The Ibero-American Science and Technology Education Consortium (ISTEC): The Initiative Approach for Science and Technology Education, Research and Development

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Abstract - *Effective and efficient, up-to-date education and information interchange are needed for the well-being of a country or region. To this end the Ibero-American Science and Technology Education Consortium (ISTEC) has been organized. The Consortium is providing mechanisms for improvement of education, research and development, and technology transfer throughout the Americas and the Iberian Peninsula. The mechanism utilized to identify and facilitate these activities is the Initiative, which is an area of interest identified by participating institutions to address the needs of a member institution, country, or region. By creating projects organized within these initiatives, current technology and information are made available for the solution of problems.*

Four initiatives have been identified to date, and within each of these initiatives projects are being carried out to achieve the objectives of the Consortium. The Library Linkages Initiative promotes the use and creation of innovative real-time information-sharing services. Within this initiative are projects which seek to provide technical information in a timely fashion to a user community which is diverse in its needs and its geographical distribution. This includes distribution of material through networked interconnection, development of regional data bases, and improved availability of materials for education and research.

The Advanced Continuing Education Initiative seeks to upgrade human resources through a variety of activities. Included in this initiative are a number of training efforts. Short courses are being developed and delivered in a series of advanced technical presentations. Distance education is being used to distribute information about Information Technologies. Network facilities are being utilized to provide collaborative educational activities which draw together faculty and students on three continents. In addition, exchange programs, such as "sandwich" graduate programs which minimize time away from the home institution and maximize information transfer, permit the sharing of expertise among participating institutions.

The Research and Development Laboratories Initiative creates cooperating laboratories that are modular, flexible, and expandable for education, R&D, and other activities. Similar laboratories are made available in many ISTEC institutions. With common basic elements in the laboratory, experiments, experiences, and techniques can be shared. These results, both in teaching mechanisms and research explorations, are made available to minimize the impact of starting new avenues of activities.

The "Los Libertadores" Initiative has been started, an initiative which will culminate in the creation of a next-generation network connecting multidisciplinary Centers of Excellence for addressing current in-country and regional problems. The Centers of Excellence allow technology to be utilized to address concerns of a country or region, and the network of these Centers is designed to share the information between cooperating sites to effectively utilize scarce resources throughout Ibero-America.

The distributed nature of the projects and initiatives avoids duplication of efforts and responds needs identified by the members. A variety of projects are underway based on the initiatives in order to bring the benefits of technology to participants. Projects are designed to be dynamic and extensible, and maximum utilization of available resources is encouraged by transnational coordination and collaboration.

Introduction - Background

The strength of the economy of any country is directly related to its ability to utilize technology for resolution of problems in a timely and cost-effective manner, and for enhancement of productivity and quality. Paramount among the applicable technologies for improvement are the areas which are included in telecommunications and informatics. This was evident when participants joined together to form ISTEC. A survey of areas of interest among members revealed that the concerns of participants were centered in telecommunications and computers. Information must be managed and communicated to allow effective participation in today's global marketplace. In order to improve the availability of these technologies for all countries, education in state-of-the-art technological areas is imperative, as is improvement of the infrastructure of a region to support information technology.

In order to meet this need for improved education in technical areas and to provide a mechanism for sharing of information, ISTEC was organized in December of 1990. The objectives of ISTEC include providing improved, up-to-date education for all participants, stimulating international research and development projects, providing a vehicle for technology transfer, and improving international cooperation. Members of ISTEC share a long-term commitment to work together in a partnership arrangement to coordinate activities, exchange information, conduct joint research and development activities, and find improved mechanisms for educating students and professionals about available technology. For a detailed description of ISTEC, see the companion article.

Members of ISTEC recognize that a primary concern for improvement of the Information Technology Infrastructure of a country is to identify key areas which must be strengthened, and then plan appropriate activities to address those needs. Thus, it is incumbent on the individual members of ISTEC to initiate the steps required to solve problems in their institutions, countries, and region. Once a plan has been developed, other members of ISTEC, as well as other interested parties, participate to provide the improvement needed. In this manner, resources in one area are made available in a timely and cost effective fashion to another area, and in the process, avoiding duplication of efforts which is another major thrust of the Consortium.

The activities involved in these science and technology efforts can be grouped into two different classifications. One level is the initiative, which identifies an area of concern and invites active participation in solving problems. The other level is the project, which is a specific activity undertaken to address a need which is delineated by an initiative. Thus, projects are carried out by ISTEC members to improve technology and science in a specific fashion. Funding for these projects is sought by ISTEC members and by ISTEC as a whole.

Initiatives: Planned Partnerships for Improved Technology and Science

An initiative is an area of concern, identified by members of ISTEC, that spans a particular objective or need. As the initiative is proposed and articulated, the participants identify specific needs which must be addressed in order to provide advancement for their respective areas. This permits different participants to find common areas of interest, as well as to formulate plans for joint projects in those areas. Thus, the Consortium's initiatives are member-driven, flexible, and parallel in nature. They are member driven because the initiators of the activities are the members themselves, driven by their own needs and circumstances. They are flexible because they must be tailored to meet the requirements of an individual locale. And they are parallel in nature because activity in one arena does not preclude activity in another, and both can proceed concurrently.

Four initiatives have been identified to date in order to bridge the technological gap and bring Ibero-America into the 21st century, providing for enhanced development in the hemisphere. These initiatives are:

- Library Linkages Plan: A long range initiative which promotes the use and creation of innovative, transnational information-sharing services. This is an effort to address the lack of current information.
- Advanced Continuing Education (ACE): In collaboration with educational curricula reform programs, this ambitious effort aims to upgrade human resources through on-site training, distance learning, and non-traditional exchange programs.
- Research and Development Laboratories: This effort includes the design and installation of modular, flexible, and expandable laboratory facilities for educa-

tion, R&D, and the provision of these services to the productive sectors.

- Los Libertadores: This network of Centers of Excellence, equipped with the latest telecommunications and computer technology, will provide researchers, educators, policy makers, and scientific administrators real-time access to a world-wide system of expertise and knowledge.

Within initiatives, projects are identified, planned, and implemented. The distributed structure from which the projects stem actively avoids duplication of efforts and inherently responds to membership needs. ISTEC participants encourage the free flow and access of information in the pursuit of technical excellence. Projects are designed with both short- and long-term goals, as well as consideration of social impact. They are dynamic and expandable, and coordination is enforced to maximize the utilization of available resources. Present policy targets the fields of science, engineering, and technology, without excluding future extensions into other areas.

Library Linkages Initiative

One of the basic tenets of science and technology education is access to up-to-date information. The Library Linkages Initiative aims to modernize document delivery as a complement to education, research, and curricula reform, to broaden electronic availability of research materials, to upgrade the information system skills of library staff, and to sharpen the savvy and independence of the electronic library user. The ISTEC Cooperative Interlibrary Loan project has facilitated installation of Internet document transmission software, trained users to electronically research science and engineering data bases, and coordinated electronic request and transmission of documents among libraries of ISTEC member institutions. The first year's delivery of 2,500 pages of current periodicals and theses confirmed the need for expanded, rapid, Internet-based methods of acquisition of materials in Ibero-America.

From the initial experience grew ISTEC's Information Access and Exchange Project. The project aims to break the exclusion of much Ibero-American research data from the worldwide exchange of information. User training, librarian exchange and upgrade of systems all play a role in the continuing success of expanding the Internet-based information delivery system. Sites continue to be added to this project. Recognition of the depth of collections is leading to efforts to create an ISTEC data base identifying member holdings. Expansion of the document delivery component to the social and health sciences appears imminent.

The overwhelming demand for reliable methods of data collection and accessibility to data is a tailored fit to ISTEC's computer and electrical engineering research. The above-mentioned projects have provided sufficient baseline data to permit spin-off research in distributed databases and improvement of document delivery services. One such outcome is the development of the software package RANDEX, a system developed to facilitate the exchange and delivery of documents.

Advanced Continuing Education

At the time of ISTEC's inception, higher education opportunities were on the rise in Latin America. The 1990 World Bank discussion paper, "Higher Education in Latin America: Issues of Efficiency and Equity" states "Enrollments in Latin American universities increased tenfold between 1960 and 1985, resulting in higher education opportunities equivalent to many industrialized countries." [1] However, the insufficient number of experienced post-graduate professors, and seemingly diminishing educational resources remains a barrier to taking advantage of those higher education opportunities efficiently.

International development organization reports from the early 1990s maintained that the stagnancy in the quality of Latin American science education was a result of constraints on government budgets, inefficiencies in resource allocation and inflexible curricula. ISTEC's philosophy, modus operandi, and advanced technological structure readdresses the question of whether "more or less of society's scarce resources should be allocated to higher education". ISTEC takes the positive view that the scarcity of resources is a catalyst for innovation in education.

Distance education is a working model of this innovation. The criteria for distance learning set forth by the National Science Teacher's Association (NSTA) includes interaction, flexibility, manipulative experiences, competency of instructors, a variety of appropriate resources and of appropriate technology. Science and technology disciplines readily embrace these criteria while expanding their boundaries.

The ISTEC-designed curriculum enhancement project, Tecnologías de la Información, dissolves the limits of location and shows that sharing resources goes far beyond cost-effectiveness. Tecnologías de la Información is designed to utilize the technical expertise of senior research faculty from the Ibero-American world to co-develop and present highly specialized courses for undergraduate and graduate students, faculty, and industrial scientists engaged in research, curricula reform, and faculty upgrades. Building on a project design and model course from the Polytechnic University of Madrid (UPM), ISTEC member universities were consulted to identify their technical strengths and the Tecnologías de la Información curriculum was defined. Outstanding faculty from Spain, Latin America and the United

States agreed to share intellectual and financial resources to reap benefits beyond the reach of any single institution.

The Tecnologías de la Información series is comprised of eight courses dealing with a broad range of information technologies. Eight universities are collaborating in the execution of the project, each contributing staff and facilities, and arranging sponsorship for course development and production. Via HISPASAT satellite links, the series is being broadcast by the Iberoamerican Educational Television Association (ATEI), a public system promoted and supported by Ibero-American Ministries of Education in partnership with nearly 300 member institutions in Spain, Portugal, Latin America and the U.S. ATEI is also a partial sponsor of the series' production.

The Digital Image Processing course [Ras95, Lot95] exemplifies the high standards of use of collaborative learning technologies toward which all Tecnologías de la Información courses strive. This ten-hour video course was co-produced by the University of New Mexico (USA) and the Universidade Estadual de Campinas (Brazil); the video is designed to be followed simultaneously with the Internet-accessible Digital Image Processing with Khoros 2 course.

The interactive format makes good use of web browsers, encouraging student progress and input through on-line, real-time text and images. Running atop the visual programming environment Khoros 2, users experience a hands-on approach to image processing through an extensive number of experiments. This course is being used as a self-study guide and for curriculum development.

Research and Development Laboratories Initiative

The purpose of the Research and Development Laboratories Initiative is to provide a vehicle for performing research in a variety of informatics related areas. The laboratory facilities are also designed to be utilized in teaching situations. Thus, this initiative seeks to improve the ability of technology to be applied to the resolution of problems in a variety of areas.

Several activities are underway to provide ISTEC members with the up-to-date hardware and software tools to allow members to go from the concept of an endeavor to the final deployment of it. The creation of these laboratories will also facilitate and encourage the dialogue between the productive sector and the university environment.

A laboratory currently in use at the University of New Mexico is being used as a modular, flexible prototype for this wide-ranging, adaptable laboratory system. Several ISTEC institutions with similar laboratory facilities are presently upgrading curricula in telecommunications, digital signal processing, microprocessors, control, and other areas.

With the assistance of Motorola Inc., the Consortium is in the process of installing over 30 laboratory sites throughout Latin America and the Iberian Peninsula. In the first phase, the laboratory facilities are provided with Motorola's 68000 family of microprocessors. The second phase will equip these facilities with 68HC11 microcontrollers technology. A third phase will involve the installation of DSP56000 and DSP96000 Digital Signal Processor technology where appropriate. Motorola Inc. has donated much of the necessary equipment for these facilities. In a related effort, several ISTEC institutions are in the process of creating a distributed Information Exchange System of Motorola-based-products and applications to be accessed via the Internet. Initially, the exchange of information will occur between ISTEC Motorola-based labs within the subcategories of microprocessors, microcontrollers, and digital signal processors.

Another laboratory system which is in development seeks to incorporate collective contributions from a number of institutions in the arena of telecommunications. This effort is based on a very ambitious broad-band telecommunications project proposed by the Universidade Estadual de Campinas (UNICAMP), in Brasil. The Multimodal Communications in the 21st Century (Multicom-21) project supported by Nortel, focuses on joining universities, Nortel, and other telecommunication service companies in order to develop educational curricula, joint research and development programs, laboratory facilities, and faculty development. The current effort provides funding for projects at twelve ISTEC universities.

Los Libertadores Initiative

The Los Libertadores Initiative is a "common thread" project which links together all of ISTEC goals and objectives. This ambitious project intends to create a flexible network of telecommunication services, high performance computers, and teaching stations, known as "Centers of Excellence". The project's ideology encourages innovation in adaptability to need-borne technology. Thus, each country or locale identifies needs which must be met, and then designs a Center of Excellence to address those needs.

Each Center of Excellence joins people from the private sector, the public sector, and the educational system to work together to find solutions to the needs of the area. Since those needs invariably have multiple facets, the solutions must involve multiple disciplines and the diverse contributions available from the different sectors. Thus, included in this type of Center will be appropriate computational facilities, teaching stations, telecommunication links, laboratories, and administrative capabilities. It is important that the Center be adapted to the needs of the country, identifying those areas that can be most beneficial for all the participants and

finding ways to address those needs. Thus, the Center may not be a central building, but rather a network of capabilities distributed throughout an area. The Center of Excellence will provide needed services to the country, including state-of-the-art information and education, consulting services, computational capabilities, as well as world-wide access to expertise as needed.

For all of the activities of ISTEC, creation of Centers of Excellence throughout Ibero-America and joining them together into a network of information sharing facilities will provide benefits for all participants. These benefits will be made more evident as joint activities maximize the return on investment of time and other scarce resources.

Conclusion

Education in up-to-date technologies will lead to benefits for all parties in Ibero-America, and steps must be taken which will provide the education and the technology. The Ibero-American Science and Technology Education Consortium provides a vehicle to address these educational and technical needs in a timely and efficient fashion.

Working together in a concurrent arrangement, four initiatives have been identified which target current areas of interest in participating countries. Projects that fall under the initiatives outlined above are at different stages of planning and implementation. The flexible framework provided by the initiatives allows projects to be carried out in countries or regions, or throughout the hemisphere. The framework can also be expanded by the introduction of other initiatives as other needs are identified, or priorities change to focus attention on new endeavors. Other efforts, complementary to ISTEC's initiatives, are needed to inform and educate the general public and policy makers about the problems identi-fied above, and the necessity to solve them collectively rather then discretely.

Acknowledgments

Current information about ISTEC can be found at: http://eece.unm.edu/istec.

References

1) Winkler, D. R., "Higher Education in Latin America: Issues of Efficiency and Equity," (World Bank Discussion Papers), March 1990, pp. iii.