the Special Summit of Monterrey held in Monterrey, Mexico, in the beginning of 2004, science and technology has been recognized as a vital area for the development of the Western Hemisphere. In this regard, the efforts of the Office of Education, Science and Technology (OEST) of the Organization of American States (OAS) are oriented to following up on the mandates emanating from the Summit of the Americas Process and the ministerial-level meetings in science and technology ratified by the corresponding OAS political bodies, including the Inter-American Council for Integral Development (CIDI) and the Inter-American Committee on Science and Technology (COMCYT).

Aware of the importance of science and technology to the cultural and socioeconomic development of nations, the great heterogeneity among the countries of the Hemisphere in their levels of scientific and technological capacities, the need to close this gap so that lagging nations might enjoy science and technology's benefits in solving their problems, and of the responsibility of developed nations in carrying out this task, the OEST is helping to formulate policies and strategies in science and technology for the Hemisphere.

Taking into consideration that the last Meeting of Ministers and High Officials of Science and Technology in the Americas was held eight years ago, in 1996, in Cartagena de Indias, Colombia, it is extremely important that the region's current needs and priorities in science and technology be reviewed and updated.

In May 2003, the member states of the OAS, in the framework of the Special Meeting of COMCYT, approved the project Hemispheric Cooperation in the Development of Science and Technology Policy, whose main objective was to generate science and technology policies and strategies for the Americas in the priority areas defined by the COMCYT.

The policies and recommendations from this project provided significant inputs for the Agenda of the First Meeting of Ministers and High Officials in Science and Technology in the Framework of CIDI, to be held in Lima, Peru, November 11-12, 2004. This agenda will enable the review and update of current mandates and the development of new ones to strengthen science and technology development in the Americas in the twenty-first century.

For this purpose, and as part of the implementation of the project, four workshops were carried out: Science, Technology, and Innovation to Increase Competitiveness in the Productive Sector; Scientific and Technological Development in the Americas; Science and Technology for Social Development; and Popularization of Science and Technology, cosponsored by the governments of Argentina, Ecuador, Jamaica, and Brazil, respectively, and in coordination with the OEST. These specialized workshops brought together distinguished science and technology experts and representatives of the national organizations of science and technology, to discuss and formulate science and technology policy proposals in the defined priority areas. In all, 86 experts of 16 member states were involved.

With this publication that we have entitled "Science, Technology, Engineering, and Innovation for Development: A Vision for the Americas in the Twenty-First Century," the Organization of American States would like to make available to a wider audience the extensive and rich material that resulted from this process.

The main issues and the general policy proposals were presented by the Technical Secretariat and approved during the Fourth Regular Meeting of COMCYT in April 2004, and are summarized in each of the sections of this document as follows:

Part I, “Science, Technology, and Innovation to Increase Competitiveness in the Productive Sector,” discusses how to increase the region’s productive-sector competitiveness and how to make it sustainable.

The guidelines for these policies include the recognition of the role of science, technology, and innovation in increasing this competitiveness; rethinking the model of innovation; quality for competitiveness; and the alignment of efforts with the market. Instruments that will facilitate the implementation of such policies are identified, such as flexible tools of financing; fiscal and tax incentives; strengthening of metrology integrated systems; promotion of associations and cooperatives; development of the national institutional infrastructure; follow-up, identification, and transfer of technology; institutional reforms and intellectual copyright.

Box 1

Preparatory Process for the First Meeting of Ministers and High Officials in Science and Technology in the Framework of CIDI of the OAS

Workshop Science, Technology, and Innovation to Increase Competitiveness in the Productive Sector
(Buenos Aires, Argentina, November 17-19, 2003)

Workshop Scientific and Technological Development in the Americas
(Quito, Ecuador, December 10-12, 2003)

Workshop Science, Technology for Social Development
(Kingston, Jamaica, March 3-5, 2004)

Workshop Popularization of Science
(Rio de Janeiro, Brazil, February 2-5, 2004)

Workshop Consolidation of Hemispheric Policies in Science and Technology
(Washington, D.C., United States, April 14, 2004)

Fourth Regular Meeting of the Inter-American Committee on Science and Technology (COMCYT)
(Washington, D.C., United States, April 15-16, 2004)

Four central areas of policy are examined, with profound paradigmatic implications, indicating the need of a qualitative change in current ways of thinking and acting: First, recognition of the role of science, technology, and innovation in competitiveness: It is essential that the stakeholders, businesses, governments and institutions of research and development, support the productive sector. Second, rethinking the innovation model: part of the transformation strategy is to substitute the fragmented, linear, and sequential models dominant over previous decades, for integrated innovation models that stimulate linkage and simultaneous interaction between stakeholders throughout the entire innovation cycle. Third, quality for competitiveness: Businesses' competitiveness is based on the quality of their products, and this quality is a direct result of their measurement capabilities. Metrology is the science of measurement, and good measurement capabilities allow enterprises to provide goods and services that comply with international standards and specifications---key elements to compete, access, and participate in foreign markets. It is fundamental for any country to develop a national measurement infrastructure that will support the competitiveness of their enterprises. Fourth, responding to market demands: Science and technology efforts must have a much greater scope, enriching their substantive content and synchronizing their dynamics with that of a changing market. This means that innovation, science, technology, metrology, and quality systems must be integrated in an attempt to consolidate and facilitate trade in the Western Hemisphere over the coming decade.

A set of policy tools or instruments is also identified, both to strengthen the innovation processes at the national level and to facilitate new forms of international cooperation.

Part II, "Scientific and Technological Development in the Americas," is focused on four specific areas of scientific and technological development: advanced networks and information infrastructure; biotechnology; clean technologies and renewable energy; and materials and nanotechnology. For each of these areas specific policy proposals are recommended.

In information technology and advanced networks, recommendations for policy and for the regulatory context, capacity building, and supporting strategies are formulated.

In biotechnology, mechanisms to stimulate collaborative research; networking needs for the area; capacity building; education and communication needs; and strategies and policies are discussed and recommended topics of research include agriculture/aquaculture, health/human welfare, and the environment.

In clean technology and renewable energies, specific topics on which to focus hemispheric resources are addressed, as well as mechanisms for stimulating research collaborations; establishment of networks for human-resource training and skills building; activities for strengthening the infrastructure of the scientific community; and technical assistance to the governments of the Americas for the generation of a strategy in this area.

In materials and nanotechnology, opportunities for the advancement of economies and societies for the Americas with the development of an overall program in material research and nanotechnology are discussed. The important role played by advanced materials and nanotechnology in the development of scientific and technological policies and in increasing competitiveness in the global economy is stressed.

In order to achieve the specific goals of the different areas, diverse mechanisms to stimulate collaborative research are presented, including the development of specialized networks for capacity building; activities to strengthen the structure of the scientific community and advice to governments, exploring novel financing approaches to expand domestic and regional education and research infrastructure.

Part III, “Science and Technology for Social Development,” examines seven specific areas where science and technology could contribute substantially to social development, both at the regional and national levels: democracy and human rights; provision of basic needs (water/food-nutrition/sanitation/energy/environment/health-health care); economic empowerment and poverty reduction; employment generation; gender; scientific education; and information technology and connectivity.

In addressing these needs, the traditional separation between science and technology and societal issues such as social development is no longer acceptable. Science and technology institutions must have access to information on social needs, so that research on related issues is encouraged and facilitated. Mechanisms need to be in place that involve all stakeholders concerned with the problem under discussion. Methods must be devised to insure that the science-based technologies can be implemented and reach the ultimate beneficiaries. Mechanisms for translating scientific theory and results into everyday terms for public understanding, ease of application, and dissemination activities must also be in place. Indicators and standards of impact and measurement must be developed and implemented. Implicit in all of this is the need for the computerization and integrated organization of information, and, consequently, the need for national and regional programs facilitating connectivity and supporting digital or e-government assistance for the automation of government functions and citizen services.

Part IV, “Popularization of Science,” examines the basic principles, policies, and actions for the popularization of science and technology. The different actors involved in the process are considered, and the need of permanent assessment and monitoring is emphasized. The important synergy between formal and nonformal education is also underscored, as well as mechanisms to enhance social inclusion, particularly cultural goods produced by indigenous peoples.

The concept that the popularization of science and technology plays a central role in the socioeconomic, cultural, and environmental development in the countries was discussed. From the socioeconomic perspective, popularization of science and technology can be the inspiration to scientific vocations and can encourage new talent for scientific research, technological development, and intellectual endeavors in general. It fosters creativity and innovation, contributes to producing better trained human resources, expands social opportunities, and strengthens the educational system. Culturally and environmentally, the popularization of science and technology enhances the critical skills of the population, thereby increasing its involvement in decision making, and contributing to democratic stability and sustainable development.

To conclude, the question of funding is examined and a proposal for a hemispheric cooperation agenda in the popularization of science and technology is laid out.

At the end of this report is a set of Annexes, which list the names of participants given at the four workshops.

Central Ideas and General Common Policy Proposals

The main agreement reached is the fundamental importance of having the countries of the region incorporate science and technology as a driver in their economic development strategy. In addition, the following central ideas emerge as key to a sustainable development of science, technology engineering, and innovation in the Americas:

Investment in science, technology, engineering, and innovation in the Americas

Investments in science and technology equivalent to 1 % of the gross domestic product (GDP), usually the target of many Latin American countries, is not enough to achieve critical levels of development and reduce the increasing scientific and technological gap. In this regard, political support is essential. Policymakers should understand the potential benefits of dedicating considerable resources to science and technology in a consistent manner, and that doing so is not an expense, but rather an investment for the improvement in quality of life and the general economic development of the region. In the 1970s, Latin America's technological development with respect to Asia was quite similar. However, the increasing investments dedicated to research and development (R&D) in science and technology and in education made by some Asian countries during the following decades contributed to the region's surpassing many other developing countries, including those in Latin America and the Caribbean. This trend continues, and as a clear example, South Korea's research and development expenditures in science and technology in 2001 totaled US$12.5 billion, and 2.96% of GDP, a 16.3% increase from the previous year. South Korea's predicted growth is expected to far exceed that of Japan in the near future, and its forecasted real GDP growth rate of 4.3% in 2003 is expected to be the highest among the Organization for Economic Cooperation and Development (OECD) countries. South Korea's investment in education is even more impressive. Its rapid economic growth and industrial development is attributable to its highly educated and skilled work force, as well as to its dynamic market and active research and development investments by both the government and the private sector.

The proposition calling for international mechanisms that would consider domestic investments in education and the building up of internal scientific capacity of Latin American countries as part of their foreign-debt payment was discussed and favorably assessed.

The need for a common area of scientific research for the Americas

Economic and commercial integration is not enough for the sustainable development of the Western Hemisphere. Integration based on scientific and technological common interests and efforts is also necessary for the better use of scarce resources and the collaboration, and strengthening of the scientific community, among other things. Investment in cyberinfrastructure, for example, will allow smaller countries to have access to highly elaborate and sophisticated research facilities located in other more developed countries. With these new forms of collaboration, efforts such as thematic networks and transnational laboratories could be more easily introduced in the region. In delineating national and regional policies and strategies, it is essential for intergovernmental institutions like the OAS to stimulate an active dialogue between the scientific community and the political and social leadership.

Global implications of scientific research

The unique situation of the Western Hemisphere reinforces the global implications and impacts of scientific research in the region. Studies in climate changes, for example, greatly benefits from the collaboration among all countries of the Americas, from north to south. The proposed policies and recommendations formulated for the development of science and technology of the Americas can also be seen as important models and points of reference for other regions.

National, international, and regional collaboration

International organizations have an important role in promoting collaboration in conjunction with institutions that share the same purposes. Collaboration can complement expertise and result in increased funding, so that more ambitious projects and programs can be undertaken to benefit the countries of the region. Smaller countries can take advantage of the economy of scale afforded by such collaborative schemes, while the entire scientific community of the region will be a beneficiary of greater cooperative possibilities.

The generation of national and regional policies and strategies requires the establishment of a very active dialogue between the scientific community and political and social leaders. In this sense, intergovernmental agencies such as the OAS should stimulate dialogues and contacts that facilitate this encounter. Academies of sciences and other scientific institutions also have a major responsibility in presenting the opinions and initiatives of the scientific community.

Science and technology in democracy and social development

Science and technology is fundamental for promoting and expanding democracy. The concept of democracy must encompass the active involvement of all citizens in making and monitoring decisions that affect the public welfare. In the Knowledge Society of today, this means that citizenship should involve training and literacy in basic scientific principles. In this regard, the importance of having the scientific perspective as an integral part of the education system from its very earliest stages was stressed.

A crucial aspect of social development is the capacity of employment generation as the basis of sustainable development. It is important to ensure that innovation systems reach the medium and small enterprises that are the economic basis of many countries in the region and expand their capacity as a source of better quality jobs.

To attain these objectives, it is necessary to greatly increase investments in scientific research and development and to examine creative, new ways of funding research and development.

Multidisciplinary research

Incorporating the perspective of social sciences in all scientific development is today recognized as essential for achieving the necessary balance between social needs and scientific progress. Modern scientific advances are related to a greater interaction between natural and social scientists.

Measuring the social impact of national and regional science and technology programs

It is increasingly accepted that monitoring and measuring the social impact of national and regional science and technology programs is fundamental. The importance of the existing indicator network is undeniable, but its expansion and reinforcement is necessary to encompass indicators of impact and a data base linked to science and technology.

These central ideas converge in proposed common science and technology policies and strategies that are further addressed throughout this document. These proposals are summarized in the following seventeen issues:

1) Generating national strategies and policies in each member country

All the countries in the Hemisphere should generate national strategies and policies to develop science and technology adapted to their needs and linked to their main projects. It is essential to make this policy a national consensus agreed by all the major actors: governments, scientists, the private sector, and the general public. In the generation of these policies and strategies, experts from other countries of the Hemisphere and the OAS can provide advice and information. These national policies should include a component of regional cooperation that would consider joint efforts in achieving common goals.

2) Strengthening the scientific community and scientific institutions at the national and regional levels

National and regional development of science and technology requires a strong and committed scientific community and an active network of collaborating scientific institutions. It is therefore necessary to undertake efforts to strengthen these communities and their institutions. One way to attain this objective is for the pertinent national and regional authorities to invite representatives of this community to express their opinions and suggestions on the main components of national and regional science policies and to provide opportunities for their discussions with decision makers and social leaders.

The national academies of science, medicine, or engineering are merit-based institutions that have prestige, credibility, and autonomy and for those reasons constitute ideal institutions that should be called to provide objective advice and opinions representing the national scientific community. A very positive development is that the academies of sciences of the Hemisphere have adopted the initiative to create a network, the Inter-American Network of Academies of Sciences (IANAS). This network should be an important source of advice to regional and international organizations, which, like the Organization of American States, are involved in promoting scientific development in the Americas.

In the disciplinary areas of basic science, the existence of Latin American networks of biology, chemistry, mathematics, physics, and astronomy are important actors for questions dealing with those important disciplines as are more specialized networks dealing with specific problems or technologies. Regional and national projects that require the participation of an organized scientific community will benefit from strong scientific institutions that can serve as instruments to secure that participation.

3) Focusing on the support of countries that are lagging in science and technology

The heterogeneity of the present stage of the science and technology establishment among the different countries in the Americas demands that special care should be taken when proposing mutual collaborations and partnerships. To be effective, the proposed policies must attend the double requirement of focusing on the needs and fulfilling the expectations of all countries involved.

When well-defined or spontaneously grown but well-established domestic scientific agendas exist, the proposed bilateral or multilateral collaborative schemes proposed should respect them by incorporating the mutually compatible themes. Different concerns arise, however, when the collaboration involves scientists from the least-developed (in science and technology) Latin American countries, for those usually do not have clear and consensually defined national scientific priorities; here, the risk is that a substantial fraction of already lean budgets and scarce resources of these countries will be diverted to pursue an extraneous scientific agenda.

At the same time, specific measures should be devised so that these countries are not once again left off the bandwagon of hemispheric collaboration. Multilateral, or even bilateral, partnerships with them should be based on more than a standard manner of financing, abandoning---when appropriate---the practice of equally splitting the costs. In this regard, special attention should be given to novel financing, including the possibility of exchanging part of the foreign national debts for well-defined investments in “capacity building” in terms of science and technology, i.e., selectively investing in the domestic educational, scientific, and technological infrastructure, as well through the creation of specific funds, such as green bonds, among others.

4) Hemispheric cooperation for the popularization of science and technology

The popularization of science and technology has a central role in socioeconomic, cultural, and environmental development in the countries of the Americas. In socioeconomic terms, the popularization of science and technology allows for the awakening of vocations and the stimulation of talents for scientific research, technological development, and intellectual work in general; fosters creativity and innovation; contributes to the preparation of human resources; broadens social opportunities; and strengthens the education system. In the cultural and environmental spheres, the popularization of science and technology encourages critical thinking within the general population, increasing its participation in the process of decision making and contributing to democratic stability and sustainable development. In addition, the popularization of science helps to amplify individual satisfaction and self-esteem. With the increasing importance and role in popular life of science and technology, the need for the creation of a policy at the hemispheric level that coordinates strong and effective action among the countries in the Americas is imperative. This will allow the expansion of efforts to improve the population’s scientific and technological literacy.

5) Training and education of human resources

One of the essential components to achieve excellence in science and technology is human resources. Most of the countries in Latin America and the Caribbean have great deficits in scientists and technologists with advanced training to enable them to carry out high-quality research. Training of scientists and technologists at the postgraduate level (master’s and doctoral degrees) requires centers and institutions of higher education with high academic standards. There are a number of such high-level institutions in Latin America that provide excellent postgraduate training in areas highly relevant to the problems of the countries of the region. It is essential that these institutions be entrusted with the task of training scientists and technologists from the neighboring countries that are lagging in science and technology. This requires a robust program of fellowships. Once trained, these young scientists and technologists should be assisted to return to their countries with positions and grant support that will allow them to establish research efforts that are attuned to national priorities. The developed countries of the Hemisphere, the United States and Canada, should help in this effort by providing high-level scientists who would provide on-site consultation and training at the institutions of the south, to strengthen and raise the level of these programs.

In addition, “sandwich fellowships” which provide opportunities to doctoral students from Latin America and the Caribbean to carry out research in the laboratories of developed countries, are highly enriching experiences. Postdoctoral fellowships in the developed countries are also important components of the training of the most talented students and allow them to acquire contacts that will be essential for their research careers. These postdoctoral programs should include reentry grants that stimulate and facilitate the students’ return to their home countries.

Regional accreditation of postgraduate training programs would be very useful to allow co- validation of courses and activities and mobility of students within the region.

Short-term fellowships for research and training would be a helpful mechanism for updating knowledge of new fields and emerging techniques and would also facilitate the use of special “facilities” that are unique in the region, such as synchrotrons, astronomical observatories, the Galapagos biodiversity research station, oceanographic research ships, etc. Complementary to these short-term fellowships, intensive, short-term hands-on training courses should be organized in centers of excellence in the region, and these should be open to all qualified applicants from the region.

It is also essential to raise the level of science education of the general public. This is best achieved through improvement of the methods used in science education for students of primary and secondary schools. Inquiry-based methods now being introduced with the support of the National Academy of Sciences of the U.S. and several Latin American academies have greatly enhanced the interest of children in science and changed their perception, making it a living and exciting subject. Children who learn science through their own experimentation also integrate the values of science, such as respect for truth, rigor, and critical assessment of dogmatic statement. This knowledge and the values acquired will make them better and more responsible citizens of a more free society.

6) Promoting the formation of networks of scientific institutions and individuals

Multi-user facilities exist in different institutions in some of the American countries. Specific funding mechanisms should be devised to enable individual scientists and students to have free access to this important research infrastructure and to foster collaborative projects reuniting institutions from different countries.

It is essential that the domestic and regional cyberinfrastructure be upgraded to enable the full exploitation of the opportunities afforded by the information and communication revolution.

7) Stimulating collaborative research in projects involving south-south, and north-south (triangulation) interactions

The Inter-American Collaboration in Materials---CIAM, is a good example of a regional initiative of supporting bilateral and multilateral collaborative projects in a specific area (materials) that should be enhanced, expanded, and adapted to other themes of inter-American interest. The Brazilian National Laboratory of Synchrotron Radiation (LNLS) is a good example of a prototype Latin American facility.

8) Identification of centers of excellence for training and research for the region

It is important that at the national and regional levels, the centers that have the highly qualified human resources, adequate infrastructure, organizational leadership, and management to carry out research and training at an international level be identified. Schemes like the Millennium Initiative of the World Bank, in which international communities participate in the selection of the best centers, could be replicated to identify these groups. Once identified, governments and international institutions should stimulate their undertaking of projects of special relevance to the country and region and should stimulate their participation in networks that enhance their potentiality and encourage their interaction with the best centers of the industrial countries.

9) Collaboration with other international and regional institutions that share similar purposes

The OAS should pursue its responsibility in promoting scientific and technological development in the Hemisphere through collaborations with other institutions that share similar purposes, such as the United Nations Educational, Scientific and Cultural Organization (UNESCO), Pan American Health Organization (PAHO), the Economic Commission for Latin America and the Caribbean (CEPAL), the Inter-American Development Bank (IDB), and the World Bank (WB). This collaboration can complement expertise and result in increased financial resources so that more ambitious projects and programs can be undertaken. This possibility requires that the OAS adopt flexible and efficient methods to select and finance joint initiatives.

10) Promotion of clusters and enterprise associations

This is necessary to promote interactive agents at intra- and multinational levels. This includes the promotion of different collaborative schemes, such as networks and clusters, through innovation efforts.

11) Development of the national institutional infrastructure

Complementary ties should be sought among the member state institutions and enterprises, and adaptable and flexible institutions promoted, capable of creating networks in order to generate and articulate the knowledge required by the enterprises.

12) Intellectual property

This is necessary in order to promote processes geared towards product export, as well as to stimulate and provide patent registration by entrepreneurs and small-and medium-sized enterprises and to preserve technology development and limit frivolous challenges.

13) Technology transfer and industrial development

It is important to develop “incubator” facilities near the locations where both research and new technology development take place, developing partnerships with existing industries to promote change.

14) Facilities and standards

Shared facilities will be required to favor research, common understanding, and novel phenomena and materials. In this regard, new standards will be required. Common laboratory infrastructure for smaller countries in the region would be of great benefit for all. Some examples include the areas of metrology and standards, biotechnology, and material science. Hence, nanometrology is a new frontier to be implemented throughout the Americas. Major shared facilities needs include advanced microscopy and structural characterization (synchrotron); NMR; neutron; femtosecond optical, nano-PL; computational facilities and nano to macro phenomena (multiscale).

15) Development of science and technology indicators

As a follow-up to the Summit of the Americas Process, the countries should promote, with the support of existing cooperation mechanisms, the development of a regional program on science and technology indicators.

16) Science and technology to promote and expand democracy

Democratic frameworks based solely on voting rights are too limited; the concept of democracy must encompass the active involvement of all citizens in making decisions and monitoring their execution. Science and technology contributes to social inclusion and should be considered as a means to strengthen democracy.

17) E-science, cyberinfrastructure, and the digital gap

Advanced networking and information infrastructure is a critical vehicle for propelling countries of the region into competitive knowledge-based economies. It strengthens other areas, provides access to global scientific and technology resources, and empowers critical social and economic activities. In the current global economy, the use of ITC is essential for the development of small-and medium-sized enterprises and broadening access to e-commerce and e-government.

Part I

Science, Technology, and Innovation to Increase Competitiveness in the Productive Sector

Background and Context

In an open and highly competitive economy, survival of the productive sector cannot continue to be based on the comparative advantages that in the past gave it its strength. In the global economy, the productive sector can survive only by competing through quality, novelty, and a diversity of products and services that can only be generated through innovation and continuous technological change.

With each passing day, society reaps the benefits of a growing flow of new products -medicines, vaccines, advanced materials, communication technologies, instruments, processed foods, and agricultural products- supplied, more and more, by advanced science and technology. It is worth noting that most of the world commerce is based on manufactured products with a high technological content. The presence of science and technology in our daily lives is growing, inevitable, and cannot be denied. It is very surprising that leaders---both political and business---should underestimate the importance of science and technology programs, given that they are vital to a sustainable competitiveness that will ensure the long run survival of the productive sector.

More recently, governments of the Hemisphere have begun to express their interest in using science, technology, and innovation as a means to improving the competitiveness of their enterprises internationally. This process should contribute to an improvement in the quality of life and the easing of extreme poverty in their societies. It implies not only individual national efforts but also a new approach to inter-American cooperation. Under this new concept, cooperation includes not only scientific and technological research and metrology organizations, but also other actors. Businesspeople, government agents, organizations, and communities are all involved in the processes of innovation and improvement, and their participation is crucial for a development based on sustainable competitiveness and conceived as integral and dynamic.

Part I is based on the recommendations stemming from the Workshop Development of Hemispheric Policies for Science, Technology, and Innovation to Increase Competitiveness in the Productive Sector, which took place November 17, 18, and 19, 2003, in Buenos Aires, Argentina. The Secretariat of Science, Technology and Productive Innovation of Argentina cosponsored the event.

Participating were representatives and experts from eleven countries of the Western Hemisphere and two international cooperation agencies. The Workshop included presentations of innovative programs and different national experiences in support of the productive sector, as well as successful cases of businesses in several OAS member countries. There was also an analysis of the role of government, private enterprises, and research institutes. This was integrated into a working methodology for the Workshop, with the resulting recommendations detailed here.

The recommendations were synthesized in order to elaborate a set of policy instruments that, according to the participants, will help to improve national, regional, and hemispheric competitiveness through an integrated effort toward science, technology, quality, and innovation.

This part is divided into two sections. The first, Background and Context, summarizes the perceptions of participants on the state of quality, innovation, and competitiveness of the productive sector in the region and discusses the driving forces that demand a new framework of instruments to promote innovation. The

Figure 1. Expenditures on Research and Development (R&D) in Selected Countries, 2000

Country	% GDP	Origin of Expenditures, %				
		Government	Business	Education	NGOs	Foreign
United States	2.68	27.1	68.4	2.3	3.2	0
Canada	1.81	22.7	42.6	16.4	2.6	15.8
Brazil	1.05	60.2	38.2	1.6	0	0
Chile	0.56	70.3	23.0	0	1.9	4.7
Argentina	0.42	N/A	N/A	N/A	N/A	N/A
Mexico	0.40	59.1	24.3	10.8	0.1	5.6
Panama	0.40	34.4	0.6	0.4	0.7	64.1
Uruguay	0.24	20.3	39.3	35.7	N/A	4.8
Colombia	0.18	16.6	48.4	33.6	1.4	N/A
Peru	0.11	N/A	N/A	N/A	N/A	N/A
Honduras	0.05	N/A	N/A	N/A	N/A	N/A

Source: Indicators of the RICyT network, available at http://www.ricyt.org or http://www.science.oas.org/ricyt second, Mission and Vision of Hemispheric Policy: a Blueprint for Transformation, spells out a new hemispheric policy on science, technology, and innovation, and suggests detailed recommendations derived from the presentations, dialogue, and synthesis of successful case studies of innovation.

In recent years, the science and technology systems of the majority of the countries in the Americas have been unable to speed up their dynamics to match the growth of a knowledge-based economy. Expenditures and sources of financing Research and Development are very heterogeneous, as shown in Figure 1 for the year 2000.

This table illustrates the virtuous (or vicious, according to point of view) circle between economic activity and investment in research and development (R&D). It also shows the impact of economies of scale in countries of lesser economic activity carrying out marginal R&D actions. In the countries with the highest economic development, the United States and Canada, the productive sector carries out most of the R&D activities. The situation is very different in the selected Latin American countries, where the participation of the private sector is much smaller. As shown in Figure 2, the last decade has seen an increase in this trend.

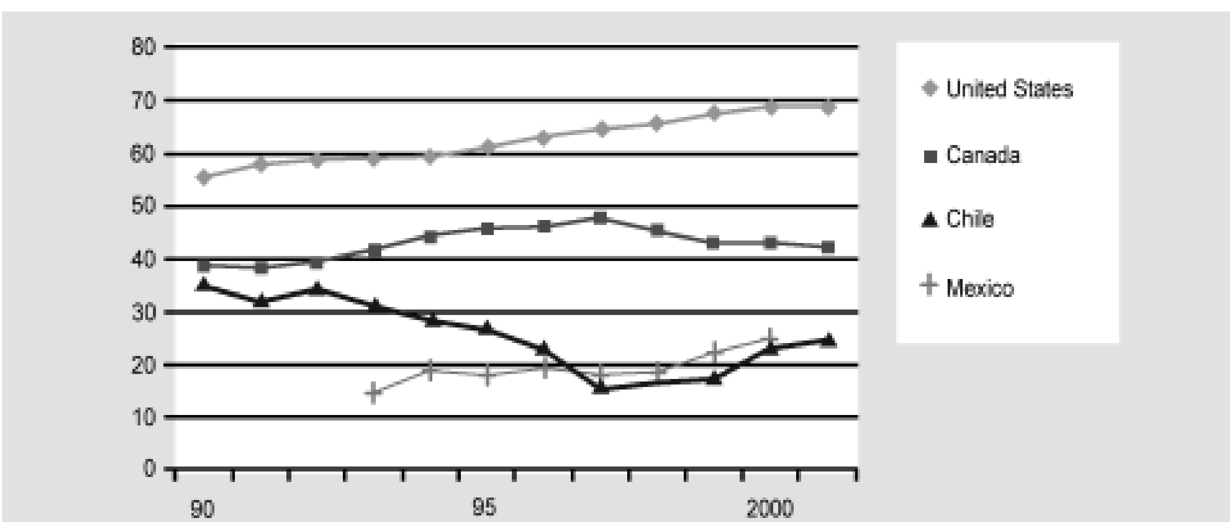
In addition to aspects related to financing, it is important to list the following:

- Experiences with diverse ways of financing have been tried and can be used regionally, such as the sectoral funds operating in Brazil, Mexico, and Chile.

- Successful cases of innovation in the region have resulted from the interest of the producers and advanced by their capacity for association and collaboration.

- There have been considerable efforts at coordination among the region's metrology, certification, and

Figure 2. Participation (%) of the Productive Sector in R&D Expenditures in Selected Countries, 1990-2000



Source: Indicators of the RICyT network, available at http://www.ricyt.org/ or http://www.science.oas.org/ricyt accreditation organizations. This has advanced recognition that these are essential practices for productive-sector competitiveness.

- Nowadays, technological centers that respond to market demand can contribute valuable experiences. Their role can be seen as integrators of the knowledge required by business to solve technological problems and to incorporate systemic competitiveness strategies.

- Scientific production has grown exponentially as compared to institutional infrastructure, where growth in the number of centers has been linear.

- The level of human-capital development is very heterogeneous in the region, both in quantitative and qualitative terms. Brazil is now graduating more than six thousand Ph.D.'s a year and Mexico about one thousand, while in other countries the numbers are closer to one hundred or even less. In many cases, academic training does not emphasize the necessary coordination with the needs of the productive sector.

- There is a growing need to shift from comparative to competitive advantages. This requires a cultural change, particularly at the management level of enterprises.

- Low productivity and a lack of strategic thinking remain deficiencies of the agro-industrial sector, as, for example, in the dairy products industry of Mexico and Central America. This offers opportunities for regional collaboration projects.

In the Hemisphere, around 90% of economic activity and of employment generation comes from small- and medium-sized enterprises (SMEs). Any effort to develop competitiveness of the productive sector has to take the SMEs into account. This is a complex task, given the number and the diversity among SMEs. But also because it must take them from comparative advantages, linked to labor costs, resources, and natural resources availability, to the development of competitive advantages, associated with technology, knowledge, management, quality, productivity, and creativity, that is, to a business culture based on quality and on scientific and technological innovation.

Therefore, during the current transition towards the Knowledge Society, the science and technology systems in the region are under great pressures where direct forces prevail. These pressures include the exponential increase of knowledge as a central ingredient in the competitiveness of the productive sector; changes in the innovation model, where science and technology are integrated into complex processes of exponential generation of knowledge and value for the production of goods and services; integration of the innovation process with the accelerated dynamics of market globalization, requiring scientific and technological alignment toward entrepreneurial activities; and the turbulence associated with the globalization process and its effects. These latter effects are economic, political, and technological, and require a long-term vision supported by "shield" policies, that is, protectionism of unprotected innovation processes, which take science and technology into account.

Except for a few cases, all science and technology systems in the region were created during the last half of the twentieth century. Most of these systems focused on the development of basic sciences, with lesser efforts toward knowledge application and industrial research. In general, they were oriented to stimulate the "supply" of scientific knowledge. Thus, their best accomplishments related to promote the creation of physical and institutional infrastructure, the expansion of human capital, and, in some cases, the decentralization of their activities.

Consequently, efforts towards innovation did not have a similar development. During the seventies, efforts were focused on the development of technical

information and industrial liaison services, without evolving into more integral services supporting technological development and innovation in the productive sector.
These systems are experiencing the challenge of adapting to the new era and the need to integrate into the market dynamics, helping to increase the competitiveness of the productive sector with emphasis in the countries' SMEs. The science and technology systems of the countries in the region should now be geared not only to attend the problems of the productive sector, but also to promote deep structural transformations based on new policies to promote innovation.

Some countries have already begun these structural transformations. They seek to integrate the knowledge "supply" and "demand" in a virtuous circle stimulated by strategies that go from the transformation of their legal framework and the creation of diverse financially decentralized mechanisms, to the exploration of new approaches towards the linkage between the productive sector and the scientific and technological research institutions through advanced ways of collaboration. New efforts were identified to generate the necessary experiences to facilitate a paradigmatic change in order to develop a new platform for innovation in the productive sector.

Common regional issues include the following:

- A great imbalance in the evolution of national science, technology, and innovation systems, and a lack of participation by the productive sector in their development.

- Successful cases of innovation that contain valuable experiences in strategic design and incentives for policy elaboration to promote the productive sector.

- The need for supporting quality through the improvement of integrated systems.

- A favorable environment for promoting new mechanisms of inter-American cooperation.

- The opportunity to develop a new generation of tools to support the productive sector, which will allow the countries to take a "quantum leap" in the field of innovation.

Mission and Vision of Hemispheric Policy: A Blueprint for Transformation

The mission of a hemispheric policy for science, technology, and innovation should be to increase, in a sustainable way, the competitiveness of the productive sector, through the development of new capabilities through the added value of new knowledge coming from innovation that is systemic, dynamic, and integrated.

This means that one has to aim toward an experimental model for innovation based on the interaction between science and technology, quality improving processes, market strategies, and a new platform of policy instruments that can leverage, through strategic stimuli, the development of linkages and new behaviors conducive to innovation and competitiveness.

The design, development, and application of policy instruments--both national and inter- American--are essential to a new model of innovation in a market context. Governments have a key role in making this process sufficiently smooth by concentrating their actions on the establishment of a set of policy instruments for innovation on a hemispheric scale and with important impacts. These include increasing the competitive advantages of the SMEs; creating collaborative structures that enable the creation of clusters and economies of scale without loss of individual flexibility; and integrating processes of experimentation, continuous improvement, and innovation. With these changes, policies will evolve and establish a virtuous circle with the innovation process which, in turn, will be continuously reconceptualized.

Four basic elements are central for the design of hemispheric policies in science, technology, and innovation. They have profound paradigmatic implications and indicate a qualitative change in current ways of thinking and acting. These elements---the recognition of the role of science, technology, and innovation in competitiveness; the rethinking of the innovation model; quality-oriented competitiveness; and the response to market demands---are immersed in turbulent national and international environments, with which they are in constant interaction, as shown in Figure 3 below.

Figure 3. Elements of Hemispheric Policies

Recognition of the Role of Science, Technology, and Innovation

Innovation, science, and technology are concepts that must become part of the new corporation culture in the twenty-first century so that firms, without regard to size, sector, and context of their productive activities, may be able to compete in the new world order. In past decades, quality control, continuous improvement, and certification were widely adopted by many firms and businesses. Today, however, in the Knowledge Society, it is fundamental to recognize innovation as a competitive advantage that must be developed and embraced. It must also be recognized that innovation cannot be separated from science and technology.

Governments, too, must update their perceptions. A fragmented support of science and technology systems is no longer sufficient. It is imperative to put in place an integrated innovation system, which implies new attitudes, forms of organization, and the promotion of greater collaboration between the public and private sectors.

Research and technological development centers must also revise and broaden their forms of support to the productive sector, in order to be integrated in the wider process. Their efforts of scientific research and development of human resources must be complemented by a new and deeper perception of the innovation process. They will have to redefine objectives, functions, and services to improve their interaction with the productive sector and to create an innovative context.

Recognition of the role of science, technology, and innovation in the competitiveness of the productive sector must be supported in different ways. These include awareness-raising programs for the different stakeholders in the innovation process; programs for the dissemination of innovation concepts in the communities concerned with productive activities so that science and technology can be better known and understood and thus better utilized; responsiveness on the part of science and technology research centers to the demands of the productive sector; measurement of results through feedback and monitoring systems (such as surveys and interviews); and appropriation, that is, the ability of firms and businesses not only to operate but also to contribute to the improvement of transferred technologies.

Rethinking Innovation

It is not sufficient for innovation to be a model shared by the productive, governmental, and scientific and technological research sectors. The model must evolve as a result of collective learning and the need to constantly adapt in response to the turbulence originating from transition and from market forces.

Part of the transformation strategy is to substitute the fragmented, linear, and sequential models dominant over previous decades for integrated innovation models that stimulate linkage and simultaneous interaction between stakeholders throughout the entire innovation cycle. The convergence of the process of productive innovation with the role of governments in promotion and support is fundamental.

Developing competitive advantages in the productive sector consists in part of having access to an innovation model adjusted to current reality, internalizing and putting into practice a model that includes not only science and technology but, and this is more important, its critical relations with the process of value generation.

These are some elements that form the basis for recasting the innovation model:

- Causality link of competitiveness and innovation, forming a virtuous circle.

- Research and development relevant to the innovation strategy of the sector.

- Importance of technology transfer in the critical relationship between R&D and the productive sector, a link in the value-adding process.

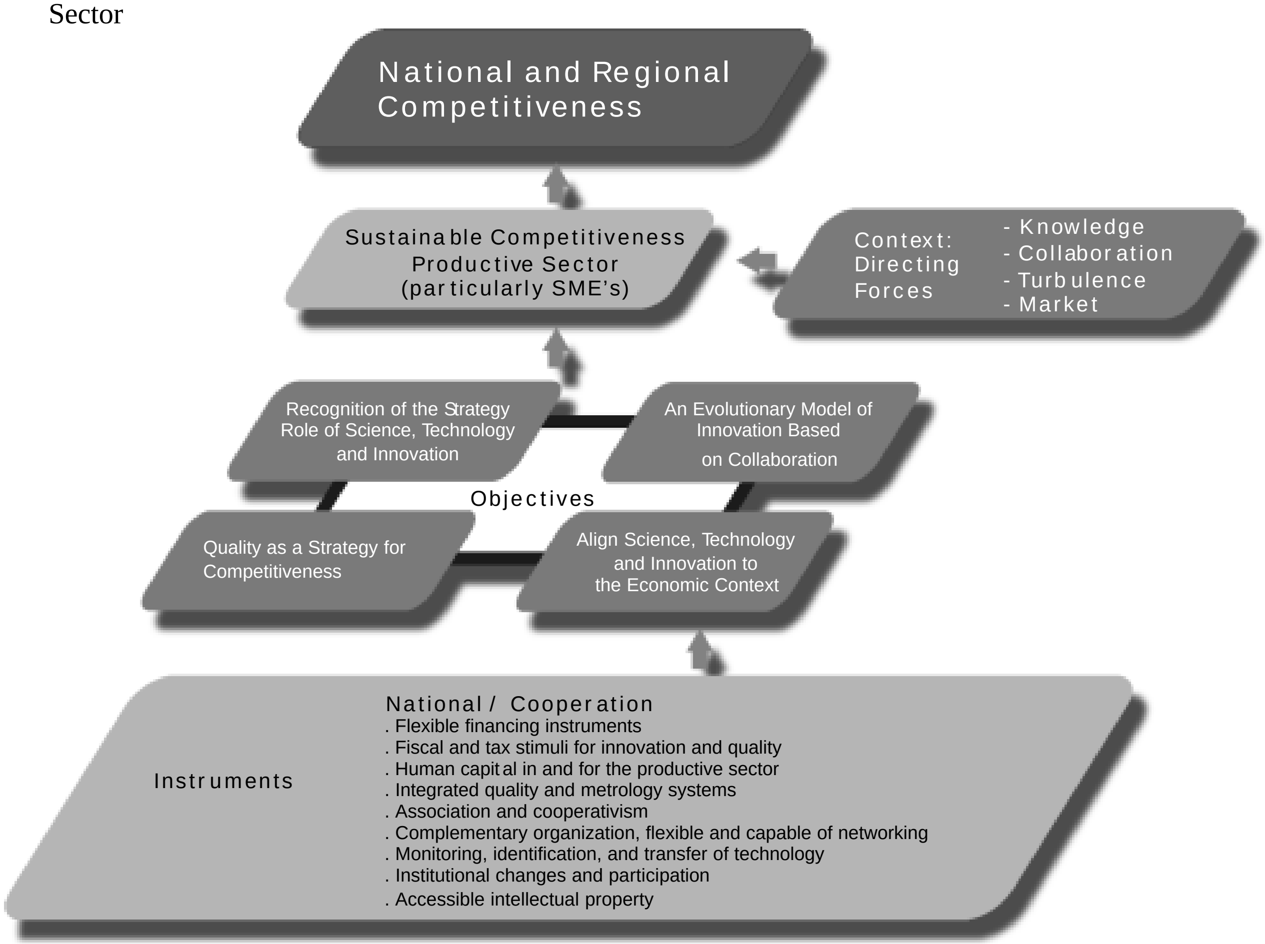
- Significance of interaction between actors in innovation.

- Relationship between centers for conformity assessment (metrology, accreditation, and certification) and productive-sector competitiveness.

- Measurement systems, SIM (the Inter-American Metrology System)

- A strategy of linkages, including creating innovation networks and networks of mobile, proactive entities to stimulate the demand for knowledge.

Figure 4. Blueprint for Innovation: Essential Elements for Promoting Competitiveness in the Productive Sector



- Virtual innovation centers, for different productive sectors.
- A new innovation culture (systemic, collaborative, and with longer time frames).

- Development of new institutional leaderships, such as the existing national institutes of metrology.

- Technological monitoring, intellectual property.

- Knowledge and learning management, creation of new knowledge, new forms of social learning.

- Joint capacity building by academia and business; joint teaching of human resources (master's and Ph.D.) and training.

- Technical assistance, scholarships, internships, and exchanges of students, professionals and professors

- Promotion of "business incubators" designed under the new innovation model.

- Capacity building by skills.

- Business technological missions.

- Evaluation, follow-up, competitiveness indicators, including those related to gender.

Quality for Competitiveness

Quality is an emerging element of a system (business, productive sector, country) that depends as much on individuals, enterprises, and the contextual environment acting on their own, as on the interactions among them. Interactions, however, have exerted far more leverage in the area of quality improvement, due both to interdependence and to synergy generated whenever purposes, goals, meanings, time frames, and methods are shared.
We are all aware of the risks and opportunities presented by globalization and how difficult the transition is; but to survive and grow with globalization, it is mandatory to learn and put into practice better ways of managing businesses. Today, education and the abilities of managers and workers are the dominant competitive resources. If, however, these are to become the reality in the countries of the region, a transformation is required because in this new economic era the prevailing managerial style has ceased to be functional. Most businesses continue to be based mainly on a mechanical concept in which people are considered as living machines whose main job is to follow orders.

The current concept of quality is related to training and development of individuals, collaborative work, the statistical control of processes, client satisfaction and, as a result, higher productivity, better competitive position, higher returns and, in time, to the creation of more and more jobs. It is no longer a matter of adjusting to a list of things to do, nor of obtaining certifications. What is needed is a different way of thinking about the business, the people who work in it, the clients, the suppliers, the environment, the decision-making methods, and the type of leadership required from top executives. To become engaged in quality implies a structural change, and it is thus a difficult and long process.

The competitiveness of a business is based on the quality of its products and this, in turn, is a function of its measuring capabilities, related to the field of metrology, the science of measurements. A good metrology system allows the productive sector to provide goods and services that comply with international specifications or standards, which are a requirement when competing and getting access to wider markets. Measurement capability is directly related to the technological level of a country. It is fundamental for any country to develop a national measurement infrastructure that will support the competitiveness of its enterprises.

Integrated quality systems fulfill two roles. On the one hand, they permit enterprises to export quality products, goods, and services. On the other hand, by controlling imported products and goods, they block "bad quality" imports, that is, products that do not comply with national standards and regulations. As more markets open up and expand based on products with a higher scientific and technology content, the need for advanced metrology increases. Developing or sharing an advanced metrology system will be a road to advanced scientific and technological knowledge for the nations of the region.

By committing to quality, businesses must accept that they will be engaged in development, not growth only, because the latter is but a consequence of the former. Utilities for shareholders are a legitimate concern that must be satisfied, but it is no longer the main purpose. The ideal is to be ever more proficient in the sense of a growing capacity to satisfy the legitimate wishes and aspirations of all interest groups.

Responding to Market Demands

The economic context is under constant change and deregulation. Amid this turbulence, the productive sector must develop and sustain competitiveness based on value added through improvement and innovation. This implies adjusting its perception and strategic thinking to the new dynamics and complexities.

Within this framework, the role of government is redefined as a catalyst for the process of opening markets, protecting innovation processes, and promoting new market opportunities.

Some of the most important policy instruments have a collaborative approach (among countries) for accessing international funds; are cooperative among emerging countries to promote access to markets (such as the European Economic Union); stimulate market demand by the state; improve infrastructure (airports, ports, roads); have strategies for product diversification from a technological platform (such as fish culture, viticulture, and floriculture); and promote national interest.

Instruments for Policy

Increasing competitiveness through innovation and continuous improvement is a constant process that requires support, stimuli, the elimination of restrictions, and a flow of resources. It requires a general support system, where national efforts can be complemented by cooperation among the nations of the American continent. This support system is an integral process of policy instrument design. It is a new concept in which policies are no longer limited to government action but rather linked to the productive sector and international agencies as well.

From the standpoint of innovation, the design of policies must be a continuous process, striving to increase effectiveness by improving mechanisms for support and follow-up.

It is recommended that the design of policies be an ongoing process integrating government, productive sector (public and private), research and experimental development organizations, and international agencies. The following related mechanisms must be emphasized.

Flexible financial tools

Opportune, diversified, and decentralized, these include funds, soft loans, and venture capital.

Fiscal and tax incentives

These imply the payback of part of the innovation costs, through taxes.

Training human capital for the productive sector

Continued education of professionals trained in technological and legal issues. Strengthen the interaction between business and the academic sector and promote the generation and flow of knowledge from one sector to the other.

Strengthening integrated metrology systems

This includes standardization, accreditation, inspection, and quality assurance for conformity assessment. Promote inter-American networks that will allow less developed countries with limited resources to enter the innovation cycle is required in the region.

Promoting clusters and enterprise associations

To promote intra- and multinational interactivity between agents. This includes the promotion of different collaborative schemes, such as networks, clusters, and strengthening of unions through the innovation efforts.

Developing national institutional infrastructure

Seeking complementary ties among member state institutions and enterprises. Promote adaptable and flexible institutions, capable of creating networks in order to generate and articulate the knowledge required by the enterprises.

Monitoring, identifying, and transferring technology

Promote the monitoring of technological development trends leading to new innovation fields. Likewise, develop the ability to identify, select, and transfer technology to the productive sector.

Institutional reforms

There is the need for a deep change that will point to the development of adequate state participation; to stimulate the leadership and network integration of scientific and technological centers.

Intellectual property

Promote processes geared towards product exports, as well as stimulate and provide patent registration by entrepreneurs and SMEs.

These tools must have two levels of design and application, national and international.

National refers to state mechanisms for the development of science and technology and the promotion of productivity, quality, and innovation, involving the productive sector (public and private), the government sector, and the institutions and organizations dedicated to carry on related activities, such as scientific research, technological development, and technological services (metrology, standardization, accreditation, inspection and certification, training, organizational development, and technical-economic information).

International refers to the exchange of experiences and the integration of inter-American collaboration networks among the countries of the Americas that are essential elements to accelerate the transformation. It is necessary to explore new forms of collaboration and complementarities between institutions and the productive sector of the member countries, such as networks and conformity-assessment systems, knowledge mobility, exchange of human capital, and strategic projects innovation in common productive activities.

It is fundamental to reflect on the governments' role in the transition towards a new culture of innovation: creating market opportunities; stimulating the creation of important links among science, technology, and the productive sector; leveraging strategic issues; eliminating restrictions; and facilitating processes. Trade agreements must create equitable opportunities for market access and integration from their inception; they must integrate the search for sustainable competitiveness of the productive sector through quality, innovation, and science and technology. It is not possible to achieve competitiveness in commercial exports without quality.

Part II

Scientific and Technological Development in the Americas

Background and Context

Part II analyzes the main issues and policy proposals addressed at the Workshop on Scientific and Technological Development in the Americas held in Quito, Ecuador, December 10-12, 2003, under the auspices of the OAS and the Foundation for Science and Technology (FUNDACYT) of Ecuador. The main goal of this Workshop was to formulate science and technology policies and strategies for the Americas in information technology and advanced networks, biotechnology, clean technology and renewable energies, and materials and nanotechnology.

An inaugural plenary meeting was held the first day, with a keynote presentation by the Vice President of the Republic of Ecuador, the Honorable Alfredo Palacio, who spoke about the importance of science and technology in this new interdependent world of globalization. In the plenary session, Professor Jorge E. Allende presented the report of the Inter-Academy Council, "Inventing a Better Future: A Strategy for Building Worldwide Capacities in Sciences and Technology." This initiative of the international scientific community was considered highly relevant to the objectives of the Workshop.

The last part of the inaugural plenary session consisted of a joint debate among all the participants and experts with the aim of looking at the four specific areas in a more integrated way. Later, each of the four work groups convened separately, for a day and a half, with the participation of their corresponding experts and other participants. Within each work group, the global situation of the corresponding area was analyzed, including its limitations and barriers, and the cases of successful collaborations in the region were also examined. Each group elaborated policy proposals and recommendations for the specific area.

These materials were presented in a closing plenary session for general discussion. A special acknowledgement is given to Professor Jorge Allende, of Chile, and Professor Celso Pinto de Melo, of Brazil, as general raporteurs of the Workshop.

There is an important relationship among the four areas addressed during the Quito Workshop: biotechnology, clean technology and renewable energies, information technology and advanced networks, and materials and nanotechnology.

With respect to advanced networks and information infrastructure, the use and application of these networks can facilitate the access of less-developed countries to laboratories and sophisticated equipment located in other regions. Networks can be an efficient tool to facilitate the creation of regional laboratories open to remote connection from disadvantaged countries that otherwise would be unable to take part in current expensive technology.

Problems in infrastructure for the management of extensive data bases are common in bioinformatics, physics, environmental sciences, and astronomy. In fact, some of the largest data bases for nonmilitary purposes are those for the study and prediction of global climatic changes. Advanced networks are not only important for scientific purposes; they will play a key role in education, health, and prevention of disasters as well.

One of the most promising technologies of our times is biotechnology. Advancements in this area will have a tremendous impact in the agro-food industry. Genetic modification of some basic foods, especially in rural zones, would become an important strategy for the improvement of global nutrition and health in the region. Biotechnology could be also used to mitigate environmental problems through microbial transformation of waste.

At the same time, bioinformatics plays an important role for the improvement of the health of the population in developing countries, making use, through high-speed networks, of massive data bases to implement simpler and more effective methods of producing vaccines and medicine.

It is expected that the work at the nanoscale level will facilitate the development of materials with dramatically new properties, relevant to all sectors of the economy that will also increase energy efficiency, improve the environment, transportation systems, and health. Discoveries and applications of science and technology, at the nanoscale level, will become one of the main engines for economic and social development during future decades.

General Policy Proposals

Generate national strategies and policies in each member country

The countries of the region agree on the importance of science and technology as a vital instrument of national planning and a strategy for development. In order to improve science and technology and make it available to the countries of the Americas, national strategies and policies in science and technology adapted to the countries' needs and linked to their main projects must be formulated. It is also essential to make these policies a national consensus, agreed to by all the major actors: governments, scientists, the private sector, and the general public. In the generation of these policies and strategies, experts from the countries of the Hemisphere and the OAS can provide advice and information. These national policies should include a component of regional cooperation that would foster joint efforts to achieve common goals.

Strengthen the scientific community and scientific institutions at the national and regional levels

National and regional development of science and technology requires a strong and committed scientific community, as well as an active network of collaborating scientific institutions. Therefore, it is necessary to undertake efforts to strengthen these communities and their institutions. One way to attain this objective is for the pertinent national and regional authorities to invite representatives of these communities to express their opinions and suggestions on the main components of national and regional science policies and to provide opportunities for their discussions with decision makers and social leaders.

The national academies of science, medicine, or engineering are merit-based institutions that have prestige, credibility, and autonomy, and for these reasons they are ideal institutions for providing objective advice and opinions representing the national scientific community. A positive development is that the academies of science of the Hemisphere have adopted the initiative to form a single network, the Inter-American Network of Academies of Sciences (IANAS). This network could become an important source of advice to regional and international organizations, such as the Organization of American States, which are involved in promoting scientific development in the Americas.

In the areas of the basic sciences, Latin American networks of biology, chemistry, mathematics, physics, and astronomy are important for dealing with questions regarding those disciplines, as are the more specialized networks for dealing with specific problems or technologies. Regional and national projects that require the participation of an organized and strong scientific community will benefit from scientific institutions that can serve as instruments to secure that participation.

Focus on the support of countries that are lagging in science and technology

The heterogeneity of the present stage of the science and technology establishment among the different countries in the Americas demands that special care be taken when proposing mutual collaborations and partnerships. To be effective, the proposed policies must attend to the double requirement of focusing on the needs and fulfilling the expectations of all countries involved.

Where well-defined or spontaneously grown but well-established domestic scientific agendas exist, the proposed bilateral or multilateral collaborative schemes proposed should respect them by incorporating mutually compatible themes. Different concerns arise, however, when the collaboration involves scientists from the least developed (in science and technology) Latin American countries, for those usually do not have clear and consensually defined national scientific priorities. There is a risk, in these cases, that a substantial portion of already lean budgets and scarce resources will be diverted to pursue an extraneous scientific agenda.

At the same time, specific measures should be devised so that these countries are not once again left off the bandwagon of hemispheric collaboration. Multilateral, or even bilateral, partnerships with these countries should be based on more than a standard manner of financing, abandoning -when appropriate- the practice of sharing costs. In this regard, special attention should be given to novel financing, including the possibility of exchanging part of the foreign national debt, for well-defined investments in "capacity building" in science and technology, i.e., selectively investing in the domestic educational, scientific, and technological infrastructure, as well as through the creation of specific funds, green bonds, and other incentives.

Promote the training and education of human resources

One of the essential components in the attainment of capacity in science and technology is human resources. Most of the countries in Latin America and the Caribbean have great deficits in scientists and technologists with advanced training relative to the number necessary to enable them to carry out high-quality research. Training of scientists and technologists at the postgraduate level (master's and doctoral degrees) requires centers and institutions of higher education with rigorous academic standards.

There are a number of such institutions in Latin America that provide excellent postgraduate training in topics highly relevant to the problems of the countries of the region. It is essential that these institutions be entrusted with the task of training scientists and technologists from the neighboring countries that are lagging in science and technology. This requires a robust program of fellowships. Once trained, these young scientists and technologists should be assisted in returning to their home countries with permanent positions and enough grant support that would allow them to establish research efforts attuned to national priorities. The United States and Canada, the developed countries of the Hemisphere, should help in this effort by providing high-level scientists who can be available to participate in and advise such training, strengthening, and raising the standards of such programs.

In addition, "sandwich fellowships," which give doctoral students from Latin America and the Caribbean the opportunity to carry out research in the laboratories of developed countries, are highly enriching experiences. Postdoctoral fellowships in the developed countries are also important components of the training of the most talented students and allow them to acquire contacts that will be essential for their research careers. These postdoctoral programs should include reentry grants that stimulate and facilitate the students' return to their home countries.

Regional accreditation of postgraduate training programs would be very useful to allow not only co-validation of courses and activities but also mobility of students within the region.

Short-term fellowships for research and training would be helpful for updating knowledge of new fields and emerging techniques and would also facilitate the use of special "facilities" that are unique in the region, such as synchrotrons, astronomical observatories, the Galapagos biodiversity research station, oceanographic research ships, etc. Complementary to theses short-term fellowships, intensive, short-term hands-on training courses should be organized in centers of excellence in the region, and these should be opened to all qualified applicants from the region.

It is also essential to raise the level of science education of the general public. This is best achieved through improvement of the methods used in science education for primary--and secondary--school students. Inquiry-based methods now being introduced with the support of the National Academy of Sciences in the United States and several Latin American academies have greatly enhanced the interest of children in science and changed their perception, making science a vibrant and exciting subject. Children who learn science through their own experimentation also integrate values such as respect for truth and rigorous, critical assessment of dogmatic statements. This knowledge and the values acquired will make these students better and more responsible citizens of a more free society.

Promote the formation of networks of scientific institutions and individuals

Multi-user facilities exist in various institutions in some countries of the Americas. Specific funding mechanisms should be devised to enable individual scientists and students to have free access to this important research infrastructure and to foster collaborative projects uniting institutions from different countries.

It is essential that the domestic and regional cyberinfrastructure be upgraded to enable the full exploitation of the opportunities afforded by the information and communications revolution.

Stimulate collaborative research in projects involving south-south and north-south (triangulation) interactions

The Inter-American Materials Collaboration (CIAM) is a good example of a regional initiative of supporting bilateral and multilateral collaborative projects in a specific area (materials) that should be enhanced, expanded, and adapted to other themes of inter-American interest.

Build and invest in required infrastructure

Investment in infrastructure, including cyber-infrastructure, is critically needed in the Americas to accelerate educational research and industrial development activities. This infrastructure may allow smaller countries in the region access to expensive facilities and laboratories located in more advanced countries.

Identify centers of excellence for training and research for the region

It is important to identify national and regional centers that have highly qualified human resources, adequate infrastructure, organizational leadership, and management to carry out research and training at an international level. Schemes like the Millennium Initiative of the World Bank, in which international communities participate in the selection of the best centers, could be replicated to support these groups. Once identified, governments and international institutions should stimulate their undertaking of projects of special relevance to the country and region and should increase their participation in networks that enhance their potentiality and promote their interaction with the best centers of the industrial countries.

Collaborate with other international and regional institutions that share similar purposes

The OAS should pursue its responsibility in promoting scientific and technological development in the Hemisphere through collaboration with other institutions that share similar purposes, such as the United Nations Educational, Scientific and Cultural Organization (UNESCO); the Pan American Health Organization; the International Centre for Genetic Engineering and Biotechnology (ICGEB); the Economic Commission for Latin America and the Caribbean (ECLAC); the Inter-American Development Bank (IDB); and the World Bank (WB).

This collaboration can complement expertise and result in increased funding so that more ambitious projects and programs can be undertaken. This possibility requires that the OAS adopt flexible and efficient methods to select and finance joint initiatives.

Other important possibilities of cooperation include extending to all Latin American countries access to the Brazilian mechanism of national negotiation with editorial companies for access to electronic journals ("Portal da CAPES"); and supporting the proposal presented by President Nestor Kirchner of Argentina (and endorsed by Brazil), which asks for international mechanisms that would consider domestic investments in education (at all levels) and the increase in internal scientific capacity of Latin American countries as part of their foreign-debt payment.

Analysis of Specific Thematic Areas and Policy Recommendations

Distinguished science and technology experts from the region participated in each work group, exchanging views on technical questions and formulating science and technology policies for the Americas. As a result, information related to the state of the art of the area, a diagnosis of its limitations and barriers, and a series of recommendations and policies for development are presented. In addition, important examples of successful collaboration in the region are provided.

Information Technology and Advanced Networks

Advanced networking and information infrastructure is a critical vehicle for propelling countries of the region into competitive, knowledge-based economies. It strengthens other areas (science, health, and education), provides access to global scientific and technology resources, and empowers critical social and economic activities. The failure to make this investment will result in continued loss of competitiveness.

State of the Art

Advanced networking and information infrastructure (cyberinfrastructure, e-science) consists of people, networks, software, computational and storage resources, digital libraries, scientific data bases, scientific instruments, sensors, and facilities. It is a rapidly growing and changing knowledge-intensive, high-technology area with profound impact on a broad array of social and economic activities and productivity growth. Numerous developing nations (e.g., South Korea and Ireland) from other regions have made large, strategic investments in this area that have allowed them to advance rapidly to the ranks of advanced countries. Countries worldwide are investing billions of dollars in national, dedicated, advanced networks and information infrastructure, connecting universities, research centers, and other educational institutions.

Status in Latin America

With over a decade of network development in the Hemisphere, achievements include islands of progress with state-of-the-art infrastructure, as well as the emergence of the Latin American Cooperation for

Advanced Networks (Cooperación Latino Americana de Redes Avanzadas - CLARA), to support regional advanced networking. However, national research and education networks (NRENs) are largely based on commercial Internet services at low speeds; there is limited global connectivity and great unevenness in levels of country development. The region is not positioned to participate effectively in global research or global economy.

Why are advanced networks important? Networks enable students to be educated by radically different methods and participate in science in completely new ways; campuses with advanced-network access prepare the next generation for leadership, innovation, and global participation; exposure of students to new knowledge and techniques represents an efficient vector of technology transfer for the society as a whole; interconnecting regional and national networks builds multinational scientific communities.

- Networks make critical knowledge widely available to society as a whole in essential areas such as education, health, environment, and public safety.

- Advanced networking and connectivity supports research and education in all fields of science and is an important area of scientific and technological development in and of itself.

- Advanced networks support the conduct and advancement of all other academic disciplines, including strategic emerging areas of research, often multidisciplinary in nature (biotechnology, nanotechnology, materials research, environmental sciences).

- Networking enables integration with the global scientific and technology community, which allows scientists, no matter where they are located, to participate in leading-edge research.

- Networks speed the use of leading-edge scientific knowledge to solve local problems by providing access to global, state-of-art knowledge resources.

- University graduates trained in cutting-edge technology bring new knowledge and capabilities to the private sector and act as the most important means of technology transfer.

- Advanced research and education networks are testing grounds and incubators for innovation in industry.

Limitations and Barriers

- There is an insufficient awareness among policymakers and user communities regarding the need for long-term, strategic support to sustain advanced networking and information infrastructure for national economic development.

- Regulatory frameworks are inappropriate for creating advanced networking and information infrastructure and encouraging new technologies and models.

- There is a lack of access to price-competitive, high-bandwidth capacity throughout each country and between countries to build advanced networking and information infrastructure.

- There is a limited availability of appropriately trained and educated local human resources to support network development and user communities.

- Disparities in capabilities and resources across countries present special challenges to collaboration within and outside of countries.

- Adequate funding is lacking for research and education and for advanced networking and information infrastructure that support research and education.

Recommendations and Policies

- Invest in advanced national networks to stimulate national and regional economic development with the objective of providing connectivity to every university and research center with at least 100 megabits per second (Mbps) capacity to the global set of research and education networks by the end of 2006.

- Promote a policy and regulatory environment that encourages the deployment of advanced networking infrastructure and ready access to new technologies for research and education.

- Invest in the research capability of universities and research centers that enables and utilizes network development.

- Invest in human resources to build, operate, maintain, and help user communities to utilize advanced networking infrastructure.

- Reach out to local press, authorities, and communities to communicate importance, benefits, and uses of networks.

- Partner with telecommunication companies to invest in capacity building of providers of telecommunications training (PTT) engineers, to teach them about research, education, and network needs and new technologies.

- Focus on building local cyberinfrastructure first, expanding in concentric circles to national, regional, continental, and worldwide scale.

- Focus first on getting broadband capabilities to those with immediate needs, e.g., universities and hospitals.

- Promote uses of networks within government.

- Promote new models of organizing telecommunications, such as university-owned networks and unregulated spectrum.

- Work with municipal governments to build fiber-optic networks for universities.

Examples of Success

- Multi-country science facilities (e.g., Gemini and Pierre Auger observatories) networks

- Advanced internet network in Costa Rica to make broadband access available throughout the country

- Multicast distance training of mathematics teachers - To become a real player in the information society, Brazil faces the challenge of improving the quality of education provided to its young people, the training of teachers, and the application of the most recent advances in information technology to education. To address this need, the Brazilian Research and Education Network (RNP) and the Pure and Applied Mathematics Institute (IMPA), in collaboration with research universities all across the country, launched an initiative in 2002 for distance training of high school teachers in mathematics. IMPA, the premier mathematics institute of Latin America, was established in 1952 to support teaching and research in pure and applied mathematics and to contribute to the improvement of mathematical learning throughout Brazil. Since 1990, IMPA has trained high school teachers at its headquarters in Rio de Janeiro. However, its ability to reach teachers in other parts of the country was constrained by distance and related costs. The impact of the RNP/IMPA multicast distance learning initiative can be measured by a 41% increase in the number of teachers in training and the inclusion of 14 of the 27 Brazilian states in the network. This experience, although still in its early stage, is readily applicable to other areas of training, with major benefits for Brazilian society.

- Municipal collaboration for advanced telecommunication infrastructure - The state government of Chihuahua, Mexico, is pioneering models for the deployment of new telecommunications infrastructure. In the city of Chihuahua, the state capital, the government has laid 70 kilometers of municipally owned optical cable. Initially justified as a means of improving vehicular traffic management, the network now connects 34 government office buildings, city hospitals, the state university (Autonomous University of Chihuahua), and other educational institutions. The network uses the municipal right of way and allows connected institutions to enjoy high-capacity connections at significant savings over the prices presently offered by telecommunications carriers in the city.

- International research collaboration in high-energy physics - The Large Hadron Collider (LHC) at CERN will be the most powerful instrument ever built to investigate the properties of particles. It is expected that the many high-energy and nuclear physics experiments will break new ground in our understanding of the fundamental interactions, structures, and symmetries that govern the nature of matter and space/time in our universe. The LHC's huge detectors, expected to be operational by 2007, will study what happens when the LHC's beams collide. Communities of thousands of scientists around the world, including scientists from Latin America (particularly Brazil), will extract small signals from enormous backgrounds via computationally demanding analyses of datasets that will grow from the 100 terabyte to the 100 petabyte scale over the next decade.

In the future, Latin American scientists in all disciplines, including astronomy, distance education, computational grids, space sciences, genome research, meteorology and climatology, and high-energy physics will be increasingly dependent on dedicated high-capacity networks to participate in cutting-edge research and education and to bring the benefits of international collaborations to their local and regional communities. High-performance networks make possible collaborations that bring direct experience of the most outstanding science to remote locations, access powerful computing resources for data analysis, improve ease of use, and lower costs.

Biotechnology

State of the Art

Biotechnology is a multidisciplinary field that utilizes techniques to manipulate biological systems, providing goods and services. While some of the molecular methodologies are sophisticated and expensive, other approaches are more familiar, accessible, and inexpensive. Biotechnology is intimately linked to bioinformatics through the need to use intensive computing and data-base resources. Additionally, nanotechnology interfacing with biotechnology could complement and significantly expand the application possibilities. Hence, there is a need for parallel investment and integrative development across these fields.

Biotechnology can provide significant benefits to society through the improvement of the quality of life. These benefits accrue to, but are not limited to, economic development, health, agriculture, industry, environment, and social welfare. The benefits from biotechnology in developed countries include increases in crop production, food quality (agriculture, aquaculture, and livestock), pharmaceutical production, diagnostics for pathogens, and bioremediation, among others. The world market in 2002 for plant biotechnology alone was US$6.5 billion and continues to grow. In the health sector, transgenic organisms provide models for human disease, allowing, for example, testing of new drugs and therapies. In industry, bioreactors are used to make products in quantities not previously possible, as well as new products for health and commercial applications. This success of biotechnology in developed countries has resulted from a strong investment in human and material resources, reflecting a vigorous governmental commitment. These countries typically commit more than 1% of the GDP to research and development, within a well-defined legal framework for biosafety, technology transfer, and intellectual property rights.

In contrast, Latin America and the Caribbean countries, for the most part, invest an average of 0.5% of GDP in research and development. The legal framework has not been properly established, and political support is meager. Nevertheless, a few countries within the region (for instance Brazil, Mexico, and Chile) have increased their commitment to research and development in biotechnology. The most successful applications of biotechnology in the region have been in the field of crop micro-propagation and plant viral diagnosis. However, the region shows great heterogeneity in its development. For instance, only a few countries have moved ahead with genome projects, production of genetically modified organisms and industrial applications, in response to their needs and markets.

Further development of biotechnology capabilities must be a priority for the region, to allow the achievement of the full potential of its natural resources and its biodiversity and fulfill its commitment to sustainable development. Biotechnology promises to increase the standard of living by opening new job possibilities, offering new products to the world market, improving health and human welfare, and promoting the administration of justice.

To achieve biotechnology proficiency, the countries in the region must increase their commitment to research and development, establish collaborative efforts at the hemispheric level, develop human resources and infrastructure, and create a legal framework within which biotechnological development may occur.

Limitations and Barriers

Among the problems that restrict biotechnology development in Latin America and the Caribbean (LAC) countries are the following:

Most countries lack a national strategy that defines priorities and goals for biotechnology development

Generating such a strategy requires in-depth studies of the capacities and opportunities within the scientific and business establishments of the LAC countries, including infrastructure, financial investment, and human resources. It is also necessary to understand the mechanisms by which these capacities can be increased to achieve competitive advantages for the region. National policies can and should support the establishment of regional strategies, including issues concerning biosafety and regulatory policies. In fact, lack of a stable national strategy makes it more difficult for a country to pursue long-term scientific objectives with regard to domestic progress in biotechnology.

Trained human resources

Biotechnology demands the creation of large multidisciplinary research teams in order to advance from basic discovery to the development of new products and services. On a per capita basis, the number of scientists and technologists in LAC countries is in general 5-10 times lower than that found in industrialized countries. For that reason, it is difficult to assemble groups with a critical mass that can undertake the ambitious biotechnology projects necessary to address crucial problems for the region. The new areas of post-genomic biology, such as bioinformatics, proteomics, and comparative genomic, are seriously deficient in trained human resources.

There is also a need for leadership training for scientists in areas such as project and personnel management, including nurturing of academic groups, intellectual property, technology transfer, and entrepreneurship, to prepare individuals who can champion the application of research findings and discoveries, stimulate technology growth, and focus the resources within and among countries.

Financial support of research and development projects by the public sector.

Most LAC countries invest very little in scientific and technological research. The average investment of these countries is around 0.5 % of GDP, which is five to six times less than that of industrialized countries. If we consider the amount invested per capita in LAC, then the absolute amount is 20-30 times less than that of advanced countries. This very limited support for research means that the few researchers working in the region have laboratories that are, in general, poorly equipped to carry out pioneering research and that most institutions lack the sophisticated infrastructure to permit that research. The limitations in R&D funding often mean that support provided to projects is limited to small individual grants that do not allow for the establishment of the large groups and consortia of laboratories that are required for solid and broad-based biotechnology projects.

Critical lack of essential research materials

There are significant problems with regard to access to reagents and other biological materials. This problem is exacerbated by new restrictions on the transport of these materials subsequent to September 11, 2001, and issues associated with customs regulations. Further, there is a lack of access to scientific and other data bases among LAC countries and researchers, as well as convenient and rapid access to the scientific literature, in general.

Small investment by the private sector in research and development

As stated, biotechnology research must be product oriented. That means that active participation of the business sector in all aspects of that research, including the financial arrangements, is required. This has been limited by the tradition, existing policies, and operations of transnational companies. The business sector in Latin America and the Caribbean regions, as in all developing countries, has no tradition of investment in research and development, and the academic sector responsible for the bulk of the research has no cultural history of directing their interests to applied areas. In addition, academics in the LAC countries generally do not become entrepreneurs to develop their own ideas or findings.

In many LAC countries, the policies and legal systems do not provide incentives to the private sector to invest in research and development. Policies and laws of this type have greatly favored the investment of venture capital, which has created the explosion of biotechnology companies in the developed world over the past decades.

Another factor that limits private investment is the fact that large transnational companies today dominate many areas of biotechnology. Companies that operate in the areas of pharmaceuticals and agriculture (particularly in the large agricultural crops such as corn, tobacco, cotton, rice, wheat, and soybean) carry out intensive research programs, which are obviously concentrated in large facilities located in developed countries.

Critical situation of universities

LAC universities are responsible for a large part of the research capacity of the region. Unfortunately, these universities are in the midst of a crisis that is the result of several factors. One factor is the rapid growth in the number of undergraduate students. Over the past 20 years the number of university students in Latin America and the Caribbean has increased enormously, without a parallel growth in the number of trained academics or in the amount of public investment in higher education. These financial constraints have resulted in public institutions that face serious difficulties in maintaining research efforts as private "for-profit" universities, which have little interest in mounting relevant research efforts, have also emerged.

The financial crisis within the universities has caused internal turmoil and, as a result, their leadership has not paid sufficient attention to the institutional and disciplinary structures necessary to foster the transdisciplinary research consortia required for biotechnological studies.

Public awareness of the need for science and technology research

The general public in most LAC countries is not aware of the potential role that endogenous research can play in their socioeconomic development. There is still a widespread belief that research in science and technology is the province of the rich industrial countries and that LAC communities do not have the capacities and the resources to carry out significant research. Thus, contributions and achievements of local scientists are ignored by both the public and by policymakers, and acknowledgement of local research providing solutions to local problems is limited. A key factor in this lack of attention is scientific illiteracy, which derives from the completely inadequate level of science education provided by primary and secondary schools. Science is presented as a boring series of concepts, facts, equations, or definitions that are learned by memory from a teacher or from books. There is very little experimentation by the students or discussion of scientific ethics and values. Both of these elements should be an integral part of science education in order to produce an informed public.

Lack of clear regulation and laws regarding research and use of biotechnology products

Many countries of the region do not yet have in place a legal system addressing and adapted to the biotechnology revolution in matters of intellectual property rights and biosafety regulations. Such a legal and regulatory system is essential to foster investment by the national and international private sector.

Deficiency in the number of collaborations among and within LAC countries and among LAC countries and North America and Europe

There are difficulties not only in providing sufficient resources between and among researchers but also in sharing those resources in a convenient and collaborative fashion. This may result from cultural traditions, particularly those favoring individualism. For example, in academic-career evaluation, to be a principal investigator of a project is considered to be much more significant than to be a collaborator on someone else's project. Financial support for these collaborations, including international collaborations, may be hindered by the lack of local financial reciprocity to co-fund these interactions.

Recommendations and Policies

Listed below are three recommended topics of research important to the region, organized by application.

Agriculture/aquaculture

These include development of viruses that affect agricultural production of crops such as corn, potatoes, and beans and can be used as a biological control of pests; research on the micro-propagation of plants species, technology for which is not yet available; plant biotechnology for improved production of crops of regional economic importance: beans, soybeans, corn, and potatoes; and development of biotechnology in aquaculture, particularly with regard to virus-free salmon and shrimp production.

Health/human welfare

Important are research and biotechnology applications for the diagnosis of diseases endemic to the region and epidemiology (humans, plants, and animals); DNA analysis for forensic applications and paternity cases and for studies of human population and ethnic diversity; development of DNA vaccines for domestic animals and humans; and crop production of plants that contain biomolecular and active pharmaceutical principles, as well as natural products and medicinal plants.

Environment

Included here are studies of the biodiversity of the region, such as local plants of nutritional/medicinal importance, domestication of edible plants and ethnobotany, as well as studies aimed at bioprospecting and bioremediation.

- There is ample evidence that collaborative research projects in biotechnology can count on the participation of the more advanced laboratories in Latin America. There is also evidence that they can greatly stimulate the capacities of the scientifically lagging countries in the region that are included within their scope. These projects do not require large amounts of funds since they should include laboratories whose staff and infrastructure is provided by the host country. A large part of the external financing is dedicated to the support of exchanges of personnel and to training activities.

For example, it is possible to support five of these projects in one priority area of biotechnology (fruit ripening, resistance to arid stress in cultivars, defense mechanisms of plants against viral pathogens) with only US$100,000 to US$150,000 per year. These projects, which would involve 10-15 laboratories in different countries, would constitute an active research and training network that would encompass the whole region.

Once the projects are selected, they could include one laboratory from the United States or Canada with special interest in the area of research, which would interact in a triangular fashion, facilitating north-south, as well as south-south, collaboration.

There are successful projects that several institutions might join the OAS in co-funding and promoting. The scientific communities, represented for instance by the Latin American Network of Biological Sciences (RELAB) and the Technical Co-operation Network on Plant Biotechnology (REDBio), should be active participants in these projects.

One of the main tasks would be to define ways in which these projects could be implemented that would be highly relevant to Latin America.

- To facilitate research exchange and availability to the current literature, data banks could be created for researchers' CVs: a good example is the Brazilian CNPqs' CVLattes databank, now integrated in an international network called ScienTI. Another example is BIREME, a regional library for medicine which offers access to the current literature produced in as well as outside the region. Additionally, data bases should be made more generally available, and interaction fostered among the centers of excellence and groups in the region.

- Regional strengthening of research capacity has to be based on building human resources. The proposed ways to achieve this include short, hands-on, on-site courses hosted by universities and other institutions, private organizations, and NGOs, to teach researchers state-of-the-art bio-techniques that can be applied to their specific needs. Internships should be funded at regional laboratories for exchanging techniques and knowledge among scientists, and a reward system created for continued professional training and updating knowledge.

- “Leadership” training for outstanding researchers should be conducted, following a model such as the LEAD program of the Rockefeller Foundation. Include topics such as personnel and laboratory management, bioethics, legal aspects of technology transfer, and intellectual property.

- A program for master’s and Ph.D.-level fellowships should be developed for long-term training.

- Opportunities should be created for scientists trained abroad to reenter their countries’ scientific community. Give incentives (such as tax breaks) to private companies, universities, and the public sector to create job opportunities for biotechnology-trained people.

- Institutions, facilities, and programs that have shown outstanding performance should be strengthened, and those that haven’t should be eliminated or reorganized.

- Core facilities should be established within universities or regions that could provide access to infrastructure and support the establishment of critical-mass research programs and collaborations. This may require creative thinking and action to break away from the status quo. A model of organizational structure could be multidisciplinary centers extending across departmental boundaries. Establishment of centers of excellence could go hand in hand with core research facilities. These centers should be merit based, with a level of autonomy and subject to critical review by outside experts. They should also have the ability to train graduate students. They may be supported by institutional grants as opposed to program grants.

- Scientists should be trained for implementation of the Cartagena Protocol on Biosafety, using those regulations already in place in other countries. These training efforts can be greatly enhanced through the formation of multidisciplinary networks.

- To demystify the field and reduce apprehensions regarding the applications of biotechnology, especially in food, it is imperative that the public becomes educated in the general concepts, applications, risks, and benefits of biotechnology. An international effort to create a media campaign with the appropriate information needs to be a priority.

- Biotechnology modules should be incorporated into the syllabi of elementary and secondary education. To address scientific illiteracy we need to create effective teacher training and lesson plans that stimulate students’ involvement in the fascinating experience of discovery. Additionally, high-level secondary-school courses should be developed that can be applied to university credits.

- Meetings should be held to foster direct interaction between biotechnologists and political leaders, to educate them about the potential economic and social impacts of biotechnology.

- Given the dependence on agricultural activity for economic development in the region, one of the areas of emphasis for biotechnology application should be agriculture. Crops such as corn, soybeans, and cotton have greatly benefited from applications of biotechnology, such as resistance to viruses, pests, and environmental adaptation. Production yields can be increased dramatically and the use of pesticides and other chemicals reduced as a result of biotechnology.

- It is imperative that there be equal access to funding and opportunities to all countries of the region, including those with less scientific development.

- As a regional effort, the ministers of science or pertinent authorities need to facilitate the logistics and importation of reagents, equipment, and supplies needed for research and eliminate or reduce customs restrictions for clearance of imported reagents.
- The countries of the region should be stimulated to increase their investment in biotechnology development. The OAS, together with major funding institutions such as the World Bank, the Inter-American Development Bank, and major foundations, should generate a forum with national decision makers to stimulate them to increase their investment in biotechnology research. Through the scientific communities, support can be obtained to ensure that high-quality projects and programs are presented to their respective governments. A small fraction (2-5%) of the national investment in biotechnology should be dedicated to regional activities that will enhance the research and training efforts of the specific country and help to build a regional community and network in this area. We should try to achieve a commitment from each government to have a state policy to increase the percentage of its GDP to science and technology. The goal recommended by the UN is to reach 1% of the GDP in increments of at least 0.1% each year.

- The OAS, acting together with the International Centre for Genetic Engineering and Biotechnology (ICGEB), the Food and Agriculture Organization (FAO), and Biotechnology for Latin America and the Caribbean (BIOLAC), should promote the establishment of regulatory and intellectual property rights systems in all countries of the region. As part of this project, training should be provided to those who will have responsibility for biosafety monitoring and the implementation of the Cartagena Protocol in Biosafety, as well as for training individuals in the areas of intellectual property and technology transfer. These will be addressed in the subsections below.

Biosafety

At the country level, there is the need to develop national biosafety systems and procedures involving technical-capacity building, strengthening, and support of institutional biosafety and regulatory procedures. The development of regional regulatory guidelines for the application and use of biotechnology would facilitate interaction among countries. Further, aid should be provided to LAC countries so that they can implement the regulations outlined in the Cartagena Protocol for the cross-border movement of genetically modified organisms (GMOs).

Patents and intellectual property issues

During the last twenty years, biological scientists have had to adapt to a change that had already occurred in other areas of science (chemistry, some areas of physics). One of the components of this change is the patenting of discoveries with potential commercial value and the confidentiality of research topics and results that may have biotechnology applications. One of the most affected areas of this new phenomenon has been agriculture research. Traditionally, agriculture research has been mainly the responsibility of publicly funded research institutes that freely distributed new varieties and new knowledge to all interested parties. Today, companies, many of which are large transnational enterprises, carry out a large part of the biotechnology research in agricultural products. Obviously, their products are patented and are only available to those who can pay for them. The results of the research carried out by these companies are restricted and not available to the global scientific community.

Latin American countries have no culture of patenting, and the separation of the academic sector from the business sector is the norm in our societies.

Protection of intellectual property rights and restricted licensing of biotechnology products are new facts of life that have appeared as a result of globalization and the widespread establishment of free-trade agreements. This new situation requires countries and regions to establish legal regulatory systems and clear policies that protect their societies and allow scientists and businesspeople to develop biotechnology products that improve competitiveness and the quality of life.

Technology transfer

Technology transfer must be implemented within a legal framework in order to comply with the intellectual property rights of inventors. Concomitant with the patenting of inventions, the licensing of those inventions to the business sector provides a close framework of interaction between academic scientists and the business sector and also provides financial resources in the form of licensing fees and royalties, which are returned to the universities and perhaps shared with inventors. Technology-transfer offices can be established within the framework of the university administrative structure to serve this function. This system has been quite successful in North America and Europe. The transfer of biotechnology to the enterprise sector is very important in LAC countries, since it will accelerate the application of biotechnology to benefit both economic and social development. It is advisable to create new mechanisms through our science and technology councils and financial institutions in order to better manage and negotiate biotechnology agreements within the LAC region and the United States, Canada, and Europe.

Models of technology-transfer offices within the university and institute environment include the Wisconsin Alumni Research Foundation of the University of Wisconsin, Arizona Technology Enterprises, LLC, of Arizona State University, and the Technology Transfer Office of the Scripps Research Institute, La Jolla, California, all in the United States. It is often necessary to consider as well the licensing of technology as a requirement in the pursuit of commercially relevant research. Technology-transfer offices can also be instrumental in negotiating such licenses with other institutions.

Examples of Success

Health and health policy

One of the successful models in collaborations and health research is the partnership developed over fifteen years between the Sustainable Science Institute (SSI) and the National Center of Diagnosis and Reference (Centro Nacional de Diagnóstico y Referencia - CNDR) at the Ministry of Health in Nicaragua. Collaboration with the Department of Parasitology resulted in simplification of polymerase chain reaction (PCR) techniques for the diagnosis of leishmaniasis, which have been used routinely there for over a decade. This work also led to the discovery of a new form of disease caused by Leishmania chagasi infection (atypical cutaneous leishmaniasis---ACL). This research fostered the production of informational posters about ACL, which were distributed throughout the nation’s health centers, increasing government purchase of the therapeutic agent glucantamine, thereby making treatment more readily available. SSI also worked with the Department of Virology at the MOH to strengthen laboratory capacity and improve the epidemiologic surveillance of dengue virus at a national level. A 1995 epidemic of acute febrile illness was successfully managed in large part because scientists were able to rule out dengue virus as the cause based on the knowledge they had just acquired through AMB/ATT (Applied Molecular Biology / Appropriate Technology Transfer) training. Subsequently, a sentinel study was conducted to investigate risk factors for severe dengue disease, which resulted in novel epidemiologic findings and has led to the establishment of a productive collaboration between laboratory, epidemiology, and clinical sectors of the health system that have traditionally functioned in isolation. The study design has recently been adopted by a European Union project to conduct sentinel surveillance at a national level in Nicaragua.

Plant virus control

Plant disease caused by viruses is one of the main factors limiting agricultural productivity in Latin America and the Caribbean. Viruses that are of significance in the region include potyviruses and Gemini viruses, and they infect a wide range of crops, such as tomato, beans, potato, papaya, and peppers. In response to the near devastation of the papaya industry in Jamaica due to papaya ringspot virus (PRSV), the Biotechnology Center of the University of the West Indies in Jamaica, in collaboration with Cornell University and the Jamaica Agricultural Development Foundation (JADF), initiated a project to develop papaya with resistance to PRSV.

In 1994, the JADF supported the training of a Ph.D. student from Jamaica in plant molecular pathology at Cornell University, specifically in biotechnology, to develop transgenic papaya. The coat protein gene of the Jamaican isolate of PRSV was successfully transferred to the Jamaican solo papaya variety (Carica papaya) at Cornell University using the strategy of pathogen-derived resistance developed in the mid- 1980s. This has been one of the most successful strategies used to develop plants with resistance to viruses. In 1996, the Jamaican technology and transgenic papaya plantlets were transferred to the Biotechnology Center in Jamaica, where further work was carried out to evaluate the transgenic lines and undertake field testing. Field testing and toxicological evaluations are still under way, and it is expected that by mid 2004 transgenic papaya with resistance to PRSV will be commercially available.

Concurrently, the National Biosafety Committee (NBC) was established by the government in 1996 to address the imminent growth in biotechnology and to develop protocols and procedures for importation, safe handling, and the use of transgenic papaya in Jamaica. In 1997, regulations were gazetted, under the Plant Quarantine Act, thereby allowing the importation of transgenic plants and outlining the role of the NBC in monitoring and regulating the importation of transgenic plant material for contained, supervised research.

Since then, the plant transformation group at the Biotechnology Center has embarked on the transformation of Sea Island cotton (Gossypium barbadense) containing the Bacillus thuringiensis (Cry1 and 2A) toxin gene for resistance to insect pests. This project is also funded by the JADF. Other research focuses on the development of transgenic tomato plants resistant to the Gemini virus tomato yellow leaf curl virus (TYLCV) (funded by a CDR-USAID project in collaboration with the University of Wisconsin-Madison) and regeneration protocols as a prelude to developing transgenic hot peppers for resistance to tobacco etch virus (TEV) in the Caribbean region (funded by the Caribbean Development Bank).

Regional cooperation in biotechnology

There are a number of successful cases demonstrating that regional cooperation in biotechnology research and training can increase the effectiveness of efforts in the individual countries and can enable the region to undertake ambitious projects related to common problems of high social relevance. The Latin American scientific community is willing and eager to participate in these regional collaborations. Examples can be found in RELAB projects, in the UNDP/UNIDO/UNESCO regional project of biotechnology, in the CABBIO (Argentina-Brazil Center of Biotechnology), the CYTED networks, UNU/BIOLAC, and the REDBIO/FAO. The ICGEB has also played an important role in generating joint research projects in biotechnology and regional training opportunities. The Pan American Health Organization has also developed joint multicenter projects in the health sciences.

DNA identification in Costa Rica

Human identification using DNA markers and the polymerase chain reaction (PCR) were first applied in Costa Rica in 1990 at the Center for Cell and Molecular Biology Research of the University of Costa Rica. A population sample was analyzed with short tandem repeat (STR) markers, and then microbiology professionals from the Judicial Laboratory were trained in the determination of paternity and in the analysis of human remains. By 1995, the Judicial Laboratory had started to resolve paternity cases with STR markers in sequencing gels stained with silver nitrate. As the lab developed credibility, the judicial court invested in the acquisition of automated sequencers (ABI310), which quickly raised the capacity to resolve both paternity and forensic cases.

In 1999, with the support of the First Lady Lorena Clare de Rodriguez, and scientists from the university, a law was passed by the Legislative Assembly to promote responsible paternity, following the example of Portugal. This law responded to the high percentage of children born out of wedlock (over 50%), hence with no legally recognized father. The law allows unwed mothers to declare the identity of the father. If the father does not comply with the assignment of paternity, a DNA test is done to resolve the case. Thus, in Costa Rica every child today knows the identity of his or her father, and unwed mothers have access to alimony support.

Bacterial leaching of copper in Chile

In the mid eighties, an ambitious multidisciplinary biotechnology project was launched in Chile with the support of the UNDP and UNIDO. This project, which studied bioleaching of copper, lasted seven years and required an investment of over US$2 million. It involved biologists, mining and chemical engineers, and CODELCO, a major copper mining company. As a result, important advances in the understanding of the bacterial physiology and of the mineral oxidation process that is catalyzed by these microorganisms were achieved. This knowledge led to patents of a much-improved process and an increase in the efficiency of the bioleaching method of mineral extract.

Today, Chile exports 4% of its copper by the bioleaching process, which saves hundreds of millions of dollars and is much cleaner environmentally. The Chilean government and Bio-Sigma, a joint project of CODELCO and Nippon Mining, have initiated a US$5 million program to study the genomics of the bacteria involved in the process.

Clean Technology and Renewable Energies

Limitations and Barriers

The countries of the Hemisphere confront differing information-technology realities. Poverty, unemployment, inflation, and economic and political instability all magnify the problem. In more advanced countries, such as the United States and Canada, the situation is very different from that found elsewhere in the region: More resources result in more technologically advanced development, thus generating a better quality of life for their populations. Concepts of cleaner production (P+L) have not been incorporated into the cultures of the less developed countries. In the poorest countries an increased trend toward pollution, due to their technological limitations, is observed. However, these countries are not the world's major polluters. Pollution control is not a priority in the allocation of state resources, as are the issues of poverty, health, unemployment, or the fight against corruption, among others, in which great efforts should be made.

It is not common for governments to allot adequate funding for development projects in science and technology, and in particular to those dedicated to the study of cleaner technologies and renewable energy. However, there is a consensus within the scientific community that efforts should be made to persuade countries to dedicate at least 1% of their GDP to scientific and technological research, with the sharing of this responsibility divided between public and private sectors. Naturally, each country should establish the priorities that best suit its own particular reality (health, education, access to potable water, environment, foodstuffs, etc.). An insufficient provision of resources and the brain drain also directly affect the quality of research-and-development technology.

The topic of cleaner technologies is not uniformly treated in the Hemisphere. For example, Ecuador possesses a cleaner production center (CEPL), but similar institutions do not exist in many other countries. Implementation efforts for cleaner technologies are not sustainable and continuous over time. Cleaner technologies projects do not have a positive response in all entrepreneurial sectors. In fact, there are very few success stories that show economic viability for entrepreneurs. In addition, the few that do exist are not well publicized either within or outside the country, since there are no adequate mechanisms for doing so. In general, the press pays little attention either to this topic or to other scientific and technological topics. In areas far away from economic activity, the situation is even more problematical, given the difficulty of access to information and to other means of education and control.

The level of productivity of the small- and medium-sized enterprises is highly dependent on the use of adequate materials and technologies. Cleaner technologies are more complex if applied to a plant whose original design did not take environmental considerations into account. This is the case with plants that utilize obsolete machinery---which also produce waste---and at the same time consume more energy. Resources are often not sufficient to update machinery adequately or to introduce cleaner technologies programs, owing to a lack of tax incentives or of other types of economic compensations that would facilitate the acquisition of equipment and the new technologies.

Another factor to take into consideration is that energy saving is a fundamental aspect within a cleaner-technologies work strategy. One part of the problem is related to the imminent global-wide scarcity of petroleum, as cited by successive studies, carried out on ever-more scientific bases. Besides, given that petroleum is a nonrenewable resource, markets will be affected in the short run, and therefore, other possible alternatives for the generation of energy in the Hemisphere should be explored. The search for renewable substitutes for energy generation is a controversial and still unresolved topic of ongoing concern and consideration for the Hemisphere.

Environmental legislation currently existing in the Hemisphere makes little mention of the concept of “cleaner production” (P + L). Therefore, guidelines and policies on the topic do not exist. For the region’s entrepreneurs, the priority is the generation of earnings and profits, and cleaner technologies may be considered more as a cost than as a profit factor. Entrepreneurs continually ask how much they have to invest and how much it is going to cost. Standards for quality and equipment function --already developed and adopted in the United States and Europe-- do not exist. Examples analyzed in some countries repeatedly show that the application of cleaner production carries economic benefits for the business sector and for society as a whole.

As mentioned, with respect to the dissemination of information, there are no means for its mass use because these are limited by the availability of economic resources. Adequate skills building and training exercises in the use of information resources likewise do not exist. Thus, researchers do not publish in mass media such as the Internet.

Globally, there are a large number of information sources on polluting substances, their health effects, and ways of controlling them; however, this wealth of data is unknown in many Hemisphere countries and therefore not used. For instance, in rural areas, the problems of potable water and environmental sanitation could be remedied and/or avoided by the use of very simple and widely available cleaner technologies.

Recommendations and Policies

- Formulate, propose, and develop policies in cleaner technologies and renewable energy.

- Stimulate dissemination, education, and research and development on cleaner technologies and renewable energy.

- Convince all stakeholders of the benefits available with the use of cleaner technologies.

- Share countries' research experiences, skills, and knowledge in the areas of cleaner technologies and renewable energy, through fellowships, technical-assistance missions from the more to the less developed countries, and joint research projects oriented toward problems, related topics, and other tools.

- Promote the Internet as a vehicle for improving the quality and augmenting the exchange of information, through discussion groups and courses, workshops, or specialized meetings on specific topics.

- Take advantage of the availability of expertise and existing resources in financing organizations, cooperation agencies, and countries highly advanced in these topics, so as to promote both horizontal and vertical cooperation (south-south and north-south).

- Promote the development of specialized data bases with relevant information for the use of lesser developed countries.

- Given the need for creating a change of attitude in both the public and private sectors with respect to the importance of cleaner technologies and renewable energy, it is important to establish multinational networks between the Hemisphere's most highly trained groups for the purpose of sharing experiences. In like manner, alliances of collaboration between and among governments, the private sector, and research (academic and technological) bodies to advance the topic should be sought.

- Implement training, skills building, and orientation programs at all levels.

- Carry out campaigns to orient and educate entrepreneurs and society on the benefits of cleaner technologies, which start from the premise that such policies will help reduce costs and augment profits through a better use of resources.

- Promote the development of print and virtual monographs with the OAS to disseminate and increase knowledge of cleaner technologies and renewable energy. Take advantage of new tools, such as the Virtual Forum implemented for this Workshop and others, such as the Portal of the Americas.

- Develop education programs oriented toward the general community on these topics, so as to generate a change of attitude with regard to the environment, cleaner technologies, and renewable energy.

- Develop on-line distance education courses on cleaner technologies and renewable energy with the support of the Inter-American Agency for Cooperation and Development of the OAS.

- Identify specialized technical personnel in cleaner technologies and renewable energies in the Hemisphere who can develop the courses and the technologies in the different official languages of the OAS.

- Publicize the global sources of information on contaminant substances, their health effects, and methods of controlling them.

- For rural and isolated environments, promote alternatives to the Internet for mass dissemination, such as education by radio and television.
- One of the principal objectives in the Hemisphere ought to be the search for resources to finance scientific and technological research applicable to the areas of cleaner technologies and renewable energy. Projects with components with immediate application are more complex and require greater amounts of resources for their implementation.

- This does not mean neglecting basic research, which is fundamental for consolidating the conceptual aspects of the topics involved. The participation of the national governments and of academic institutions, both of which play a significant role in basic research, is important. In this regard, the universities and research institutes that provide and promote the development of human resources in cleaner technologies and renewable energy have the primary role.

- As a support for strengthening scientific infrastructure, the virtual media are today indispensable and complement the personal and institutional relationships that translate into activities of technical cooperation, exchange of experiences, on-site training, and others. Therefore, these media ought to complement the activities just mentioned, but the traditional forms of cooperation, such as scholarships, fellowships, courses, seminars, workshops, and exchanges, should be maintained and expanded.

- Demonstrate to the ministers of economy and finance the advantages of applying cleaner technologies as a way of reducing pollution and environmental impact and improving productivity and enterprise competitiveness, with the concomitant reduction in unemployment stemming from the creation and expansion of new markets. To that end, roundtables on clean technologies for civil servants and experts should be held.

- Governments should be counseled to seek mechanisms that operate to change the mentality at all levels of society regarding cleaner technologies and renewable energy.

- A general lack of overall policies in the areas of cleaner technologies and renewable energy has been noted. It is therefore necessary to recommend to the pertinent authorities that the appropriate legislation be established in every country that does not have it.

- Each country's environmental legislation should also be standardized to avoid contradictions and bring it in line with national realities.

- Basing itself on current developed-country practices, it is important to establish economic penalties for transgressions. Given that the mechanisms for curbing pollution are known, it is imperative to make industries comply with the legislation in force, and not to continue investing too much money in monitoring activities, but to put practical solutions into effect.

- Given that it would be impossible to operate in the same industrial and service sectors in all countries, possible niches for each country or subregion should be considered. One example could be improving the production of coffee in the Andean countries, the Caribbean, and Central America through the use of technologies that do not produce noxious environmental effects, and at the same time offer better quality.

- In those countries where institutions charged with promoting cleaner technologies and renewable energy do not exist, efforts to create and develop them should be undertaken.

- Meetings should be promoted among the technical organizations in the Hemisphere that work in or research these topics, including universities and research institutes. This could be done using both face-to-face and virtual methods.

- Promote all possible forms of incentives and financing methods that will help small- and medium-sized enterprises effect technological changes that would improve equipment and processes for less harmful environmental impacts. Instruments to use could be state subsidies, tax incentives, and loans to the industrial sector that carry low interest and adequate grace periods.

- Seek the support of multilateral financing agencies to complement these actions.

- Create novel mechanisms, such as a "green bonds," available to the entire population.

- Financial support should be provided from international organizations, cooperation agencies, and developed-country governments, through special programs in the form of seed capital, to sustain development until such time as the countries develop their own capabilities. This support should be promoted at the national and hemispheric level.

- It is recommended that teams of multinational experts be formed to study standards of quality and functioning for renewable energy equipment already developed and adopted in the United States and Europe, and that their standards be adopted by the countries of the Hemisphere.

- Alternatives for the generation of renewable energies, such as photovoltaic, wind, gas use, coal, biomass, mini-hydroelectric centers, should be explored in order to substitute for scarcities in other sources, with priority given to isolated rural communities. In all these alternatives, possible negative environmental impacts ought to be considered.

- Take into account the concept of ecological design within the industry, oriented toward optimizing resources and protecting the environment, through the application of environmental indexes.
- Create opportunities for industry personnel and environmental authorities to develop mutually agreeable criteria in order to demand compliance with environmental responsibilities.

Examples of Success

The presented cases from the print media, as well as chemical, metal-mechanical, service, potable water, and timber sectors, are listed in the Annexes. Included are cases related to generation of safe water in isolated areas through simple, economic, and socially accepted technologies.

Materials and Nanotechnology

State of the Art

Due to its very nature, materials research is interdisciplinary, including concepts from sciences and engineering, and the field is continuously evolving. Nanotechnology, based on materials research at the nanometer scale, represents the confluence of diverse fields to enable nanoscale phenomena for new technologies.

Current Examples in the Americas

- Nano materials networks in Mexico (nano clays, nano composites, nano magnets, nano catalysts, optical devices and sensors)

- In Brazil, four nano materials research networks (nanobiotechnology, nanostructured materials, interface and molecular nanotechnology, and nano semiconductor devices) were established as the Nanosciences Millennium Institute.

- International materials institutes in the U.S.:
Princeton University / Wole Soboyejo: "US-Africa Materials Institute" (USAMI);
http://usami.princeton.edu
Rensselaer Polytechnic Institute / Krishna Rajan: "Combinatorial Sciences and Materials Informatics Collaboratory" (CoSMIC);
http://www.rpi.edu/~rajank/cosmic/overview.html
University of Tennessee-Knoxville / Peter Liaw: "Advanced Neutron Scattering netWork for Education and Research" (ANSWER);
http://answer.utk.edu

- National Science Foundation (NSF) / nanoscale science and engineering centers in the United States:

Columbia
Center for Electron Transport in Molecular Nanostructures
Cornell
Center for Nanoscale Systems in Information Technologies
Harvard
Science of Nanoscale Systems and their Device Applications

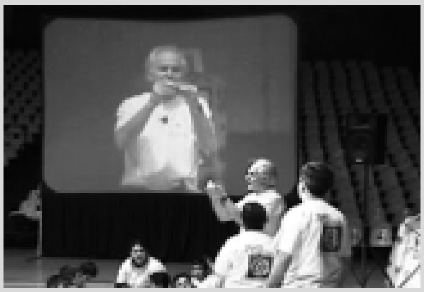
Box 2

Inter-American Materials Collaboration (CIAM)

- Promotes collaborative materials research and education
- Coordinated between national funding agencies in Argentina, Brazil, Canada, Chile, Colombia, Mexico and the USA
- 28 Projects, each involving participation of at least two countries, financed in 2003
- A second coordinated call for proposals for collaborative projects to be issued in 2004

Box 3

Harold Kroto Popularizing Nanoscience in San Luis Potosí, Mexico



■ Harold Kroto teaching primary school pupils how to build a Fullerene molecule

■ Proud children successfully contructing a Fullerene

Illinois
Center for Nanoscale Chemical-Electrical-Mechanical Manufacturing Systems
Northwestern
Integrated Nanopatterning and Detection Technologies
Rice
Center for Nanoscience in Bio & Environmental Engineering
RPI
NSF Center for Directed Assembly of Nanostructures
UCLA
Center for Scalable and Integrated Nanomanufacturing

- International Nano Science Institute in formative stages in Canada

- Formative programs in Argentina and Chile

- Materials Research Science and Engineering Centers (with focus on nanotechnology) in the USA
http://www.mrsec.org/home/
Alabama; Northwestern; Brown; Oklahoma/Arkansas; Columbia; Pennsylvania; Cornell; Penn State; Johns Hopkins; Princeton; Maryland; Stanford/IBM/UCDavis/UC Berkeley; MIT; Wisconsin; Nebraska; Virginia.

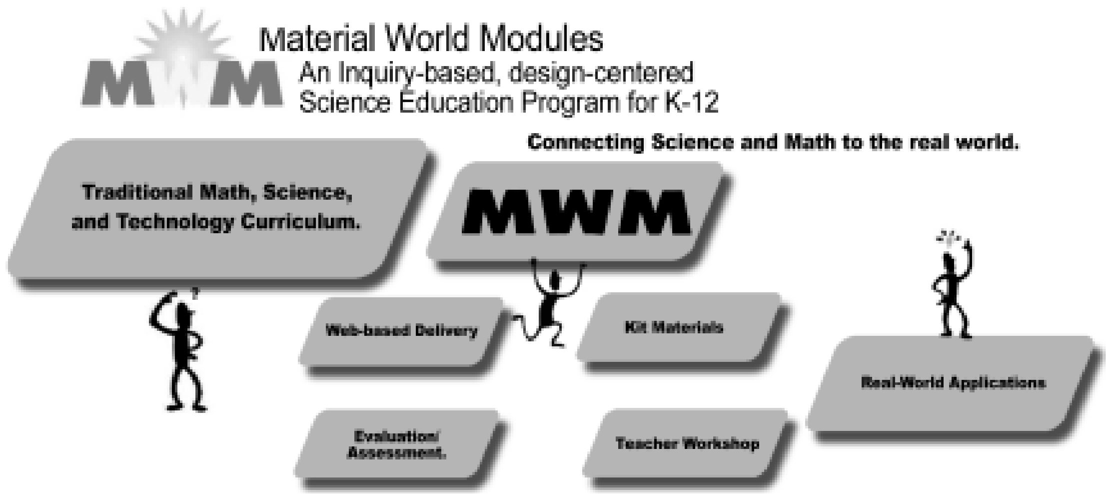
Critical Nanotechnology for the Americas

- Nano biomaterials---necessary for the medical health of our societies
- Structural materials and fibers improved with nanotechnology---highly engineered, low-cost materials to replace traditional structural materials that are adaptable to the conditions of the Americas.
- Nanotechnology-based optical, electronic, chemical, environmental, magnetic, biological, mechanical sensors, measurement, and control systems.
- Nanoscale-designed pharmaceuticals and drug-delivery systems.
- Nanoscale materials for chemical, energy, and environmental systems.

Limitations and Barriers

Materials research is very heterogeneous in the Americas, with some strong programs and little

Box 4



overall coordination and communication among countries. There are strong scientific programs in some countries (e.g., U.S., Canada, Mexico, and Brazil), and emerging programs in other countries.
Technology development and industrial interactions based on materials research are limited in most countries, except the U.S. and Canada.

Interdisciplinary graduate education in science and engineering is critical for the development of materials research and nanotechnology but is severely lacking in the Americas. Undergraduate, precollege, and workforce education also represent critical areas for the development of human resources.
While research infrastructure is essential for the development of materials and nanotechnology, with the exception of the U.S. and Canada, it is highly deficient in the Americas. Therefore, the following diagnosis areas of focus should be considered.

Education

These include graduate education---interdisciplinary, yet grounded in fundamentals; university level--developing a language of nanoscience and technology, involving the best students; precollege---challenging and exciting our youth with new opportunities; and workforce training---developing human resources across society.

Research teaming and assessment

Research topics and teams cross discipline technologies as never before. The necessary expertise does not exist at most locations, and researcher-and-student exchange is critical for advancing science and technology. Assessment requires expertise beyond the scope of individual researchers.

Technology transfer and industrial development

Develop “incubator” facilities near the locations where both research and new technology development take place; develop partnerships with existing industries to promote change. With regard to intellectual property, policies should work toward preserving technology development and limiting frivolous challenges.

Facilities and standards

Shared facilities for nanofabrication will be a necessity. Shared characterization facilities enable research and common understanding; novel phenomena and materials will require new standards. Hence, nanometrology is a new frontier to be implemented throughout the Americas.

Major shared facilities needs

These include advanced microscopy, structural characterization---X-ray (synchrotron), NMR, neutron; dynamics--femtosecond optical, nano-PL; computational facilities--nano to macro phenomena (multiscale); nanofabrication: electronic, bioelectronic, biochemical, nanoparticle, nanomechanial, nano-electro-mechanical, optoelectronic, bio-nanofluidic, nanopolymeric, textile, and structural.

Recommendations and Policies

Materials research and nanotechnology are important for the Americas because the economic development of all societies is dependent on advanced materials. Materials research and nanotechnology offer tremendous opportunities for the economies of the Americas and the benefit of their societies. Likewise, the intersection of nanotechnology, biotechnology, and information technology is vital for the Americas.

There is a tremendous opportunity for the advancement of the economies and societies of the Americas with the development of an effective overall program in materials research and nanotechnology. To be competitive in the global economy, advanced materials and nanotechnology will play an increasingly important role in the scientific and technological policies of all American countries.

The following recommendations address critical areas that will help achieve these goals.

- Enhance and expand support for collaborative research activities involving small groups. (e.g., Inter-American Materials Collaboration--CIAM).

- Establish regional materials-research and nanotechnology centers and networks with shared facilities for fabrication, characterization, modeling, and applications development.

- Establish regional centers of nanoscale metrology.

- Encourage strong industrial collaboration and establish incubator facilities near the research centers to leverage the research infrastructure.

- Enable exchanges of students and researchers across the Americas.

- Promote materials meetings and workshops to report on advances and identify new opportunities.

- Encourage and support activities that take advantage of nanoscale science and engineering to promote mathematics, science, and technology learning.

- Encourage and support activities where researchers present the excitement of discovery and innovation in nanotechnology to precollege students.

- Establish graduate programs and infrastructure to support materials research, nanotechnology, and industrial development (e.g., establish graduate programs in materials science).
- Develop nanotechnology and advanced materials short courses for professional development and workforce training.

- Encourage the establishment of national and regional materials research societies.

- Regional networks, small research groups, centers, and shared facilities are critical for development.

- Develop graduate programs and infrastructure to support materials research, nanotechnology, and industrial development.

- Develop cyberinfrastructure to accelerate educational, research, and industrial development activities.

- Government officials should develop collaborative science and technology programs in the Americas to implement the proposals of this report. These will lead to enhanced economic development and a better quality of life for their citizens. Specifically, it is recommended that governments, first, include materials research and nanotechology as a national priority in the science and technology agendas and provide the funds for the programs recommended here; second, adapt the science and technology agendas of each country to maximally benefit the national interests; third, explore novel financing approaches to expand domestic and regional education and research infrastructure; and fourth, establish effective mechanisms to support the activities and programs recommended in this document.

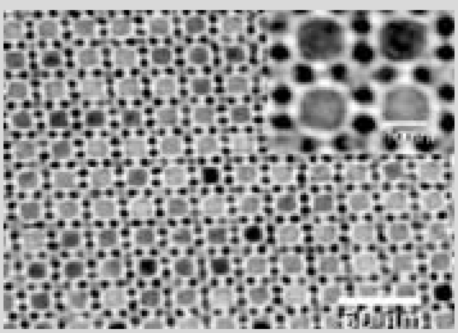
Examples of Success

The Brazilian National Laboratory of Synchrotron Radiation (LNLS) is a prototype of a Latin American facility. Other examples include:

Box 5

Columbia University MRSEC (Materials Research Science and Engineering Center)

First 3-D Assembly of Magnetic and Semiconducting Nanoparticles



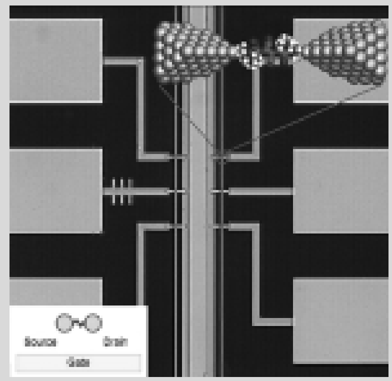
One challenge in preparing new nanomaterials is fabricating three-dimensional designer materials assembled from two different types of nanoparticles. Professor Stephen O'Brien, in collaboration with Dr. Chris Murray of the IBM T. J. Watson Research Center, MRSEC/IBM bridging postdoctoral scientist Dr. Franz REDl, and co-workers at the University of New Orleans have done precisely that by tailoring the experimental conditions so that nanoparticles with dissimilar, yet complementary properties would assemble themselves into repeating 3-D patterns. One type is composed of lead selenide, a semiconductor that has applications in infrared detectors and thermal imaging and can be tuned to be more sensitive to specific infrared wavelengths. The other material, magnetic iron oxide, is best known for its use in the coatings for certain magnetic recording media. This combination of these nanoparticles may have novel magneto-optical properties as well as properties key to the realization of quantum computing.

For example, it might be possible to modulate the material's optical properties by applying an external magnetic field. To produce an ordered structure, such as that shown in the accompanying transmission electron micrograph (TEM), the particles had to be very uniform, all within 5 percent of the target size. The iron oxide particles were 11 nanometers in diameter, and contained approximately 60,000 atoms, and the lead selenide particles 6 nanometers were in diameter, and contained approximately 3,000 atoms. Forming these so-called "crystal structures," as opposed to random mixtures of nanoparticles, is essential for the composite material to exhibit consistent, predictable behavior. Such new materials with otherwise unattainable properties are sometimes referred to as "metamaterials."

Box 6

Harvard Nanoscale Science and Engineering Center

Science of Nanoscale Systems and their Device Applications - Harvard, MIT, UC Santa Barbara and Museum of Science, Boston



Single Molecule Transistor
H. Park, Harvard U.

Single-molecule transistors incorporating individual divanadium molecules. Background: optical micrograph of an array of single-molecule transistors. Upper right inset: a cartoon of a divanadium molecule bridging two gold electrodes. Lower left inset: a schematic diagram of a single-molecule transistor.

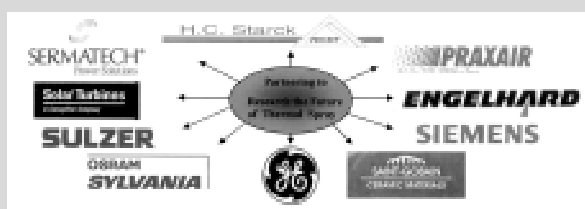
For other research highlights see:
http://www.nsec.harvard.edu/nugget_1.htm

Box 7

Industrial Outreach and Knowledge Transfer

Industrial Outreach and Knowledge Transfer MRSEC State University of New York at Stony Brook

Consortium on Thermal Spray Technology: Linking Research to Practice



Already in its second year of collaborative research, the Consortium on Thermal Spray Technology is made up of ten of the industry's leading global applicators of coatings, producers of equipment and materials and end-users of the technology.

The Consortium serves as a very effective vehicle for the transfer of the scientific base of knowledge being established by the CTSR out to those in industry. This has allowed for an immediate impact on TS technology creating exciting new perspectives and technological thrusts.

Part III

Science and Technology for Social Development

Background and Context

The experience of the twentieth and early twenty-first centuries has demonstrated a close relationship between countries' cultural and socioeconomic development and their advance in or use of science and technology to solve major development problems. Studies show that countries lagging behind in scientific and technological advances or use are currently at a disadvantage. Experience has likewise demonstrated that current development strategies have not had the desired results, since there has been a steady rise in the absolute numbers of people in poverty in the Hemisphere. A new approach to poverty reduction in the Hemisphere, which takes advantage of science and technology and its centrality for the construction and maintenance of a knowledge society, is essential.

The Science and Technology for Social Development Workshop, sponsored by the Jamaican National Commission on Science and Technology (NCST) in collaboration with the OAS, convened to exchange views and develop recommendations for science and technology policies for the Americas in support of social development, bringing together 39 experts, scientists, and government officials from nine countries.

At the Workshop's inaugural session, opened by Dr. Merline Bardowell, Executive Director of NCST, participants heard remarks by Fay Sylvester, Adviser and Representative of Jamaica's Minister of Science and Technology; the Minister of Information of Jamaica, the Honourable Burchell Anthony Whiteman; Joan Neil, Representative of the OAS General Secretariat in Jamaica; and Dr. Alice Abreu, Director of the then OAS Office of Science and Technology. This was followed by a presentation on the Millennium Development Goals, by Dr. Menelea Masin, of the United Nations Conference on Trade and Development (UNCTAD) of the United Nations. The development and application of science and technology involves significant societal investment.

It is therefore important that society's investment in science and technology provide societal benefits across the board. However, given limited national budgets, it is imperative that there be careful planning and a reasoned, system-oriented, creative application of these tools of science in ways that involve all stakeholders and beneficiaries. On the other hand, since social development by nature is a long-term issue, involving heavy national investments in health, education, and social infrastructure that transcend political terms of office, in order to procure the necessary political support, scientists must be sensitive to the need for providing certain short-term, visible effects in applying their tools.

The United Nations' Millennium Development Goals aim at reducing extreme poverty by 50% by the year 2015. The United Nations Conference on Trade and Development (UNCTAD) posits three important activities through which science, technology, and innovation could improve the current policy environment and facilitate accomplishing these goals: creating international networks for strengthening basic and applied research and development; strengthening technological support institutions; and facilitating universal access to the Internet through the construction of strategic partnerships.

The multiple issues that affect social development include investment in science and technology; application of science and technology to social development through support for employment generation, access to technology, gender inclusion, and the incorporation into society of the poor and other marginalized groups; the role of intellectual property as a component of the productive process and its impact on product research, employment generation, and social development; the importance for national development of a well-structured system of metrology to support scientific progress, systems of innovation, and trade; the importance of access to information and communications technologies (ICTs); and the development of digital government and of electronic content for implementing social development initiatives and aims. Indicators to measure the impact of applying science and technology must be developed and implemented, particularly in view of the more recently developed definition of democracy, which dictates the incorporation into society of previously marginalized groups.

Other salient issues relate to areas where the application of science and technology could be of value in facilitating national and regional social development. These include the following:

Fulfillment of basic human needs

These concern the concept and role of democracy in needs fulfillment; the importance of research in agriculture and agro-industry; the role of biotechnology; science and technology's role in satisfying the needs of the poor; and the use of metrology as a tool to regulate daily activities related to fair exchange of those goods necessary to fulfill these needs.

Reduction of poverty

What is the role of science and technology institutions and national science academies in furthering social development? Issues include the relevance of science, technology, and education; scientific education as a tool for capacity building in developing countries; and science and technology policies for social research.

Development of micro-business and employment generation

Innovation and the generation of employment by small and medium enterprises can help to reduce poverty. Other issues include intellectual property rights and their effect on micro-business and employment generation.

Bridging the world's digital gap through democratic and universal access to information and communications technologies

These issues concern gender equity and poverty reduction in the Knowledge Society; knowledge networks and electronic links in the Americas; science and technology indicators; and the example of the Mexican state of Colima in e-government and the provision of public services.

General Policy Proposals

For science and technology to affect social development, countries must construct and put into place a system that:

- Allows science and technology institutions access to and knowledge of social needs in a way that facilitates research on problem related issues;
- Involves all stakeholders concerned with the problem under discussion;
- Insures that science-based technologies and research results be implemented and reach the ultimate beneficiaries;
- Facilitates the translation of theory and results into layperson's terms for understanding and ease of application and encourage their wide dissemination;
- Measures the impact of programs and projects utilizing indicators and standards, incorporating and maintaining metrological standards necessary for science and trade.

To construct such a system, consideration must be given to issues of metrology, intellectual property, and the critical need for increased public investment in scientific and technological research and development. In this regard, the possibility of pooling resources and of undertaking cooperative inter-country activities should be considered as options for complementing expertise and making ambitious research projects feasible. International organizations must play an important role in promoting such collaboration. Activities must be undertaken to insure the necessary short- and long-term political support, as well as the involvement of policymakers who recognize the potential benefits of such investment in quality of life and economic improvements. There is an imperative need that government leaders and politicians be sensitized to the advantages of scientific and technological applications

Also of particular concern, in view of its profound impact on the application of science and technology to social development and to social development itself, is the issue of gender. Gendered patterns of effect and opportunities to benefit from science and technology for social development should be recognized and approached in terms of their impact on the home and at the family, community, employment (both formal and non formal), and societal levels.

The application of science and technology to issues of social development also presents a challenge to the traditional separation of government functions. In a Knowledge Society, if science and technology applications for social development are to succeed, there must be cooperation among the various agencies and government sectors, as well as multiple coordinating and information-sharing roles. Therefore, models should be developed in various countries to illustrate how science and technology could be applied to specific social development areas. Implicit in all these recommendations is the need for the computerization and integrated organization of information, and, consequently, the need for national and regional programs facilitating connectivity and supporting digital or e-government assistance for the automation of government functions and citizen services. Consideration must also be given to increasing investment in science and technology, as well as to issues of intellectual property and its critical impact in raising the possibilities for the application of science and technology to social development.

Within science and technology itself, the mission of science and scientific institutions must be transformed, in the direction of advancing science while serving society and of monitoring the societal impact of research. It is fundamental to establish a two-way relationship between science and societal issues and practice, to incorporate nonscientists into the decision making process and to increase public understanding of science and technology.

The fact that the topic of science and technology as applied to social development is so vast, that it does not lend itself to easy compartmentalization within a government structure, suggests that governments and regional organizations will have to play different roles to insure success. Likewise, issues such as economic empowerment, poverty reduction, ICTs, digital government, employment or agro-industrial research, suggest that the application of scientific- and technological-based initiatives can only be achieved through the design and execution of an integrated process that examines stakeholders, linkages, design, execution, results, and difficulties or opportunities. Such a model, or models, should include information dissemination activities, a clearinghouse and, if possible have the input of the different groups in the society.

Therefore, an urgent need exists for:

- Applying a science and technology philosophy and perspective---characterized by openness, a preoccupation with evidence, and tolerance for differing approaches---both to the solution of existing development problems and in the education of students and the general public---in order to progress and compete in a Knowledge Society;

- Changing the approach to and terms of the current intellectual property system;

- Expanding the concept of democracy to include poor and marginalized groups and the intervention of these groups in social development research and democratic and economic-empowerment activities that give them a stake in technological applications and the management of national resources;

- Recognition of the importance of measurements, their application, and additional development both as uniform standards and indicators that would measure progress at a national and regional level;

- Universal access to ICTs, the development of digital government, and the development of electronic content enabling the implementation of social development initiatives;

- Intensification of technical and scientific cooperation across the Hemisphere, between north and south, and between south and south;

- Sensitizing government leaders and politicians, many of whom have a limited grasp of scientific topics, as to the benefits and advantages of applying science and technology to development problems, and providing for certain short-term visible effects in their application that will foster as well as procure necessary political support.

Specific applications of these proposals could take many forms, such as improving the policy environment; strengthening existing networks; promoting science education and public and private partnerships; connecting communities, universities, schools, research centers, and other cultural institutions; developing programs to tap the skills of expatriate scientists; building biotechnology capacity; and assisting in developing national action plans and lists of best practices.

In addressing these needs, the traditional separation between science and technology and societal issues cannot remain. New technologies have made evident the importance of a synergy between sectors. However, for science and technology to affect society in ways that will contribute to its social development, a number of things must happen.

For any such plan to succeed, governments and regional organizations must insure an interconnection between stakeholders, beneficiaries, relevant ministries, producers, operators, customers, project executors, and the people who will disseminate or store results. In a Knowledge Society, the government's role may be that of central coordinator, pointing to the right direction and solutions. Government may also have important evaluation functions. Cooperation among the stakeholders will be essential, particularly as concerns human resources and financing. Automation of information and government functions and university connectivity will be important in this process.

Two other central ideas are important: first, the need to incorporate the perspective of the social sciences in all scientific development and to have more interaction and joint research between natural and social scientists; and second, the importance of measuring the social impact of national and regional science and technology programs for development through the expansion and reinforcement of the indicator networks that already exist.

Proposals for Specific Thematic Areas Important for Social Development

The following recommendations and strategies for common science and technology policies to further social development in the Americas cover seven thematic areas.

Democracy and Human Rights

Democracy and elementary human rights affect and are key to a society's social and economic development. Existing frameworks for democracy and human rights in the Hemisphere focus heavily on political participation through voting rights. However, they are immature and ineffective both with respect to the active political inclusion of major sectors of the population with limited economic influence and/or information access, and to providing these sectors with the economic sustainability and educational and literacy levels that would facilitate their more active involvement. Creating and maintaining democratic and human rights frameworks within which all a nation's citizens can both participate in the making of decisions and the monitoring of their execution will be a major factor in the reduction of poverty, a phenomenon definable as an extreme manifestation of under-development, denying people the chance to achieve their individual financial, social, economic, cultural, spiritual, political, and environmental goals.

While some recent definitions of democracy have mentioned concepts of individual economic security and community-level organization as important for full democratic participation, changes to existing structures and the design and execution of mechanisms to stimulate and sustain wider citizen participation need to be elaborated and implemented. Such changes also need to address the need for economic viability and the involvement of actors at the community level.

Democratic frameworks based solely on voting rights are too limited. The concept of democracy must encompass the active involvement of all citizens in the making of decisions and the monitoring of their execution. In defining a role for science and technology in attaining this goal, the recommendations in this report focus on populations not currently in the mainstream of democratic systems and suggest development of national policies and programs that utilize science and technology to expand democracy to all societal groups, giving particular and priority emphasis to those groups that may have been historically excluded due to ethnicity, gender, race, or socioeconomic class.

Such policies and programs should open up opportunities for democratic participation to societal groups traditionally underrepresented and empower their social development through the incorporation of concepts of economic security, the provision of access to information, particularly Internet information and literacy programs, as well as the development of policies for national education and citizen development that, beginning at the earliest stages of the educational system, foster a scientific mindset and philosophy with an evidence-based rather than a subjectivity-based orientation toward solving problems and making decisions. Additional recommendations focus on the inclusion and engagement of the poor in research (such as agro-industrial research) and in other science and technology interventions and activities for social development, so as to enable their acquisition of a stake in the management of national resources and their use of technology.

Basic Needs

Basic human needs cover a wide range of disciplines and activities. In examining science and technology applications suitable for their provision, those basic needs most important for survival were analyzed ---water and sanitation, food and nutrition, health/health care/disease prevention, housing and energy---and the metrological norms and standards vital for their delivery. Both the world's and the Hemisphere's situation in a number of these areas is critical and women have an important role in the delivery of basic needs. However, the effect that this has both on social development and on the women themselves has not received the attention it deserves and should be addressed.

Traditionally, scientific and technological research has been based on the concerns and intellectual curiosity of individual researchers and in isolation from other sectors of the community. A tradition and structured mechanisms for developing and applying research to problems of major concern to society and/or to particular segments of society is not highly developed. Facilitating the creation of this connection is of concern if science and technology are to play an effective role in the promotion of social development in the region.

Today, science and technology, and particularly scientific and technological research, play only a limited role in devising solutions for the provision of basic societal needs. Existing positive examples are limited in scope, extension, and/or are project bound with little provision for continuity over time.

One vital basic need is potable water. The Hemisphere has very severe problems regarding potable, secure water and environmental sanitation, particularly in the rural areas, that could be resolved and even avoided through the use of very simple and widely available cleaner technologies. Research exists that has provided some low-cost answers in a number of areas, but application and dissemination of results in the locations and populations where it is needed are challenges.

A 1983 CARICOM regional policy of agro-industrial research based on the exploitation and adding of value to local natural resources, labor, and markets has yielded examples of individual and cooperative action and science research that could facilitate social development. Jamaica and other Caribbean countries undertook research in food processing in jelly, sweet potatoes, salt fish, and arrowroot, which ultimately resulted in a number of products accepted both by local people and tourists. The program included laboratory upgrading, training, research and development in processing and preservation, phytochemical screening of medicinal plants, food standards, and advice to farmers on quality control. The need now is for human-resource training, small-business credits, reduction in costs, pooling of research and development resources in the CARICOM region, and more cooperative work among regional institutions.

In biotechnology, an extensive OAS-supported project in the Caribbean financed improvements in hot pepper production. The project resulted in better pepper productivity in Barbados and Jamaica, a gene bank that aided Trinidad and Tobago's cross-breeding efforts, screens for disease resistance and the planting of resistant plant strains, the discovery of compounds with biological activities, the extracting of metabolites with medicinal and pesticide value, and the development of a website with pepper information. Important project by-products were the sensitizing of workers to the importance of biodiversity and national recognition of the importance of and the need for more such value-added projects.

Further discussion revealed, nevertheless, in both cases, the need to strengthen linkages with producers, track project results over the long term, and consider other concurrently occurring social phenomena, such as workers' migration from micro-production toward tourism, all factors with potential impact on long-term effectiveness and continuity. Additionally, in some countries, the execution of such projects occurred without benefit of inclusion within an existing overall national science and technology policy, thus potentially limiting impact.

Without the linkages forward to markets and backward to producers, projects cannot be totally successful. The lack of linkages uniting the different project beneficiaries and the lack of national policies guiding project selection are important limitations in getting maximum benefit from the application of science and technology to the provision of basic needs.

A partnership between government and the science and technology research community that emphasizes such projects and cooperates to identify and develop new research areas and technologies for supplying and expanding government provision of basic needs and services, within a comprehensive framework of process, and respect for people's rights and expectations, could significantly affect social development in the Hemisphere.

Given its greater resources, the Hemisphere's private productive sector could find these types of projects to be of significant interest. Attempts to link them into the process could reap great benefits.

Accordingly, recommendations for incorporating science and technology into sound social policy suggest that governments:

- Elaborate national policies and mechanisms that foster and insure partnerships between government and the science and technology community to, first, identify national basic and social development needs and develop and link the satisfaction of these needs in a special way to national and regional policies and programs for researching, developing, and applying science and technology; second, promote interactions and joint research projects between natural and social scientists and between these scientists and communities and organizations related to social development and basic needs and their satisfaction through science and technology; third, include all relevant stakeholders in the development and execution of policies, research, and projects related to the application of science and technology to social development, insuring that the total research chain from conceptualization to execution and evaluation in the society is applied and considered in all activities and that linkages between and among the chain of production and stakeholders or beneficiaries exist that promote project continuity and effectiveness; fourth, emphasize local research on local products, particularly agro-industrial research with the potential for providing added value to local natural resources and products and for creating new opportunities and connections among sectors utilizing such products (i.e., micro-production/tourism); and finally, stimulate the use of measurement and standards, i.e., metrology, in local research so as to insure a smooth flow of commerce and product quality control;

- Familiarize policymakers and politicians with the linkages between science, technology, and social development, the benefits and requirements of a national science and technology policy, and the positive impact of a system of indicators to measure the effects of such a policy on social development;

- Consider the feasibility of a regional program that will devise, elaborate, apply, and evaluate models in one or more countries, illustrating the complete process and showing the functionality of applying science and technology to social development.

Economic Empowerment and Poverty Reduction

Despite multiple efforts and experimentations over the past few decades, poverty continues apace in both developed and developing nations. Trickle-down theories of economics and traditional industrial applications appear to have had little effect in raising living standards for large majorities of the world's population. In many countries, disparities have increased between the rich and poor. Disparities are also notable and potentially increasing among countries. Challenges are numerous and the recent phenomenon of globalization is causing unease in many national capitals. Traditional approaches to aid have also not reversed a trend of relative decline. New approaches to economic empowerment and poverty reduction must be found. These approaches should contemplate the increased involvement of society's various social actors and development beneficiaries.

To address the challenges of economic empowerment and poverty reduction in the face of globalization requires the mobilization and integration of the different societal sectors that will affect or can contribute to resolving these challenges. Since, as mentioned above, studies show a high rate of development for countries that have taken advantage of advances in science and technology, one approach is the mobilization of the global science and technology community. For this, effective means must be found to insure countries' generation of sufficient science and technology talent, and to effect the transfer of knowledge and technology to poor and middle income nations.

To participate in the global knowledge economy, countries require a highly developed system of metrology and standards compatible with international norms; the creation and maintenance of a modern education base that includes and utilizes women and their skills; and the capacity to access and use new technology, as well as the ability to generate technological innovations.

In addition, countries must possess the ability to participate as equal partners in international initiatives to solve global problems. A related factor contributing to success will be national public investment in research and development approximating 1% of GDP, a level that most countries in the Americas have not attained. A related problem is the tendency of some governments to view research and development investment as a luxury rather than an expenditure that repays itself in development benefits.

In a new empowerment approach, the national and international structure of science institutions and networks can play an important role, both because of their ongoing studies of problems associated with capacity building in science and technology, and the possible influence of science and technology on issues like measurements, energy, food security, and the environment. The creation of new methods of meeting social challenges by involving the scientific community presents a unique opportunity to address critical issues.

Scientific institutions and national science academies can advise governments and international bodies, increase public understanding of science issues, and facilitate cooperative ventures in science and technology research on social and other development issues. This facilitation of cooperation can be of special utility to smaller countries with narrowly developed scientific infrastructures.

A major social problem affecting developing countries in their struggle to reduce poverty is the emigration of their educated professionals, particularly in science and technology. The development of incentives and mechanisms, both to stem this migration and/or to formulate opportunities whereby scientists who have migrated to other countries can continue to contribute to the advancement of science and technology in their countries of origin, can offset to some extent this migration's negative effects. Similar mechanisms to attract the best young minds into scientific careers and to provide them with opportunities to undertake research under both national and expatriate scientists could both help the transfer of technologies from the developed world and provide the scientific base for national research. The national and international scientific communities could be mobilized to invent and administer such mechanisms and programs.

In contradistinction to the past, economic empowerment and poverty reduction are currently taking place in an atmosphere of unfettered competition. Is this type of cooperation now possible? While the enormous perceived and unperceived changes currently taking place relegate a response to the future, because of its open tradition, science offers a useful model for cooperation within a competitive world.

These are key economic empowerment and poverty-reduction issues: the level of investment in science and technology research; the introduction and use of metrology to insure fair trade and market access equity; the interplay among all sectors of society in insuring the attainment of development goals; and the measurement of the impact of social development through a system of regional science and technology indicators.

To facilitate economic empowerment and poverty reduction among the Hemisphere's citizens, it is recommended that governments:

- Institute a system of innovation that illustrates the linkages between science, technology, and society; promote dialogue among the sectors for the solution of problems; and include the scientific community in the design and application of programs to meet the challenges of economic empowerment and poverty reduction programs;

- Link science and technology research to national development priorities; stimulate the scientific community, favoring research useful for solving development problems; promote and implement partnerships between governments and the science and technology research community (private sector and international community); communicate the importance of science and technology for social development; and generate support for this concept and participation in its implementation at all levels, particularly at the community level;

- Expand the concept of science institutions, with a view both to applying science and technology to social problems and disseminating and transforming institutions' research into practical applications; provide for a back-and-forth interaction between and among the scientific, government, and business communities;

- Examine and focus on creative strategies and possibilities for funding national and regional research and development investment, including negotiation of reductions in foreign indebtedness in exchange for increased national research and development investments and on the cost/benefit potentials of new cooperative models for funding research; focus the attention of politicians and policymakers on the importance and benefits of investing in science and technology for development with specific focus on its benefits for social development;

- Design and implement a national strategy and an appropriate legal framework for the investment of public and private funds in research and development, and elaborate and approve the legal and institutional mechanisms necessary to insure equity in their implementation;

- Create a climate favorable for the development of indicators and mechanisms that measure the success of science and technology applications to social development problems and their wide and suitable dissemination, including the possible establishment of a clearinghouse;

- Consider a regional program to study and make recommendations on the application of metrology to science and technology in social development;

- Create a climate favorable to the development and application of global and regional metrological standards, particularly for the informal sector to facilitate its integration into the formal economy, and encourage the development of national systems and standards necessary for social development;

- Design policies and programs to stem the migration of scientist to areas of more opportunity and/or to formulate opportunities and programs whereby scientists who have migrated to other countries can continue to contribute to advancing science and technology in their countries of origin;

- Design a system of indicators that illustrates the impact of innovation and the use of science and technology with particular emphasis on measuring factors limiting women's access to land, credit, education, and professions across the labor environment, and any increase or decrease in that access, with a view to implementing innovative mechanisms to increase women's access and entitlements.

Employment Generation

As traditional development schemes failed throughout the developing world, people with the need to make a living turned to small entrepreneurial activities in the informal sector. In many countries today, micro- and small enterprises comprise a large part of national economic activity, and women generally make up the majority of business owners in this sector. Such enterprises are characterized by low productivity, low employee and management skill sets, low use of technology, low ability to innovate, low profitability, and inadequate financing. These characteristics translate into a low standard of living for both entrepreneur and employee and minimal or nonexistent revenues for the state and economic development. In some countries, this informal sector may compete directly with the formal economic sector, which does not enjoy their low overhead.

Given their minimal resources, it is difficult for these enterprises to solve their own problems. They need outside assistance, training, and access to technology and technology services, and in many cases direct access to financing and/or venture capital at reasonable rates. Otherwise, meager profits dissolve into repayments on high-interest loans.

In spite of their difficulties, these small enterprises serve as an important source of employment. Business-improvement programs that educate these enterprises on production chains and clusters and innovation systems, as well as provide technical assistance, training, and access to venture capital and other funding to grow their enterprises, can generate significant improvements, facilitate the entry of such enterprises into the formal economy, and expand their capacity as a source of employment.

Questions regarding intellectual property are important to national employment generation and the growth of national productive capacity; methods of disseminating accumulated business experiences; venture capital for small and medium enterprises; and the enhancement of the productive and employment-generating capacity of the informal economy sector and its eventual integration and inclusion into the formal economy.

Accordingly, governments should elaborate and implement policies that recognize the importance of the informal sector, provide for its stimulation and development as a source of employment, and project its eventual incorporation into the formal economy through:

- Application of new processes of science and technology to production and marketing in the informal sector;

- Dissemination of the experiences of small and medium enterprises through such vehicles as the existing network of technological centers and the establishment of an oversight committee for the formation of and execution of projects;

- Provision/procurement of financing for informal sector enterprises;

- Implementation of mechanisms of support such as: generation and maintenance of venture-capital funds, pooled resources of cooperatives, allocation of public funds for technological development in which industry is not involved and which can be destined for non-traditional institutions, and negotiations for foreign direct investments with the inclusion of technology transfer and maximum linkages of management, entrepreneurial skills, and foreign-market access enhancement of the sector’s employment capacity and future integration potential. These could be promoted through the use or participation of: incubators, technological parks, students and retirees as advisers to small and medium enterprises, alliances between craftspeople and science and technology experts in the production process, science and technology enterprises at the community level, training and technical assistance programs for small and medium enterprises, and development programs to recruit expatriate scientists to provide industry stimulation and research and training opportunities in their countries of origin;

- Partnerships with private companies for the transfer of technology to the informal sector.

Governments should also consider the feasibility of developing national and regional policies and programs regarding the current international system of intellectual property, with a view to expanding policy options and improving access to the system's development and modification. Actions to be considered include:

- Expanding the concept of intellectual property to protect biodiversity, environmental resources---both land- and knowledge-based assets---to gain competitiveness;

- Undertaking the steps necessary for a national policy and a national plan on intellectual property, including gathering information and experience, creating an inventory of national resources that can be subject to intellectual property protection, establishing criteria for a credible and fair system that considers interests of producers and consumers, and creating infrastructure;

- Developing common policies on intellectual properties---including policies to change system inequities---and the establishment of a regional program for assisting in the development of national intellectual property plans, policies, and guidelines;

- Adjusting the intellectual property system to allow for the participation of civil society in the study of methods for the protection of intellectual property and for decreasing the tolerance of system violations by large-market countries.

Further proposals involve promotion of socio-cultural prospective research, as well as technological foresight for the region and the definition of relevant priorities and actions; as well as consideration of the other side of the gender-issue coin, such as insufficient numbers of men in the teaching profession. This includes recognizing and addressing the falling rate of education and increasing rate of violence among young men in many countries, and considering strategies such as promoting more male teachers at primary levels.

Gender

Women make up over 50% of the world's population but comprise 66% of its 854 million illiterates; 66% of the world's children without access to basic education are female. In the developing world, women account for 60-90% of agricultural-production activities, provide societal energy resources through cooking and gathering firewood and water, harbor and transmit indigenous knowledge, and oversee family health care. Economically, women make up 66% of the informal sector.

In spite of these important contributions to society and the need for women's participation, if both development and the application of science and technology to social development are to succeed, a variety of factors hinder women from and counteract internal and external efforts at their inclusion and development. These include socio-cultural attitudes, lower literacy and education levels, limited access to resources, and low benefit from information technologies.

In fact, after decades of development interventions, women's overall position has declined relative to that of men, and women have become disproportionately poorer in relation to men. A continuation of this situation bodes ill for women, for development, and for women's ability to participate in the Knowledge Society.

In many parts of the world, women are also hindered by the fact that scientific subjects are not considered "suitable" for girls; and when women do take up scientific studies and disciplines, their participation decreases as the educational hierarchy increases. Generally speaking, women worldwide are underrepresented, underemployed, and under-promoted in every area of science and technology. For example, in the United States, a country widely supposed to be progressive in this area, only 29% of women in full-time science and technology university teaching positions are tenured, compared with 58% of the men. While the figures for Latin America are slightly higher, only the Caribbean enjoys an equal status, with 59% of women working in science and engineering.

Gender inequality has persisted over time in spite of the fact that research shows that societies that discriminate by gender pay a high price in a reduced ability to eliminate poverty and to develop their societies, and that eradicating poverty depends on improving the situation of women and increasing the efficiency of their work. Research also shows that a reduced gender gap in health and education reduces poverty and encourages economic growth and that when technologies improve women's production and income, school enrollment, literacy, and environmental conservation rise, and birthrates decrease. This situation of gender inequality produces a range of negative effects: The national science and technology system is not able to benefit from the creativity and talent of over half its population, and the failure to meet the science and technology needs of a group that is responsible for the well-being of the population will have effects on standards of living and national health and nutrition rates.

The severe social, economic, and cultural development disadvantages faced by women mean that special efforts must be made in favor of the application of science and technology to women's social development. Therefore, it is recommended that governments develop and implement national and recommend regional policies that recognize the relation of gender to social development and science and technology with respect to differential patterns of impact on the home, family, community, job culture, and society. Such recognition will help to break down gender stereotypes and enhance women's societal participation and access to development goods and resources. This can be achieved through:

- Elaboration of developing-country-relevant gender equality and sex-disaggregated indicators and the collection of sex-disaggregated data to establish and measure women's and men's current status and development progress over time, recognizing other factors of race and socioeconomic status;

- Establishment of criteria and action programs to understand, analyze, and address issues women face for inclusion and advancement in the Hemisphere, with particular reference to their participation and advancement in science and technology;

- Recognition of the interaction of gender equality and science and technology, understanding the differences and interconnections between women's and men's needs and perspectives;

- Support for increased female representation in scientific and technical education, and through their increased use of information and communications technologies, the promotion of their participation in education at all levels;

- Support for increased female representation and advancement in the science and technology workplace and decision making;

- Development of Internet content in social development that speaks to women's concerns, reflects their local knowledge, and is of value for their daily lives, business enterprises, and family responsibilities (including information on health, agriculture/small-scale production, natural-resources management, and small and medium enterprises).

Additionally, it is recommended that governments promote collaboration with the gender information activities of the Inter-American Commission of Women (CIM), with a view to supporting a regional clearinghouse that includes information on gender-related issues in science and technology and to developing mechanisms for integrating such information into ministries concerned with women's issues.

Governments should also consider developing a regional research program on the participation and representation of women in science and technology in Latin America, using qualitative and quantitative data and indicators to assess their current situation, and recommend action to support their increased representation in both industry and academia.

Scientific Education

The Renaissance origins of science as a profession led to its subsequent focus on individual research and to a peer-group scientific structure and culture, with in-group relationships, networking, and review of research, but with relatively few ties to the larger society outside the scientific community. As time passed, research, advanced training, and the teaching of future generations generally came to be conducted at universities and advanced research institutes. Even today, much of this structure remains intact and scientific education in the Americas is still conducted within this framework.

In recent years, and building on the contributions of science to transportation and health in the last century, a new orientation that looks to update and transform the mission of science and scientific institutions has appeared. This approach looks to advance science while serving society. It wishes to look at the societal impact of research, to have a two-way relationship between science and societal issues and practice, to incorporate nonscientists into its activities, and to increase public understanding of science and technology.

To move the historically elitist scientific structure toward engagement with larger societal issues, to imbue various sectors of society with scientific values, and to insure the creative involvement and application of science and technology in all development sectors constitute significant challenges.

Currently, most Latin American and Caribbean countries face great deficits in the number of science and technology professionals with the advanced training necessary for carrying out high-quality research. It is also essential to raise the level of science education of the general public, a goal best achieved through improving the methods used in science education for primary and secondary school students, i.e., the introduction of inquiry-based methods. The general public must also be educated to the potential of science's role and ability to undertake endogenous research for the solution of national development problems. Such public awareness can stimulate recognition for local scientific research efforts.

In light of the challenges of globalization, poverty reduction, and the incorporation of marginalized and poor sectors of the population into the formal economy, these are the principal issues: emphasizing scientific education anew; expanding the concept of what constitutes a scientific community; introducing and consolidating a scientific mindset at all levels of society---particularly among children and in the educational system; popularizing science in a user-friendly way; and reorienting science and scientific research toward the provision of solutions for society's national development priorities without, however, losing sight of wider scientific possibilities.

Accordingly, to enhance the influence of science and technology in society and allow its application to major development issues, particularly those in social development, governments should prepare and execute policies and programs that insure the construction of the scientific culture and world outlook necessary for full participation in globalization and a Knowledge Society through:

- Inclusion of science and technology in formal education, beginning at the earliest levels, in a way that balances education and science concerns;

- Teacher education and training programs and the development of curriculum components and knowledge content that insure teachers' ability to transmit and students' capacity to receive basic scientific principles and a scientific message and outlook;

- Educational activities grounded on basic scientific principles and the provision of local opportunities for students to apply science and scientific principles at the local level in response to local needs;

- Involvement of the scientific community as change agents in the development of a scientific mindset within the educational system;

- Promotion of foreign language learning to facilitate information exchange;

- Utilization of the educational portal of the OAS for scientific education.

Moreover, governments should develop and execute national and regional policies and programs that remove or mitigate gender-related considerations hindering the construction of a science-based outlook and mindset through:

- Removal of gender-role stereotypes affecting career choices, attitudes, teacher behavior, and education and training materials; instead, targeting girls for science careers;

- Incorporation of the concept of gender fairness into the educational curriculum and the establishment of a balance between male and female teachers;

- Examination of existing programs addressing gender issues and provision of mechanisms to facilitate their use by education professionals.

Government policies should be developed and executed that expand scientific knowledge and implant a scientific mindset at all levels of society through:

- Inclusion within the concept of "scientific institutions" and "scientific community" those institutions and groups (hospitals, museums, zoos, etc.) capable of collaborating in science research, dissemination, and popularization activities necessary to insure science and technology's viable and effective contribution to social development;

- Programs that popularize science and technology in a user-friendly way;

- Expansion of educational access and the formal and non formal education initiatives that promote social development, a new literacy, critical thinking, and a motivation toward achievement.

Information Technology and Connectivity

With the advent of the Internet, which opened up the possibility of worldwide instantaneous message exchanges, connectivity, information, and communications are becoming increasingly viewed as essential needs. The countries of the Americas confront distinct information technology and connectivity realities. Factors of poverty, unemployment, inflation, and economic and political instability magnify the problems of developing countries in dedicating high levels of public resources to building connectivity and information technology infrastructures and of devising and using these infrastructures in ways that will enhance governance and government services for citizens. ore advanced countries with greater resources and more technologically advanced development experiences, like the United States and Canada, face a very different situation, with widespread use of information and communication technologies.

Many governments in the Hemisphere nevertheless realize that connectivity and information and communications infrastructure will be critical for participation in the global economy and for the creation of competitive knowledge-based economies and societies. They also recognize the importance of connectivity in building capacity in other areas. For example, connection to the Internet enables students to be educated and to participate in science in radically new ways and to access many new resources. It enables scientists to participate in distant and multinational projects and supports their research. It makes critical areas of knowledge widely available to society as a whole for such things as solutions to local problems, health advice, and the enhancement of business. It enables governments to provide information and services and to automate their operations to reduce costs and even to increase revenues. In that regard, the automation of government functions and operations presents both national and transnational opportunities for reducing costs and facilitating information exchange.

To realize the potential represented by the Internet and information and communications technologies and to harness both to development needs, the governments of the Americas face major challenges. As a whole, the Hemisphere is not yet positioned to participate in global research or a global economy. On the technical side, many countries are forced to depend on private-sector monopolies that limit access, access speed, and bandwidth.

Internet usage in Latin America is currently low compared to the rest of the world. With 8.6% of the world's population, LatinAmerica records only 5.3% of Internet users. In terms of gender use, women in Chile, Brazil, and Argentina---countries with the highest Internet access rates in the region---use the Internet only about 40% as much as men. In countries where Internet access is less available, the percentages in general are lower. However, in rural Jamaica women use the Internet more than men. With respect to the Internet and connectivity, the gender gap operating in other areas of science and technology affects women in ways besides use. Socio-cultural attitudes can prevent women and girls from using information and communication technologies as much as boys. For example, in East Africa, cultural prohibitions against girls running mean that boys get to school computer labs first and stay on longer. Lower resource access limits women's purchases of equipment and access time. And, Internet content is often not relevant to women's experience or does not support their daily activities. Other issues limiting women's opportunity to benefit from information and communication technologies include lack of literacy, the predominance of English on the Internet, lack of familiarly with technology, and of accessible forms of information and communication technologies appropriate to the energy and communications infrastructure of their region or locality. Nevertheless, equalizing access for women is important, in view of their potential contribution poverty reduction, and strengthened families.

Following the declaration by the presidents of the Americas at the 2001Summit in Quebec that connecting the Americas was a priority, Canada provided support for the establishment of the Institute for the Connectivity of the Americas (ICA). ICA supports hemispheric interconnectivity through the promotion of partnerships; the innovative use of information and communications technologies; capacity building; the creation of knowledge; support for local and regional connectivity strategies; and project financing. It facilitates transnational sharing of experiences and is considering development of an e-link for the Americas, which, when finished, will permit end-to-end connectivity by satellite. Completion of such an e-link could facilitate low-cost Internet access both for countries suffering from large private monopolies and for remote communities with limited information technology and infrastructure.

A much more serious challenge exists with respect to the availability and management of information. Adequate skills building and training exercises in the organization and use of information resources to maximize services and reduce costs do not exist. The need to rethink and perhaps reengineer government processes and procedures to extract the maximum benefit from the new technologies, and to avoid duplications in the collection of information needs to be better understood by policy and decision makers.

Creating the environments that can facilitate the fullest possible development and use of connectivity and advanced information technology infrastructures for the conduct of government and private business, information exchange, and particularly the application of science and technology to social development, require actions by, the support of, and cooperation among the government, academic and research communities, and the private sector.

Governments, in combination with other public- and private-sector and regional agencies, should undertake to foster, insure, elaborate, and support national and regional policies, initiatives, and programs that develop, implement, and utilize information and communications technologies to facilitate the creation of a Knowledge Society, national social development, and good democratic governance through:

- Provision of universal connectivity and community-based Internet access for remote rural areas;

- Establishment of a regional program supporting national connectivity efforts;

- Elaboration and approval of a regional program that enables and supports OAS member states in their attempts to implement digital or e-government by automating public functions and operations and streamlining services to citizens;

- Generation of employment for women in the information-technology sector;

- Generation of local relevant on-line content to boost and support employment generation, small and medium size enterprises, health education and health delivery services, small-scale agricultural production, natural resource management, and the expansion of democracy;

- Dissemination and communication of science and technology information related to social development to target audiences critical to this development, taking into account the possibilities of mass media, radio, libraries, and other dissemination vehicles;

- Encouragement of the creation by the OAS of regional and thematic information networks supporting social development issues, and of a regional clearinghouse for science and technology information and the strengthening of existing initiatives to disseminate science and technology issues.

It is recommended that the OAS develop or reinforce the existing system of science and technology indicators so as to be able to measure progress in, and the effect of, the application of science and technology to social development, particularly as it concerns decision making and program execution in information connectivity and technology for a Knowledge Society. Thematic sub-networks should be designed and executed that include impact and methodological studies, manuals, public perceptions of science, information production, and training and technical assistance in support of specific indicators.

Additionally, the OAS should develop and support policies, programs, and activities that facilitate gender equality in access to and the use of the Internet through:

- Research on the role of gender in the development of science and technology as a whole and of its application to social development in particular, and the discovery of those factors promoting or hindering gender equality in professional functioning and advancement within science and technology's sundry disciplines;

- Creation of an environment that facilitates women's equal access to, skills development in and opportunities to benefit from information and communications technology and projects;

- E-government strategies accessible to women and favorable to women's lobbying;

- Advocacy activities.

Part IV

Popularization of Science

Background and Context

Part IV reflects the suggestions and conclusions of the Workshop on the Popularization of Science held in Rio de Janeiro on February 2-5, 2004, generously supported by the Ministry of Science and Technology and organized by the Museum of Astronomy and Related Sciences. The Workshop brought together specialists and representatives of national science and technology agencies from 12 countries in the Americas: Argentina, Brazil, Chile, Colombia, Ecuador, Jamaica, Mexico, Panama, Peru, the United States, Uruguay and Venezuela. Following presentations on the theoretical and practical aspects of and specific experiences relating to the popularization of science and technology, working groups were established to examine cooperation policies and methods for popularizing science; agents of popularization; the relationship of science and technology both to social inclusion and formal and non-formal education.

The popularization of science and technology is the system of dissemination, appropriation, and value attribution of all aspects of science and technology, among which one could include critical thought, ideas and values, the history and sociology of scientific knowledge, how science is practiced, and the results of scientific research and technological development.

Considered under this broad framework, the popularization of science and technology plays a central role in the socioeconomic, cultural, and environmental development of the countries in the Americas. From the socioeconomic perspective, popularization of science and technology can be the inspiration to scientific vocations and can encourage new talent for scientific research, technological development, and intellectual endeavors in general. It fosters creativity and innovation, contributes to producing better trained human resources, expands social opportunities, and strengthens the educational system. Culturally and environmentally, the popularization of science and technology enhances the critical skills of the population and increases its involvement in decision making, thereby contributing to democratic stability and sustainable development.

Popularization of science and technology also helps to enhance the population's personal satisfaction and self-esteem. With the growing importance that science and technology has taken on in all arenas of social life, popularization of science and technology is thus turning into a significant strategic issue.

In recent decades, the number of popularization programs and initiatives in the countries of the Americas has increased significantly. Countless new science centers and museums have emerged. These centers and museums are linked through the Network for the Popularization of Science and Technology in Latin America and the Caribbean (RED-POP) and through the Association of Science-Technology Centers (ASTC) that covers all of the Americas. The number of scientific journals, Internet sites with scientific content, and books, films, and dissemination videos is constantly rising. At the same time, science and technology awards, scientific Olympiads, fairs, and parades are now organized in many countries of the Hemisphere. Some countries have declared a "science and technology day" or "science and technology week." These activities have gone hand in hand with intense research and consideration on the forms, content, and objectives of popularization of science and technology.

With the cumulative knowledge gained through the last decade and the growing social demand for broad access to science and technology, the creation of a hemispheric policy is required and justified. With a common policy, the countries of the Americas would be able to increase scientific and technological literacy through coordinated, sound, and effective action.

Box 8

Network for the Popularization of Science and Technology (Red-POP) / Latin American Prize for the Popularization of Science and Technology

Network for the Popularization of Science and Technology (Red-POP)

Red-POP is an interactive network of centers and programs for the popularization of science and technology, operating by means of regional cooperation mechanisms that foster exchanges, training, and use of resources among its members. The network was established in November 1990, in Rio de Janeiro, inspired by the UNESCO's Science, Technology, and Society Program. The members of the Red-POP are formally institutionalized centers and programs for science and technology popularization that have applied for membership to the network, to support and promote Red-POP activities. Currently, the network has over 70 members from more than 12 countries in Latin America and the Caribbean; it also relates to science and technology popularization centers in many countries throughout the world (Directory of Full Members). Red-POP activities are established in the Cooperation Program, which is discussed and approved by the General Assembly at the Red-POP meetings held every two years.

Latin American Prize for the Popularization of Science and Technology

This prize is the highest recognition awarded in the region to a center, program, or specialist for outstanding work and national and regional impact in the fields of science and technology popularization. Its objective is to promote activities to popularize science and technology in Latin America and the Caribbean and to highlight efforts and undertakings that are exceptional because of their creativity, originality, rigor, impact, and contribution both at national and international levels. The prize is awarded every two years at a Special Session of the General Assembly of Red-POP.

Guidelines for a Hemispheric Policy on the Popularization of Science and Technology

Principles and Assumptions

A hemispheric policy for the popularization of science and technology must adhere to some basic principles:

- Access to the benefits and knowledge acquired through science and technology is a right of all citizens and a duty of the state.

- The popularization of science and technology must respect the knowledge base of local cultures, particularly cultural goods produced by indigenous population.

- The popularization of science and technology must be guided by the core principles of ethics and social responsibility.

- The popularization of science and technology must be geared towards forming critical citizens who are aware of their role in society, in order to broaden social inclusion and reduce regional imbalances.

Cooperation Policy and Measures

Functional, sustainable frameworks must be built to support the popularization of science and technology, helping institutions to create programs and strengthen existing ones. To do so, the following actions were suggested.

- Create national programs for the popularization of science and technology in each country.

- Establish a hemispheric program to publicize science and technology using resources from international organizations targeted at effective, integrated action that is in line with the size and diversity of the Hemisphere.

- Take specific measures in the countries with the greatest need, with support from those countries that have more experience in and infrastructure for the popularization of science and technology.

- Foster the sharing of information and experiences among the different countries and between institutions in each country, thereby promoting the creation of new networks and strengthening existing ones.

- Establish coordination and connection systems among the different entities and agents involved in the popularization of science and technology, to formulate and generate integrated actions.

Agents of Popularization of Science and Technology

Popularization of science and technology involves many agents, with different roles and functions and needing different types of training and incentives. The popularization of science and technology requires integrated action by knowledge producers, such as scientists, researchers, and intellectuals, and knowledge disseminators, such as journalists, publicists, museologists, teachers, audiovisual-aid producers, and members of scientific, cultural, and social institutions.

The policy measures must focus on creating academic incentives for researchers who participate in activities to popularize science and technology; strengthening existing science and technology centers and museums, through the allocation of human and material resources, and promoting the establishment of new centers; encouraging the creation of scientific publishing houses and science and technology programs in the spoken, written, and digital media; and creating training programs for agents of popularization of science and technology, such as journalists, museologists, and cultural intermediaries.

Interrelation with Formal and Non formal Education

The following measures are proposed based on the assumption that science and technology are popularized differently in formal and non formal education and that formal education can reinforce non formal methods of popularizing science and technology.

- In both formal and non formal education programs, promote the professional development and training of teachers who provide scientific and technological instruction to children and youth, incorporating scientists and researchers in related programs.

- Promote education programs, particularly in early, elementary, and middle school, with a view to promoting comprehensive education for future citizens and developing an innovative spirit in young people.

- Encourage educational centers to use available resources in science centers and museums more intensely and effectively, to bring students closer to scientific activity.

Measures Targeted at Achieving Social Inclusion

Social inclusion is one of the main challenges in modern-day societies. It is understood both as reaching out to economically, socially, and culturally excluded populations and, in a broader sense, as training citizens to live in contemporary society as consumers and agents of change, enlightened by the complexity of their social and environmental context. The following activities could be carried out to broaden social inclusion in the popularization of science and technology:

- Promote conferences on current science and technology issues for the population, involving communities, associations, unions, etc.

Box 9

Association of Science-Technology Centers

The Association of Science-Technology Centers (ASTC) is an international organization, chaired, in 2004, by Finland. The ASTC is an organization of science centers and museums dedicated to furthering the public understanding of science among increasingly diverse audiences. The ASTC encourages excellence and innovation in informal science learning by serving and linking its members worldwide and advancing their common goals. Through a variety of programs and services, the ASTC provides professional development for science centers, promotes best practices, supports effective communication, strengthens the position of science centers within the community at large, and fosters the creation of successful partnerships and collaborations. The ASTC has 560 members in 42 countries. Latin American members include: Centro Científico Tecnológico Exploratorio, Buenos Aires, Argentina; EcoCentro Puerto Madryn, Provincia del Chubut, Argentina; Casa da Ciência - UFRJ, Rio de Janeiro, Brazil; Estação Ciência da USP, São Paulo, Brazil; Fundação Planetário do Rio de Janeiro, Rio de Janeiro, Brazil; Museu da Vida, Rio de Janeiro, Brazil; Museu de Astronomia e Ciências Afins, Rio de Janeiro, Brazil; Fundación Tiempos Nuevos, Santiago, Chile; Maloka-Centro Interactivo de Ciencia y Tecnología, Bogota, Colombia; Museo Interactivo EPM, Medellín, Colombia; Explora, Centro de Ciencia y Arte, Panama City, Panama; Museo de los Niños de Caracas, Caracas, Venezuela.

- Institute a regularly held event, National Popularization of Science and Technology Week, and develop specific programming.

- Encourage and enable the use of existing public spaces, such as former train stations, naval schools, and warehouses, to hold exhibitions and activities on the popularization of science and technology.

- Use major events, such as the Pan American Games and the Olympics, as venues for efforts to popularize science.

- Develop specific activities for socially excluded groups, by identifying needs, languages, and specific science and technology content.
- Provide financial support to nongovernmental organizations (NGOs), public-interest organizations, and similar institutions that work with socially excluded segments of the population, linking them to initiatives for the popularization of science and technology.

- Promote the organization of scientific exhibitions and events in low-income areas.

- Encourage youth clubs to include science-related topics in their activities.

Mechanisms for Implementation

Content and Topics

Effective efforts to popularize science and technology must consider the tools, content, and subjects for dissemination. Thus, they must take into account the following content guidelines:

- Promote knowledge of scientific tradition and history in each country or region, as a way to strengthen its role in national identity.

- Foster knowledge of current social and environmental issues.

- Support the integration and communication of science and technology with other forms of cultural expression and artistic creation.

- Identify different audiences in the segments of the population, so as to promote the popularization of science and technology, in accordance with their needs.

- Promote the creation of content and the standardization and organization of information for different audiences.

- Create mechanisms that ensure quality and ethics in the dissemination of science and technology.

Monitoring and Evaluation Systems

- Encourage and establish evaluation systems by generating national indicators on the popularization of science and technology.

- Promote public-opinion research on the perception of science and technology, so as to regularly identify popularization achievements and needs in the different countries.

- Establish evaluation standards for the popularization of science and technology.

- Have up-to-date, high-quality benchmarks for making adjustments to and strengthening the policy for the popularization of science and technology.

Financing

- Create mechanisms that guarantee ongoing public funding for promoting the popularization of science and technology.

- Promote the channeling of international and multilateral cooperation resources to the popularization of science and technology.

- Create incentives for the private sector, particularly high-tech industries (information technology, telematics, aerospace, biotechnology, etc.), to invest in the popularization of science and technology.

- Link a percentage of the resources provided for scientific and technological research to the popularization of science and technology.

Proposals for a Hemispheric Cooperation Agenda for the Popularization of Science and Technology

- Establish a committee to coordinate activities in the context of a common agenda that incorporates the stakeholders involved in existing networks, while encouraging the inclusion of new participants.

- Establish annual meetings to support, evaluate, and share information on conducted activities.

- Promote the creation of a shared data base at the hemispheric level of actions, agents, and common areas related to the popularization of science.

- Create hemispheric communication methods and spaces, using the convergence of media and the development of technologies.

- Foster exchanges that focus on the experience of popularizing science and technology, such as exhibitions and dissemination materials.

- Promote human-resources training events for the popularization of science and technology.

Part V

Annexes

Participants and Presentations

The workshops' presentations are available on the Internet at the OAS Office of Education, Science and Technology site located at *http://www.science.oas.org/Ministerial/ingles/documentos/Document_001.pdf* .

Workshop Science, Technology and Innovation to Increase Competitiveness in the Productive Sector.

(Buenos Aires, Argentina, November 17-19, 2003)

- Alice **ABREU**, Director, Office of Science and Technology, Organization of American States (OAS). *Taller sobre Ciencia, tecnología e innovación para incrementar la competitividad en el sector productivo.*
- Silvia **BIDART**, President, IT Strategy, Inter-American Development Bank (IADB), Argentina.
- Aldo **BIONDOLILLO**, President, TEMPUS ALBA SA, Argentina. *Caso vinos de Argentina (Case Study)*.

Rodolfo **BRIOZZO**, Ministry of Economy (Ministerio de Economía), Argentina.

- Enrique **CAMPOS**, Mexico.
- Mercedes Inés **CARAZO**, National Coordinator, Network of Centers of Technological Innovation, Ministry of Production (Ministerio de la Producción), Peru.
- Carlos **CHEPPI**, Vice President, National Institute of Agricultural Technology (Instituto Nacional de Tecnología Agropecuaria - INTA), Argentina.
- Salvador **ECHEVERRÍA**, Director, Technology Services, National Center of Metrology (Centro Nacional de Metrología - CENAM), Mexico. *Discusión sobre políticas e instrumentos para su implantación. Perspectiva desde el Centro Nacional de Metrología de México.*
- Karl-Christian **GÖTHNER**, Senior Consultant, National Institute of Metrology (Physikalisch-Technische Bundesanstalt Braunschweig und Berlin - PTB), Germany. *El rol de las agencias de cooperación internacional en apoyo a la competitividad del sector productivo (Case Study).*
- Susan **HELLER**, Foreign Affairs Officer, National Institute of Standards and Technology (NIST), United States. *Overview of NIST Programs.*
- Bernardo **HERRERA**, Executive Director, Technology Center of Metallurgy (Centro Tecnológico de Metalurgia), Colombia
- Arturo **INDA**, Mexico. *La integración de esfuerzos para lograr la competitividad en el sector productivo.*
- João **JORNADA**, Director, Scientific Metrology, National Institute of Metrology (Instituto Nacional de Metrologia, Normalização e Qualidade Industrial - INMETRO), Brazil. *Scientific Metrology for the Productive Sector (estudio de caso).*
- Cristian **LAGOS**, Programs Director, Fund for the Promotion of Scientific and Technological Development, National Council of Science and Technology (Fondo de Fomento al Desarrollo Científico y Tecnológico – FONDEP, Consejo Nacional de Ciencia y Tecnología - CONICYT), Chile. *Acuacultura en Chile: Situación actual y nuevos desarrollos (Case Study).*
- Huntley **MANHERTZ**, Consulting Economist, Jamaica. *The Role of Science, Technology and Innovation to Increase Competitiveness in the Productive Sector: The Jamaican Experience of Walkerswood (estudio de caso).*
- Jorge **MARTÍNEZ**, Professor, University of the Republic of Uruguay (Universidad de la República del Uruguay). *Industria forestal Uruguaya: mesa de la madera (estudio de caso).*
- Ronald **MELÉNDEZ**, Adviser, Ministry of Science and Technology (Ministerio de Ciencia y Tecnología), Costa Rica. *Integración de esfuerzos para la competitividad del sector productivo. Gestión del conocimiento, reto para Costa Rica.*
- Evando **MIRRA**, President, Center for Managerial and Strategic Studies (Centro de Gestão e Estudos Estratégicos - CGEE), Brazil.
- Martín **PIÑEIRO**, Director, CEO Group (Grupo CEO), Argentina. *Consideraciones generales sobre el papel de la ciencia, tecnología y la promoción de la innovación en el desarrollo de competitividad en el sector agroalimentario.*
- Ranjit **SINGH**, Head of Department, University of the West Indies, Trinidad. *Caribbean Case: Spice Exports (The Nutmeg and Spice Industry in Grenada) (Case Study).*
- Joaquín **VALDEZ**, Metrology and Quality Manager, National Institute of Industrial Technology (Instituto Nacional de Tecnología Industrial - INTI), Argentina. *La infraestructura tecnológica que sustenta la calidad industrial.*
- Ernesto **VÉLEZ**, President, Executive Council, ASOCOLFLORES, Colombia. *La floricultura de exportación en Colombia. Origen, desarrollo y tecnología (Case Study).*

Cosponsors

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- Mónica **SILENZI**, Multilateral Coordinator, Secretariat of Science, Technology and Productive Innovation (Secretaría de Ciencia, Tecnología e Innovación Productiva - SECyT), Argentina.
- Eduardo **TRIGO**, Scientific Advisor, Secretariat of Science, Technology and Productive Innovation (Secretaría de Ciencia, Tecnología e Innovación Productiva - SECyT), Argentina.

Workshop Scientific and Technological Development in the Americas

(Quito, Ecuador, December 10-12, 2003)

- Alice **ABREU**, Director, Office of Science and Technology, Organization of American States (OAS). *Taller sobre desarrollo científico y tecnológico en las Américas. Planteamientos generales sobre el Proyecto de Cooperación Hemisférica y Desarrollo de Política Científica y Tecnológica.*
- Jorge **ALLENDE**, Professor, ICBM, Faculty of Medicine, University of Chile (Programa de Biotecnología Celular y Molecular - ICBM, Facultad de Medicina, Universidad de Chile), Santiago, Chile. *Executive Summary of Inventing a Better Future: A Strategy for Building Worldwide Capacities in Sciences and Technology. A report from the Inter Academy Council, [Part 1] [Part 2] [Part 3]; and Challenges and Opportunities for Regional Cooperation in Biotechnology in the Americas. The Possible Role of the OAS* (Workgroup on biotechnology).
- Carol **BOGGS**, Director, Center for Conservation Biology, Stanford University, United States. *Biotechnology and Ecosystem Services* (Workgroup on biotechnology).
- Heather **BOYLES**, Director, International Relations, Internet2, Estados Unidos. *Internet2 in the United States and a Global Overview of Advanced Networks* (Workgroup on advanced networks and cyber infrastructure).
- Raúl **BURGOS**. Vice President, National University Network (Red Universitaria Nacional - REUNA), Chile. *New Generation Networks: A Necessary Policy* (Workgroup on advanced networks and cyber infrastructure).
- Guy **CARDINEAU**, Department of Plant Sciences and College of Law, Arizona State University, United States. *Applications on Plant Biotechnology* (Workgroup on biotechnology).
- Carlos **CASASUS**, General Director, Mexico's Research and Education Network (Red Mexicana para la Investigación y Educación – CUDI), Mexico. *Some Thoughts on Optical and other Broadband Networks in Latin America: How can we get there?* (Workgroup on advanced networks and cyber infrastructure).
- Marta **CEHELSKY**, Senior Adviser for Science and Technology, Sustainable Development Department, Inter-American Development Bank (IADB), United States. *Advanced Networking for Scientific, Technological, Economic and Social Development* (Workgroup on advanced networks and cyber infrastructure).
- Bob **CHANG**, Northwestern University, United States. *Opportunities for Developing a Robust Pan-American Research and Education Network* (Workgroup on materials and nanotechnology).
- Josefina **COLOMA**, Infectious Diseases Division, School of Public Health, University of California, Berkeley, United States. *Scientific Capacity Building and Sustainable Technology Transfer in Resource-Poor Environments* (Workgroup on biotechnology).
- Douglas **GATCHELL**, Program Director for the International Research Network Connections, National Science Foundation (NSF), United States. *Perspective on Cyberinfrastructure and its Importance on the Future of Science and Technology in the United State* (Workgroup on advanced networks and cyber infrastructure).
- Adriaan **DE GRAAF,** Senior Advisor, Directorate for Mathematical and Physical Sciences, National Science Foundation (NSF), United States. *Overview of NSF Activities in Nanoscale Science and Engineering* (Workgroup on materials and nanotechnology).
- Saúl **HAHN**, Principal Specialist, Office of Science and Technology, Organization of American States (OAS). *Ciencia de punta para el desarrollo. Aspectos comunes de los grupos de trabajo.*
- Anita **HERRERA**, Systems Engineer, Foundation for Science and Technology (Fundación para la Ciencia y Tecnología - FUNDACYT), Ecuador.
- Steve **HUTER**, Research Associate, Network Startup Resource Center (NSRC), University of Oregon, United States (Workgroup on advanced networks and cyber infrastructure).
- Pedro **LEÓN**, Director, Center of High Technology (Centro de Alta Tecnología), Costa Rica. *Interfaces between Biotechnology and Nanotechnology* (Workgroup on biotechnology).
- Marta **LITTER**, Head of Group of Coloides and Inorganic Oxides, National Commission of Atomic Energy (Comisión Nacional de Energía Atómica), Argentina. *Estrategias para el desarrollo de nuevas tecnologías para potabilizar el agua* (Workgroup on clean technologies and renewable energies).
- María Dolores **LIZARZABURO**, Network Startup Resource Center (SRC), University of Oregon, United States (Workgroup on advanced networks and cyber infrastructure).
- Bertha **LUDEÑA ECHEVARRÍA**, Catholic University of Ecuador (Universidad Católica Pontificia del Ecuador), Ecuador. *La biotechnología en el Ecuador* (Workgroup on biotechnology).
- Wayne **MCLAUGHLIN**, Project Manager, Basic Medical Sciences/Biochemistry, University of the West Indies, Jamaica. *Applications of Biotechnology in Jamaica and the Caribbean* (Workgroup on biotechnology).
- Celso Pinto de **MELO**, Dean of Graduate Studies, Federal University of Pernambuco (Universidade Federal de Pernambuco), Brazil. *Inter-American Collaboration in Materials Research and Nanotechnology in Brazil* (Workgroup on materials and nanotechnology).
- Lucia C P de **MELO**, Principal Researcher, Fundação Joaquim Nabuco, Brazil, Specialist in Policy and Science and Technology Management and Collaborator of the Rede Nacional de Ensino e

Pesquisa (RNP), Brazil (Workgroup on advanced networks and cyber infrastructure).

- José Luis **MORÁN**, Director, Potosino Institute of Scientific and Technological Research (Instituto Potosino de Investigación Científica y Tecnológica), Mexico. *Programa Nacional de Nanociencia y Nanotecnología para desarrollar nuevas bases tecnológicas* (Workgroup on materials and nanotechnology).
- Robert **NEMANICH**, President, International Union of Materials Research Societies, United States. *Structural Challenges for Materials Research and Technologies* (Workgroup on materials and nanotechnology).
- Carlos **OCAMPO ARBO**, Director, Office of the General Secretariat of the Organization of American States in Ecuador.
- Miriam **ORBEA**, Ecuatorian Center of Cleaner Technologies (Centro Ecuatoriano de Producción más Limpia - CEPL), Ecuador. *Eficiencia energética y producción más limpia* (Workgroup on clean technologies and renewable energies).
- Enrique **PELAEZ**, Executive Director, Ecuadorian Consortium for the Development of Advanced Internet (Consorcio Ecuatoriano para el Desarrollo de Internet Avanzada - CEDIA), Ecuador. *Challenges and Opportunities for Emerging NRENs: Case Ecuador* (Workgroup on advanced networks and cyber infrastructure).
- Amitav **RATH,** Director, Policy Research International (PRI), Canada. *The Importance of Clean Technologies for Small and Medium-sized Enterprises in the Americas* (Workgroup on clean technologies and renewable energies).
- Nelson **SIMOES** da Silva, General Director, National Network of Research and Education (Rede Nacional de Ensino e Pesquisa - RNP), Brazil. *The Continental Cooperation on Research Networking and Clara* (Workgroup on advanced networks and cyber infrastructure).
- Dale **SMITH**, Director, Network services, University of Oregon, United States.
- Guillermo **SOLÓRZANO**, President, Inter-American Committee of Societies for Electron Microscopy (Comité Interamericano de Sociedades de Microscopía Electrónica - CIASEM) and President, Brazilian Society for Materials Research (Sociedad Brasileña para la Investigación de Materiales -SBPMat), Brazil. *Materials for the Development of New Technologies* (Workgroup on materials and nanotechnology).
- Bill **St. ARNAUD**, Senior Director, Advanced Networks CANARI (Canada's Advanced Internet Development Organization), Canada. *Cyberinfrastructure: An Opportunity for Latin America to Leap Frog the World in Research, Science, and Education* (Workgroup on advanced networks and cyber infrastructure).
- Guy **DE TERAMOND**, Former Minister of Science and Technology, Costa Rica. *Advanced Internet Project. Challenges and Opportunities for Emerging NREN's: The Case of Costa Rica and the Driver for Applications in Central America and the Caribbean: Perspective for the Great Caribbean Area* (Workgroup on advanced networks and cyber infrastructure).
- Felipe **URRESTA**, Director, Ecuatorian Institute of Normalization (Instituto Ecuatoriano de Normalización - INEN), Ecuador. *The Development of Clean Technologies for Small and Medium-sized Enterprises in Ecuador* (Workgroup on clean technologies and renewable energies).
- Alfredo **VALAREZO**, Department of Technological Processes, National Polytechnic School (Departamento de Procesos Tecnológicos, Escuela Politécnica Nacional), Ecuador. *Technological and Research Development of Materials in Ecuador* (Workgroup on materials and nanotechnology).
- Francis **DE WINTER**, Kiteship Company, United States. *The Importance of Renewable Energy for the Region / Photovoltaic Collectors to Establish Internet Connections in High Schools in the Galapagos Islands* (Workgroup on clean technologies and renewable energies).

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- Alfredo **PALACIO**, Constitutional Vice President of the Republic of Ecuador (Vice Presidente de la República del Ecuador). *La importancia de la ciencia y tecnología en la agenda hemisférica.*
- Luis **ROMO**, President, Foundation for Science and Technology (Fundación para la Ciencia y Tecnología-FUNDACYT), Ecuador.
- Carlos **TRÁVEZ**, Foundation for Science and Technology (Fundación para la Ciencia y Tecnología-FUNDACYT), Ecuador. *Information and Telecommunication Infrastructure for Scientific Research in the Country* (Workgroup on advanced networks and cyber infrastructure).
- Renato **VALENCIA**, Interim Executive Director, Foundation for Science and Technology (Fundación para la Ciencia y Tecnología-FUNDACYT), Ecuador.

Workshop Popularization of Science
(Rio de Janeiro, Brazil, February 2-5, 2004)

- Alice **ABREU**, Director, Office of Science and Technology, Organization of American States (OAS). *Popularização da Ciência.*
- Ronaldo de **ALMEIDA**, Museum of Astronomy and Related Sciences (Museu de Astronomia e Ciências Afins - MAST), Brazil.
- Alessandra Menezes de **ANDRADE**, Museum of Astronomy and Related Sciences (Museu de Astronomia e Ciências Afins - MAST), Brazil.
- Jayme **ARANHA**, National Museum (Museu Nacional, UFRJ), Brazil.
- Ana Carolina **ARROIO**, Federation of industries of Rio de Janeiro (Federações das Indústrias do Estado do Rio de Janeiro – FIRJAN), Brazil.
- Alicia **BARAIBAR**, Coordinator, Youth Science and Technology Program, Ministry of Science and Technology (Ministerio de Ciencia y Tecnología - MST), Uruguay. *Clubes de Ciencia: Programa Nacional de Ciencia y Tecnología Juvenil* (Workgroup on scientific education).
- Merline **BARDOWELL**, Executive Director, National Commission on Science and Technology (NCST), Jamaica. *Civil Society and the Popularization of Science and Technology: The Jamaican Experience* (Workgroup on popularization of science).
- Hernrique **LINS DE BARROS**, Researcher, Brazilian Center for Research in Physics (Centro Brasileiro de Pesquisa em física), Brazil.
- Julián **BETANCOURT**, Director, Science and Game Museum (Museo de la Ciencia y el Juego), Colombia. *Museo de la Cien-*

cia y el Juego: Una mirada a la popularización de Ciencia y tecnología desde un pequeño museo (Workgroup on popularization of science).

- Gloria **BONDER**, General Coordinator, UNESCO Chair for Women, Science, and Technology in Latin America, Argentina. *Entorno multimedia para la educación científica y tecnológica de calidad con perspectiva de género: Fundamentos conceptuales y herramientas pedagógicas* (Workgroup on scientific education).
- Ennio **CANDOTTI**, President, Brazilian Association for the Advancement of Science (Sociedade Brasileira para o Progresso da Ciência), Brazil. *Science Truth and Politics Truth.*
- Solagne **CARDOZO**, Catholic University of Rio de Janeiro (Universidade Católica do Rio de Janeiro - PUC-Rio), Brazil.
- Virna **CEDEÑO**, National Park of Galapagos (Parque Nacional de Galápagos), Ecuador.
- María del Carmen **CEVALLOS**, Chief of Transfer and Dissemination, Foundation for Science and Technology (Fundación para la Ciencia y Tecnología – FUNDACYT), Ecuador. *Divulgación de la ciencia en Ecuador: una experiencia innovadora* (Workgroup on popularization of science).
- María Beatriz **COLUCCI**, Procit-Sergipe, Brazil.
- Gonzalo **CÓRDOBA**, President, National Secretariat of Science, Technology, and Innovation (Secretaría Nacional de Ciencia, Tecnología e Innovación - SENACYT), Panama. *Popularización de las actividades de la ciencia y tecnología* (Workgroup on popularization of science).
- Pia **CÓRDOVA**, Coordinator of Promotion and Dissemination, Ministry of Science and Technology (Ministerio de Ciencia y Tecnología), Venezuela. *Dirección General de Transferencia: coordinación de promoción y divulgación* (Workgroup on social inclusion).
- Andréa Fernandes **COSTA**, Museum of Astronomy and Related Sciences (Museu de Astronomia e Ciências Afins - MAST), Brazil.
- Demetrio **DELIZOICOV,** Federal University of Santa Catarina (Universidade Federal de Santa Catarina), Brazil. *Divulgação científica e educação escolar* (Workgroup on scientific education).
- Haydeé **DOMIC**, Red-POP, Chile. *El rol de los museos y los programas de ciencia y tecnología en la divulgación y valoración de la ciencia y la tecnología* (Workgroup on agents of scientific dissemination).
- José Ribamar **FERREIRA**, Coordinator, Museum of Life (Museu da Vida) Fiocruz, Brazil. *Centros y museos de ciencia e inclusión social* (Workgroup on social inclusion).
- Hyman **FIELD**, Senior Advisor for Public Understanding of Science, National Science Foundation, United States. *Public Understanding of Science (PUS) and Public Understanding of Research (PUR).* (Workgroup on popularization of science)
- Fernando **GALEMBECK**, University of Campinas (Universidade Estadual de Campinas - UNICAMP), Brazil. *Tools for Discovery and Learning* (Workgroup on scientific education).
- Guaracira **GOUVEA**, UniRio, Brasil.
- Ernst **HAMBURGUER**, Physics Institute, University of Sao Paulo (University of São Paulo - USP), Brazil. *Colaboração Internacional para a Popularização das Ciências: A Experiência da Estação Ciência e a Proposta da RedPop de um Projeto de Cooperação Técnica do BID em 1999* (Workgroup on agents of scientific dissemination).
- Zully David **HOYOS**, Deputy Director of Strategic Programs, Colombian Institute for the Development of Science and Technology (Instituto Colombiano para el Desarrollo de la Ciencia y la Tecnología - COLCIENCIAS), Colombia. *Lineamientos de política de fomento a la cultura de ciencia y tecnología en la sociedad* (Workgroup on social inclusion).
- Rolando **ISITA**, Science Department, Universum, UNAM, Mexico. *El impulso a la investigación científica y la divulgación de la ciencia, un problema de visión de estado* (Workgroup on agents of scientific dissemination).
- Alicia **IVANISSEVICH**, Science Today (Ciência Hoje), Brazil.
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- Nilson **LAGE**, Brazilian Institute of Information on Science and Technology (Instituto Brasileiro de Informação em Ciência e Tecnologia – IBCT), Brazil.
- Ivan **LEÃO**, Brazil. *Rompendo a barreira do jornalista ao tema da ciência e tecnología* (Workgroup on agents of scientific dissemination).
- Martha **MARANDINO**, Universidad de Sao Paulo (Universidade de São Paulo - USP), Brazil.
- Luisa **MASSARANI**, Museum of Life (Museu da Vida), Fiocruz, Brazil.
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- Tonatiuh **ORTEGA** Aviles, Mexican Council of Science and Technology (Consejo Mexiquense de Ciencia y Tecnología - COMECYT), Mexico. *La popularización de la ciencia y la tecnología: un reto a pesar de las carencias* (Workgroup on social inclusion).
- Gloria **QUEIROZ**, University of the State of Rio de Janeiro (Universidade do Estado do Rio de Janeiro - UERJ) and the Museum of Astronomy and Related Sciences (Museu de Astronomia e Ciências Afins - MAST), Brazil.
- Teresa **SALINAS**, Director, Office for Strengthening and Updating Science, National Council of Science and Technology (Consejo Nacional de Ciencia y Tecnología - CONCYTEC), Peru. *Experiencias de popularización de la ciencia y tecnología en el Perú* (Workgroup on popularization of science).
- Heloisa Helena **SAVIANI**, Dinamic Museum of Sciences (Museu Dinâmico de Ciências), Brazil.
- Luciana **SEPULVEDA**, Fiocruz, Brasil.
- Leandro **TESSLER**, University of Campinas (Universidade Estadual de Campinas - UNICAMP), Brazil.
- Patricia **TOLMASQUIM**, Consultant in Education, Brazil.
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- Alfredo **TOLMASQUIM**, Director, Museum of Astronomy and Related Sciences (Museu de Astronomia e Ciências Afins - MAST).

Workshop Science and Technology for Social Development

(Kingston, Jamaica, March 3-5, 2004)

- Alice **ABREU,** Director, Office of Science and Technology, Organization of American States (OAS). *Frame of Reference of the Project "Hemispheric Cooperation in the Development of Science and Technology Policy."*
- Marcia **BLAIR**, Technical Officer, National Commission on Science and Technology (NCST), Jamaica. *Role of Biotechnology.*
- Charlene **BUTLER**, Parish Development Office, Jamaica 4-H Clubs, Jamaica.
- Mercedes Inés **CARAZO**, National Coordinator, Network of Centers of Technological Innovation, Ministry of Production (Ministerio de la Producción), Peru. *Technological Innovation Centers: RED de CITEs. The Peruvian Case Study.*
- Stephen **CARPENTER**, Director, Office of International and Academic Affairs, National Institute of Standards and Technology (NIST), United States. *Science and Technology and Social Development: Metrology in Our Daily Life.*
- Michael **CLEGG**, Foreign Secretary, US National Academy of Sciences, United States. *Scientific Education and Capacity Building in Developing Countries: The Proposals of the Inter-Academy Council.*
- Christine **DUNCAN**, Consultant, Planning Institute of Jamaica (PIOJ), Jamaica.
- Donna **FRASER**, Research Officer, Bureau of Women's Affairs, Kingston, Jamaica.
- Anthony **FRECKLETON**, Member, Saint Elizabeth and Manchester Vegetable Growers Association, Jamaica.
- Nancy A. **GEORGE**, Institute for Connectivity in the Americas, Member Hemispheric Advisory Board, University of Technology, Jamaica. Institute for Connectivity in the Americas.
- Windsome **GREENWOOD**, Assistant Professor, Marketing, College of Business and Continuing Education, Northern Caribbean University (NCU), Jamaica.
- Jasmin **HOLNESS**, Deputy Director, Research and Development, Ministry of Agriculture, Jamaica.
- Sophia **HUYER**, Executive Director, Gender Advisory Board, United Nations Commission on Science and Technology for Development (GAB UNCSTD), Canada. *Gender Equality and the Knowledge Society.*
- Faith **INNERARITY**, Senior Director, Social Security, Ministry of Labor and Social Security, Jamaica.
- Pius **LACAN**, Heart Trust / NTA, Ebony Park Academy, Jamaica.
- Marta **LITTER**, Head, Group of Colloids and Inorganic Oxides, National Atomic Energy Commission (Gurpo de Coloides y Óxidos Inorgánicos, Comisión Nacional de Energía Atómica), Argentina. *How Science and Technology Can Satisfy the Needs of the Poor.*
- Shirley M. **MALCOM**, Director, Directorate for Education and Human Resources Programs, American Association for the Advancement of Science (AAAS), United States. *Promoting Social Development: Meeting Human Needs. The Role of Science and Technology Institutions.*
- Menelea **MASIN**, Economic Affairs Officer, Science and Technology Section, Division on Investment, Technology and Enterprise Development, United Nations Conference on Trade and Development (UNCTAD), Switzerland. *Promoting the Application of Science and Technology to meet the Development Goals contained in the Millennium Declaration.*
- Errol **MILLER**, Professor of Teacher Education, Institute of Education, University of the West Indies, Jamaica. *Science, Technology and Education.*
- Alvin **MURRAY,** General Manager, Christiana Potato Growers Co-op-Association, Jamaica.
- Joan **NEIL**, Director, Office of the General Secretariat of the Organization of American States in Jamaica.
- Charles **PANTON**, Northern Caribbean University, Manchester, Jamaica.
- Juan **PLATA**, Chief, National Program for Social Sciences, Colombian Institute for the Development of Science and Technology (Instituto Colombiano para el Desarrollo de la Ciencia y la Tecnología – COLCIENCIAS), Colombia. *Políticas de fomento a la investigación social en Colombia. Los nuevos desafíos.*
- Julio D. **RAFFO**, Responsible for Research and Development, Inter-American/Ibero-American Network on Science and Technology Indicators (Red Iberoamericana/Interamericana de Indicadores de Ciencia y Tecnología - RICYT), Argentina. *RICYT - Network of Science and Technology Indicators.*
- Harold **RAMKISSOON**, President, Caribbean Scientific Union, Department of Mathematics and Computer Science, University of the West Indies, Trinidad and Tobago, West Indies. *The Role of Science Academies in Social Development.*
- Hazle **RICHARDSON**, Jamaica.
- Jaslin **SALMON**, Director, Programming, Coordination and Monitoring Unit, Office of the Prime Minister (OPM), Jamaica. *Micro-business and Employment Generation for Poverty Reduction.*
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- Hayden **THOMAS**, Ombudsman, Antigua and Barbuda, Former Government Chief Chemist and Food Technologist, Office of the Ombudsman, Antigua and Barbuda. Agro-industry Research and Development.
- Arnoldo **VENTURA**, Special Advisor to the Prime Minister on Science and Technology, Office of the Prime Minister, Ja-

maica. *Science and Technology and Democracy. Solutions to Poverty.*

- Loreen **WALKER**, Executive Director, Jamaica Intellectual Property Office, Jamaica. *Intellectual Property Rights and Employment Generation.*
- Domingo **ZÚÑIGA CORTÉS**, Director General, Administration Secretariat, State of Colima (Secretaría de Administración, Estado de Colima), Mexico. *A New Era of Management for the Government of Colima.*

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- Fernette **WILLIAMS**, Librarian, National Council on Drug Abuse (UCDA), Jamaica.

Workshop Consolidation of Hemispheric Policies in Science and Technology

(Washington, D.C., United States, April 14, 2004)

- Alice **ABREU**, Director, Office of Science and Technology, Organization of American States (OAS). *Consolidation of Hemispheric Policies in Science and Technology.*
- María Juliana **ABELLA**, Director, National Bureau of Science, Technology and Innovation (DINACYT), Ministry of Education and Culture (Ministerio de Educación y Cultura), Uruguay.
- Michael **BEJOS**, Alternate Representative, Permanent Mission of Belize to the OAS.
- Gerardo **BOMPADRE**, Permanent Mission of Argentina to the OAS.
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- Héctor Adolfo **CENTENO BOLAÑO**, General Coordinator, National Council of Science and Technology (Consejo Nacional de Ciencia y Tecnología - CONCYT), Guatemala.
- Raúl J. **CHANG**, Executive Secretary, Nicaraguan Council of Science and Technology (Consejo Nicaragüense de Ciencia y Tecnología - CONICYT), Nicaragua.

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- Carlton **FREDERICK**, Chairman, National Science and Technology Council, Grenada.
- María del Rosario **GUERRA DE MESA**, Director, Colombian Institute for the Development of Science and Technology (Instituto Colombiano para el Desarrollo de la Ciencia y la Tecnología - COLCIENCIAS), Colombia.
- Fernando **GUTIÉRREZ**, Minister of Science and Technology, Ministry of Science and Technology (Ministerio de Ciencia y Tecnología - MICIT), Costa Rica.
- Sophia **HUYER**, Executive Director, Gender Advisory Board, United Nations Commission on Science and Technology for Development (GAB UNCSTD), Canada. *Gender and Science and Technology Policy in the Americas.*
- David **KEITHLIN**, Counselor, Alternate Representative, Permanent Mission of Canada to the OAS.
- Joycelyn **LEE YOUNG,** Registrar, National Institute of Higher Education, Research, science and Technology, Trinidad and Tobago.
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Fourth Regular Meeting of the Inter-American Committee on Science and Technology (COMCYT)

(Washington, D.C., United States, April 15-16, 2004)

• Alice **ABREU**, Director, Office of Science and Technology, Organization of American States (OAS). *Fourth Regular Meeting of the Inter-American Committee on Science and Technology (COMCYT).*

• María Juliana **ABELLA**, Director, National Bureau of Science, Technology and Innovation (DINACYT), Ministry of Education and Culture (Ministerio de Educación y Cultura), Uruguay.

• Marcia Ramos **ADORNO**, First Secretary, Alternate Representative, Permanent Mission of Brazil to the OAS.

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• Michael **BRADECAMP**, Bureau of Oceans, Environment and Science, Department of State, United States.

• María Guadalupe **CARÍAS**, Counselor, Permanent Mission of Honduras to the OAS.

• Marta **CEHELSKY**, Senior Adviser for Science and Technology, Sustainable Development Department, Inter-American Development Bank (IADB), United States.

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• Michael T. **CLEGG**, Foreign Secretary, National Academy of Sciences, United States. *Scientific Education and Capacity Building in Developing Countries.*

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[1] The Office of Science and Technology (OST) of the Organization of American States, created by Executive Order No. 97-1 of January 29, 1997, was restructured by Executive Order No. 04-01 Corr. 1 of September 15, 2004 and changed its name to Office of Education, Science and Technology (OEST).
[2] Specialist not longer working at the OEST

Acronyms

AAAS - American Association for the Advancement of Science
ACL - Atypical Cutaneous Leishmaniasis
AMB/ATT – Applied Molecular Biology / Appropriate Technology Transfer
ANSWER - Advanced Neutron Scattering Network for Education and Research
ASOCOLFLORES – Colombian Association of Flowers Exporters (Asociación Colombiana de Exportadores de Flores)
ASTC - Association of Science-Technology Centers
BIOLAC - Biotechnology for Latin America and the Caribbean
BIREME – Latin American and Caribbean Center for Health Science Information – PAHO (Centro Latino-Americano e do Caribe de Informação em Ciências da Saúde – Organização Pan Americana de Saúde)
CABBIO - Argentina-Brazil Center of Biotechnology
CANARIE - Canada's Advanced Internet Development Organization
CAPES – Coordination for the Enhancement of Higher Education (Coordenação de Aperfeiçoamento de Pessoal de Nível Superior), Brazil
CARICOM – Caribbean Community
CDR – Center for Design Research, Stanford University, United States
CEDIA – Ecuadorian Consortium for Development of Advanced Internet (Consorcio Ecuatoriano para el Desarrollo de Internet Avanzada)
CENAM – National Center of Metrology (Centro Nacional de Metrología), Mexico
CEO – CEO Group (Grupo CEO), Argentina
CEPL – Ecuadorian Center of Cleaner Production (Centro Ecuatoriano de Producción más Limpia)
CGEE - Center of Management and Strategic Studies (Centro de Gestão e Estudos Estratégicos), Brazil
CIAM - Inter-American Materials Collaboration
CIASEM - Inter-American Committee of Societies for Electron Microscopy
CIDI - Inter-American Council for Integral Development
CIM - Inter-American Commission of Women
CLARA - Latin American Cooperation for Advanced Networks (Cooperación Latino Americana de Redes Avanzadas)
CNDR - National Center of Diagnosis and Reference (Centro Nacional de Diagnóstico y Referencia), Nicaragua.
CNPq - National Council for Scientific and Technological Development (Conselho Nacional de Desenvolvimento Científico e Tecnológico), Brazil
CODELCO – National Corporation of Copper, (Corporación Nacional del Cobre), Chile
COLCIENCIAS – Colombian Institute for the Development of Science and Technology (Instituto Colombiano para el Desarrollo de la Ciencia y la Tecnología)
COMCYT – Inter-American Committee on Science and Technology
COMECYT - Science and Technology Council of the State of Mexico (Consejo Mexiquense de Ciencia y Tecnología)
CONACYT -National Council of Science and Technology (Consejo Nacional de Ciencia y Tecnología), Bolivia
CONACYT -National Council of Science and Technology (Consejo Nacional de Ciencia y Tecnología), Mexico
CONACYT -National Council of Science and Technology (Consejo Nacional de Ciencia y Tecnología), El Salvador
CONCYT - National Council of Science and Technology (Consejo Nacional de Ciencia y Tecnología), Guatemala
CONCYTEC – National Council of Science and Technology (Consejo Nacional de Ciencia y Tecnología), Peru
CONICET - National Council of Scientific and Technical Research (Consejo Nacional de Investigaciones Científicas y Técnicas), Argentina
CONICYT – National Commission of Scientific and Technological Research (Comisión Nacional de Investigación Científica y Tecnológica), Chile
CONICYT - Nicaraguan Council of Science and Technology (Consejo Nicaragüense de Ciencia y Tecnología), Nicaragua
CoSMIC - Combinatorial Sciences and Materials Informatics Collaboratory
CTSR - Consortium on Thermal Spray Technology
CUDI - Mexican Education and Research Network (Red Mexicana para la Investigación y Educación)
CYTED – Ibero-American Program on Science and Technology for Development (Programa Iberoamericano de Ciencia y Tecnología para el Desarrollo)
DINACYT - National Directorate of Science, Technology and Innovation (Dirección Nacional de Ciencia, Tecnología e Innovación), Uruguay
DNA - Deoxyribonucleic Acid
ECLAC – Economic Commission for Latin America and the Caribbean
ESSD - Environmentally and Socially Sustainable Development, World Bank
FAO - Food and Agriculture Organization of the United Nations
FEMCIDI – Special Multilateral Fund of CIDI, Inter-American Council for Integral Development
FIRJAN – Federation of Industries of Rio de Janeiro State (Federação das Industrias do Estado do Rio de Janeiro), Brazil
FONCyT – Scientific and Technological Research Fund (Fondo para la Investigación Científica y Tecnológica), Argentina
FONDEF – Fund for the Promotion of Scientific and Technological Development (Fondo de Fomento al Desarrollo Científico y Tecnológico), Chile
FONTAR – Argentinean Technological Fund (Fondo Tecnológico Argentino)
FUNDACYT - Foundation for Science and Technology (Fundación para la Ciencia y Tecnología), Ecuador
GDP - Gross Domestic Product
GMOs - Genetically Modified Organisms
IACD – Inter-American Agency for Cooperation and Development of the OAS
IADB - Inter-American Development Bank
IANAS- Inter-American Network of Academies of Sciences
IBCT – Institute for Business Continuity Training
ICA - Institute for the Connectivity of the Americas
ICBM - Programa de Biotecnología Celular y Molecular, Facultad de Medicina, Chile
ICGEB - International Centre for Genetic Engineering and Biotechnology
ICTs - Information and Communications Technologies
IDB – Inter-American Development Bank
IDRC – International Development Research Centre
IMPA - Pure and Applied Mathematics Institute (Instituto de Matemática Pura e Aplicada), Brazil
INMETRO - National Institute of Metrology, Standardization and Industrial Quality (Instituto Nacional de Metrologia, Normalização e Qualidade Industrial), Brazil
INEN - Ecuatorian Institute of Normalization (Instituto Ecuatoriano de Normalización)
INFOCYT – Science and Technology Information Network for Latin American and the Caribbean
INTA – National Institute of Agricultural Technology (Instituto Nacional de Tecno-

logía Agropecuaria), Argentina
INTI – National Institute of Industrial Technology (Instituto Nacional de Tecnología Industrial), Argentina
ITC - Information and Communications Technologies
JADF - Jamaica Agricultural Development Foundation
LAC - Latin America and the Caribbean
LEAD - Leadership for Environment and Development - Rockefeller Foundation program
LHC's – Large Hadron Collider
LNLS - Brazilian National Laboratory of Synchrotron Radiation (Laboratório Nacional de Luz Síncrotron)
MAST – Museum for Astronomy and Related Sciences (Museo de Astronomía y Ciências Afins), Brazil
MCT – Ministry of Science and Technology (Ministério de Ciência e Tecnologia), Brazil
MCT - Ministry of Science and Technology (Ministerio de Ciencia y Tecnología), Venezuela
MERCOCYT – Common Market of Scientific and Technological Knowledge
MICIT - Ministry of Science and Technology (Ministerio de Ciencia y Tecnología), Costa Rica
MIT – Massachusetts Institute of Technology, United States
MRSEC - Materials Research Science and Engineering Centers
MST - Ministry of Science and Technology
NAS - National Academy of Sciences, United States
NCST – National Commission on Science and Technology, Jamaica
NCU - Northern Caribbean University, Jamaica
NGOs - Non Governmental Organizations
NIHERST – National Institute of Higher Education, Research, Science and Technology, Trinidad and Tobago.
NIST - National Institute of Standards and Technology, United States
NRENs - National Research and Education Networks
NSF - National Science Foundation, United States
NSRC - Network Startup Resource Center, United States
OAS – Organization of American States
OECD - Organization for Economic Cooperation and Development
OPM - Office of the Prime Minister, Jamaica
OST - Office of Science and Technology, Organization of American States
OEST – Office of Education, Science and Technology, Organization of American States
P+L - Cleaner Production
PAHO - Pan American Health Organization
PCR - Polymerase Chain Reaction
PIOJ - Planning Institute of Jamaica
PRI - Policy Research International
PRSV - Papaya Ringspot Virus
PTB - National Metrology Institute (Physikalisch-Technische Bundesanstalt Braunschweig und Berlin), Germany
PTT - Providers of Telecommunications Training
PUC – Pontifical Catholic University of Rio de Janeiro (Pontificea Universidade Católica do Rio de Janeiro), Brazil
R&D - Research and Development
RED - Research and Experimental Development
REDBIO – Technical Cooperation Network on Plant Biotechnology for Latin America and the Caribbean (Red de Cooperación Técnica en Biotecnología Vegetal para América Latina y el Caribe)
RedHUCyT – Hemisphere Wide Inter-University Scientific and Technological Network
RED-POP - Network for the Popularization of Science and Technology in Latin America and the Caribbean
RELAB - Latin American Network of Biological Sciences (Red Latino Americana de Ciencias Biológicas)
REUNA – University National Network (Red Universitaria Nacional), Chile
RICYT – Inter-American/Ibero-American Network on Science and Technology Indicators
RNP - Research and Education Network (Rede Nacional de Ensino e Pesquisa), Brazil
RPI – Rensselaer Polytechnic Institute (Rensselaer Polythechnic Institute), Germany
SBPMat - Brazilian Society for Materials Research (Sociedade Brasileira de Pesquisa em Materiais)
SCIELO – Scientific Electronic Library Online, Brazil
ScienTI – International Network of Information and Knowledge Sources for Sciences, Technology and Information Management (Red Internacional de Fuentes de Información y Conocimiento para Gestión de Ciencia, Tecnología e Innovación)
SECYT – Secretariat of Science, Technology and Productive Innovation (Secretaría de Ciencia, Tecnología e Innovación Productiva), Argentina
SENACYT - National Secretariat of Science, Technology and Innovation (Secretaría Nacional de Ciencia, Tecnología e Innovación), Panama
SIM - Inter-American Metrology System
SMEs – Small and Medium-sized Enterprises
SSI - Sustainable Science Institute
STR - Short Tandem Repeat markers
TEM - Transmission Electron Micrograph
TEV - Tobacco Etch Virus
TUBITAK - Scientific and Technical Research Council of Turkey (Turkiye Bilimsel ve Teknik Arastirma Kurumu)
TYLCV - Tomato Yellow Leaf Curl Virus
UCDA - Librarian National Council on Drug Abuse
UCLA - Integrated Scalable Nanomanufacturing
UERJ - University of the State of Rio de Janeiro (Universidade do Estado do Rio de Janeiro), Brazil
UFF – Fluminense Federal University (Universidade Federal Fluminense), Brazil
UFRJ – Federal University of Rio de Janeiro (Universidade Federal do Rio de Janeiro), Brazil
UNAM – National Autonomous University of Mexico (Universidad Nacional Autónoma de Mexico)
UNCSTD - United Nations Commission on Science and Technology for Development
UNCTAD - United Nations Conference on Trade and Development
UNDP – United Nations Development Program
UNESCO – United Nations Educational, Scientific and Cultural Organization
UNICAMP - University of Campinas (Universidade Estadual de Campinas), Brazil
UNIDO – United Nations Industrial Development Organization
UNU – United Nations University
USAID – US Agency for International Development
USAMI - US-Africa Materials Institute
USP - University of Sao Paulo (Univesidade de São Paulo), Brazil
WB – World Bank
WFEO – World Federation of Engineering Organizations