MIT LINC

Inaugural Workshop

Learning International Networks Consortium

February 6 & 7, 2003

PROCEEDINGS OF THE INAUGURAL WORKSHOP

OF THE

LEARNING INTERNATIONAL NETWORK CONSORTIUM

FEBRUARY 6 AND 7, 2003

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Distributed on March 22, 2004

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PREFACE

In the developing world, national wealth used to be proportional to the value of minerals, precious metals, and oil buried in the ground. If that were true today, Iraq, Nigeria, Venezuela, and South Africa would be very rich countries. Small countries such as Singapore, with nothing of value under its soil, would be very poor. But quite the opposite is true. Why? Because a nation's most precious assets are no longer buried under ground; rather, they are between the ears of its citizens. A solid educational infrastructure is the key to a nation's success. Investment in education creates stability and economic value, and increases overall satisfaction among citizens. Tiny Singapore, with its population of 3.5 million, is an example of the value of investing heavily in education.

One of the most valued assets in the United States is its educational system, sometimes maligned, but unsurpassed in its ability to produce an educated population. Its colleges and universities are the envy of the world. In much of the developing world, education is unavailable to huge portions of the population. In some cases this is intentional. For example, until recently national policy in Afghanistan forbade the education of girls and women. But most often the lack of education is due to lack of resources, such as qualified teachers and necessary infrastructure. In most of the developing world, less than 5 percent of the population receives postsecondary education, in contrast to nearly 50 percent in the U.S. Illiteracy rates of 30 to 60 percent and more are not uncommon, compared with low single-digit illiteracy rates in Western Europe and the U.S.

CURRENT INITIATIVES

Developing nations need many types of infrastructure, but perhaps none is more important than an infrastructure against ignorance. Recognizing this need, in the past year or so many countries have announced plans for national "virtual universities,"

leveraging 21st century technology to bring quality education to knowledge-impoverished populations. These countries span the planet and include Ireland, Tunisia, Pakistan, Jordan, Indonesia, South Korea, Syria, and Uzbekistan. The United Arab Emirates, Saudi Arabia, Algeria, and Iran are also actively pursuing initiatives in distance learning. In sub-Saharan Africa, the African Virtual University has recently begun operations in 15 regional sub-Saharan countries (with support from the World Bank). South Africa has undertaken major initiatives in distance learning. China's massive distance learning programs, historically delivered primarily by satellite television, are now transitioning to the Internet. In addition, the large and successful effort by Mexico's Monterrey Institute of Technology is bringing its Virtual University to many learners throughout Latin America.

To enable more educational dialogue with the developing world, the World Bank recently established the Global Development Learning Network, a satellite and ISDN-based network linking both developed and developing countries in a collaborative network for learning. Going forward, the World Bank is committing $800 million to promote online learning in developing countries. The Australian government recently announced its decision to spend $100 million on distance programs for developing countries, and several universities in India have created e-learning collaborations with Western universities. These are but a few examples of efforts to bring much needed education and training to under-served regions, which in turn may lead to greater mutual understanding. Modern computers and telecommunications systems can be used either to exacerbate current inequities in the distribution of knowledge that leads to prosperity, thereby accelerating the "digital divide," or to bring world-class educational opportunities to people of the developing world by creating a digital bridge.

There are many compelling reasons for continuing and expanding e-learning efforts throughout the developing world:

* The number of openings in brick-and-mortar universities cannot grow at the same rate as that of the population that requires education. To retain the current proportion of those now enrolled worldwide in undergraduate degree programs, it is estimated that an average size new university would have to be built every two weeks. Technology-delivered education can be delivered at a fraction of the cost of traditional classroom education if designed in a way that fully leverages economies of scale.

* Developing countries do not have sufficient numbers of qualified professionals to serve as teachers, faculty, and mentors in the traditional educational structure. New technologies would potentially allow qualified professionals to teach larger populations.

* While studying overseas at universities, students from different countries often see each other as supportive friends and collaborators, even when the countries from which they originate are hostile toward each other. Our hypothesis is that teaching students through e-learning across national boundaries in a collaborative environment may enhance mutual understanding and prepare the next generation of leaders for taking steps toward world peace.

* Without some feasible system for improving education, developing countries are likely to fall further behind the developed world in terms of economic growth and prosperity. This could lead to even greater inequities in the distribution of wealth among nations and act as an agent that destabilizes world peace.

* The digital bridge envisioned welcomes two-way traffic. Educational content from the developing regions to the developed world will also enhance mutual understanding and provide a rich source for cultural studies.

In short, the need to build a digital bridge is essential.

GLOBAL LEARNING NETWORKS

One way to visualize global learning networks is as follows: Instead of shipping oil from oil-rich to oil-consuming nations, a global

learning network ships learning content from nation to nation; and e-learning becomes an important component of international trade. As with all international trade, some countries will have trade surpluses and others will have trade deficits. But, unlike one-time consumption of a commodity such as oil, which is burned once and lost forever, the use of educational products and services represents an investment in the future. Thus, a short-term educational trade deficit should reap long-term dividends and benefits in terms of quality of life and standard of living. Eventually, near-term knowledge importers will become net knowledge exporters.

Global learning networks have seen tremendous growth over the past five years. These networks are expanding in a variety of interesting ways.

Peer-to-Peer Partnerships. Global networks grow with peer institutions pairing up across oceans, fostering new and creative learning opportunities for their students. For example, the Massachusetts Institute of Technology (MIT) joined hands in 1998 with two peer institutions in Singapore, the National University of Singapore and Nanyang Technological University. The resulting program, the Singapore MIT Alliance (SMA), now provides five engineering masters degree programs, presented live via Internet2 videoconferencing from Cambridge, Massachusetts to Singapore. These five programs are computer science, chemical engineering, advanced materials, manufacturing, and high-performance computing. In addition to both live and asynchronous online learning, the SMA program supports extensive collaborative research among faculty and students in North America and Southeast Asia. Its campus is not fixed in a physical place, rather it is a virtual space not limited by geography or time zones. MIT recently began its second such partnership, with the University of Cambridge in the U.K. This program, the Cambridge MIT Institute[4] (CMI), seeks to build on each institution's pedagogical models and course offerings to enhance the educational environment

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and options of students on both sides of the Atlantic. Both the SMA and CMI programs also involve limited student exchanges.

Nation First, Region Second. Learning networks also grow when a developing nation creates a virtual university for students within its own borders and then expands to other countries. Mexico's Monterrey Institute of Technology started its Virtual University to utilize the country's best (but limited in number) faculty to teach students in more than 25 geographically dispersed campuses throughout Mexico. The effort has been so successful that demand for its educational products and services has spread throughout Latin America. The institute now has learners from the majority of Spanish-speaking countries throughout the Western Hemisphere. The Monterrey Tech story is an example of how one country's investment in high-quality distance education can lead to the creation of a regional educational beacon that exports fee-based educational products and services to other countries within the region. Other nations, such as Singapore, are attempting to implement the same model. Fierce competition among nations will no doubt occur as many seek to become beacons of knowledge within their regions.

One-to-Many. Many institutions of higher education, including some for-profits, are maintaining and growing markets in various regions of the world. These include open universities, private nonprofit universities heavily invested in distance learning, and for-profits, such as the largest private university in the U.S, the University of Phoenix, which is now opening markets outside the United States.

e-Transshipment Universities. Some accredited universities are only Web servers or television satellites, collecting and concentrating educational content from traditional brick-and-mortar universities, relabeling it, and redistributing it to spatially dispersed learners. One example in the U.S. is the National Technological University (NTU), which began in 1969 to redistribute college courses to masters' degree candidates. NTU graduates about 165 masters' students per year; each

graduate has taken courses from an average of seven brick-and-mortar universities via the transshipment model. The state of Virginia is planning a similar model for its residents, creating the "Virginia Virtual University," which physically will be a Web server. Ireland's new Hibernia College has a similar model in place for its first launch. **Electronic Cross Registration.** Students in college X can now take courses in college Y, not only by traveling up the street to attend classes in Y's classrooms, but through e-learning and electronic cross registration, regardless of the physical distance between X and Y. There are multiple benefits. For example, a student of foreign languages would not be constrained by the few languages taught at his or her home institution; he or she could select from well over 100 different languages taught by e-learning. The bureaucratic procedures to facilitate smooth cross registrations are not yet widely in place, but we can expect major movements in that direction.

There are several ways to create and operate global learning networks. Algeria's Université de la Formation Continue (University of Continuous Training, UFC), for example, is building its own domestic e-learning capabilities in infrastructure, pedagogy, and content. UFC is emerging as a sophisticated, stand-alone institution of higher education; it also expects to partner with the Arab Open University (financed by Saudi Prince Al Waleed Ben Talal), which is headquartered in Kuwait and has branches in at least six Arab countries. The U.K.'s Open University will provide the initial accreditation for UFC's courses and degree programs.

The UFC is joining a Euro-Mediterranean project called Avicenna, as well. The Avicenna Virtual Campus involves a consortium of 15 Mediterranean universities supported jointly by the United Nations Educational, Scientific, and Cultural Organization and the European Commission. Students in the Avicenna consortium campuses will share an extensive virtual library and will be able to electronically cross register between campuses. The UFC is also

working closely with Centre National d'Enseignement a Distance and related French-speaking consortia to introduce a large number of campuses in France and French-speaking countries, especially in Africa, to various collaborative arrangements. Finally, the UFC recently signed a letter of understanding to participate in the Learning International Network Consortium (LINC), described in the next section.

THE NEED FOR A GLOBAL CONSORTIUM

The world's learning communities need a neutral, supportive organization that supports collaborative learning free from commercial pressures and using best practices. To fill that need, one alternative may be creation of an international consortium of colleges and universities, foundations, government agencies, and private firms to support a new organization, LINC. Ideally, LINC will bring world-class educational opportunities to those who lack access to quality education. Much of its content will focus on science and technology. Equally important, teachers in developing countries will create learning opportunities for the developed world, focusing on culture, history, language, religion, philosophy, and more. Teachers in Iran, for example, will teach students and faculty in Europe and North America not only about its advances in science and technology, but also about Persia and its culture, languages, and history.

LINC will be assembled from the diverse efforts currently underway within many developing countries and will use best practices whenever possible. The effort, once fully funded, will require on-going support. Much of this funding will be internally generated in a sustaining manner from tuition, fees, and government subsidies that might otherwise have been directed toward traditional brick-and-mortar educational institutions.

LINC is envisioned as a voluntary super-network and resource center connecting and building upon individual, national, and international efforts already underway. Its goals are broad and diverse:

* To establish a sustainable international consortium supporting the creation and distribution of a variety of educational content, both domestically and internationally.

* To foster the mutual understanding of languages, cultures, history, and traditions. Students from widely disparate countries will work collaboratively on projects, learning not only course content but also to respect and bridge their cultural differences.

* To design systems and use technology to leverage scarce teaching resources within and between countries to reach a maximum number of learners.

* To establish international trade in knowledge services analogous to international trade in economic goods. Each region's contribution in the knowledge market will enhance learning elsewhere, thereby raising "knowledge standards" for all.

These goals, while enormously challenging, can be achieved if all concerned make a commitment to meet them. If not, disparities in education and income around the world, already at disturbing levels, will continue to grow, leaving a vast number of people with little hope for an education to improve their lives and global society.

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Richard C. Larson

Cambridge,

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Massachusetts

Adapted from the preface in Devlin, Maureen, Richard Larson and Joel Meyerson (eds.), The Internet and the University 2001 Forum, EDUCAUSE, Boulder, CO. 2002. The original preface is freely available as a pdf downloadable file from http://www.educause.edu/forum/ffpiu01w.asp .

First Day Opening Remarks Presented by Dr. Richard C. Larson

**Director of the Center for Advanced Educational Services at M. I. T.
Founder of the Learning International Networks Consortium (LINC)**

We would like to welcome you to the first ever LINC workshop here at MIT. LINC stands for Learning International Networks Consortium, and we are delighted to see such an extraordinary group of people gathered together this morning. Today at this meeting we have participants from about 18 countries, and you will see the flags of each one of these countries represented on the tables in front of you. We have a very rich agenda ahead of us. We decided not to split into parallel sessions because we want every one of us to get to know everyone else. One of the biggest assets of a conference like this one is just getting to meet other people who share common interests and concerns, particularly with regard to developing countries and the challenge of bringing quality education to those countries by various internet and multimedia technologies. So to encourage this kind of interaction and communication, we will not have parallel sessions. We will all be together in this room and, guess what, we have a total of 32 presentations today. We are going from dawn until dusk, and beyond. In all, we have six sessions, the final one ending at 6:00 tonight. In addition, we have an after-lunch presentation, as well as a very highly featured after-dinner speaker tonight at the MIT faculty club.

Some people have asked me what LINC is? Today LINC is a set of nascent ideas that have been co-authored with many of you over the past eighteen months. As a result of this process of co-authorship, quite a few of you are familiar faces to me. Others of you are new, and I look forward to getting to know you today and tomorrow. During the past two years, I have visited several countries represented here this morning. These visits have definitely been instrumental in the founding and development of LINC. In addition, the events of 9/11 and its aftermath have added greater urgency to the need for a truly international educational forum like LINC, one that can address the challenges of developing countries where only a very small fraction of the population gets quality tertiary education. In many of these developing countries, there are large numbers of young people who are qualified for higher education, but they are turned away due to a shortage of competent faculty. One major goal of LINC is to leverage the qualified faculty members of these countries in order to deliver quality education to a larger number of capable and deserving young people. Most of the countries gathered here today are invested in this same goal. Over the course of these two days, we will hear from these countries about what they are doing now, what their future plans include,

and what lessons they have learned along the way. We will also hear from several countries that have been pursuing and achieving this goal of expanded tertiary education for many years, and they will describe their successes to the rest of us.

As I see it, LINC is something that all of us are all going to create together, designing its specifications, qualities, and services to be rendered. In my mind, it will be a kind of professional society, but one with a highly proactive agenda. By professional society, that means it will have meetings and it will have a web-site. The web-site will provide services for communication, collaboration and information sharing among members. LINC will have publications, including a refereed scholarly journal as well as a magazine. LINC's proactive agenda will include the aggressive search for funding sources to support innovative experiments and trials employing various distance education technologies. In the LINC White Paper, which some of you have read, we proposed several programmatic initiatives to be pursued once full funding is achieved. One example of these initiatives would be the extension of some work already underway here at M.I.T., thanks to funding from the Pfizer Pharmaceutical Company. The work now in production is a bilingual, English-Spanish web-site called "Good Clinical Practices" currently being made available in Latin America. With LINC support, this project could be expanded to additional languages. For example, if French were added to the "Good Clinical Practices" web-site, then perhaps the site could be made available through our members at the African Virtual University to both the French and English speaking countries in sub-Saharan Africa.

Another such initiative might stem from the MIT African Internet Technology Initiative (AITI). Here at MIT, we have many African students who return to Africa during the summer, training trainers there at local universities in the area of information processing technologies. Under LINC, such an initiative could be expanded and broadened significantly since there are numerous students at MIT from developing countries who would like to participate in this effort all over the world. Still another example of a potential programmatic initiative for LINC involves our working jointly to create educational content. Rather than having one university create the content of a course, why not have 30 member universities create a digital repository of information about, for example, the Silk Road, contributing text, images, audio, video, etc. The outstanding product would be a joint collaborative effort by educators from many nations, greatly enhancing the teaching and research capability of us all. In such a mutual international effort, each of us is a teacher and each is a learner.

These are examples of the types of programmatic initiatives to be pursued by LINC's proactive agenda. There will be further discussions of such initiatives and of LINC's agenda tomorrow afternoon when we have our four breakout groups. The four topics of these groups will be determined tonight, but each group will have a homework assignment to

be worked on collaboratively over the next four weeks. The outcome of this collaboration will be submission of four 10-page papers, which together will become the summary LINC document, a mutual blueprint for our forward movement together. That, in summary, is the ultimate work plan for this conference.

Before getting started, I would like to read you a brief letter:

"Dear participant in the MIT LINC Workshop:

 I am pleased to welcome you to the MIT campus, with its first workshop of the Learning International Networks Consortium. The themes of your presentations, panel discussions and conversations are consistent with MIT's core educational activities and of great interest to us. During these two days, you will focus on how higher education in developing countries might be impacted through the leveraging of television and radio technologies and the Internet. You will have an opportunity to hear from leading experts about several of these efforts.

Our Open CourseWare program will have MIT course materials available free of charge on the Web. The Singapore MIT Alliance promotes in-depth investigation of remote learning technologies. The MIT World effort makes the best of MIT accessible via video and the Web. And our WebLab enables remote laboratory access anywhere /anytime.

While we are honored to share these efforts with you, we are far more interested in what we will learn from the extraordinary expertise that you bring to this conference. Participants come from both developed and developing nations and from areas of both vast and limited access to information. Your experiences with the ever-expanding dimensions of technology-enabled learning are invaluable to us, and we will be listening closely.

In the classic MIT tradition, your days here will be quite full, and you will go home with a substantive homework assignment -- to design LINC as a growing and sustainable organization. I wish you the very best with this important undertaking, and I hope that your stay on our campus is an enjoyable and rewarding one.

Sincerely yours, Chuck Vest, President of MIT."

SECTION ONE

DISTANCE/VIRTUAL EDUCATION IN DEVELOPING COUNTRIES

Education in Mexico: Challenges and Opportunities of the Monterrey Tech's Virtual University

Presented by Mariali Cardenas
Director of Education in the Division of Social Programs
Monterrey Tech Virtual University
Monterrey, Mexico

Today I am going to talk about the Virtual University of the Monterrey Tech, and after that, I am going talk specifically about the Community Learning Centers Network. This Network is a new initiative that has been going very well, and I believe it is a major project of the Virtual University that might interest you.

First of all, the Monterrey Tech is an educational system comprised of 33 campuses spread throughout 26 Mexican cities. It was established in 1943 and is the fastest growing university in Latin America. Today, the university hosts 98,000 full-time students, and its Virtual University, established in 1997, enables the university to reach students in more than 18 countries throughout the world. The goals of the Virtual University are: 1) to support the quality of traditional undergraduate programs at Monterrey Tech campuses; 2) to deliver graduate programs to cities with little or no local offerings of such programs; and 3) to deliver education to remote communities that lack resources.

As you may know, in Mexico there are cities with large populations, but there are also places with scant populations. The Virtual University access sites are specifically created in places with a smaller population of alumni or students. The Virtual University delivers high quality education through technology to remote sites in Mexico and in other Latin American countries. The University has developed a learning model that takes into account various issues, such as individual study, collaborative learning, and instructional tutoring. With this model, we have created a system that uses the Internet and virtual learning processes to provide diverse contents and to improve the educational opportunities of under-served students.

After a long history of participation in the formal Mexican educational system, Monterrey Tech realized that achieving uniform access to education across Mexico was very difficult. For example, there are widely discrepant levels of educational coverage in Mexico, where higher education, or even secondary education, have the least participation by people. Because we are a developing country, the people with the highest levels of income are the same people who have the highest levels of education. With its commitment to development, Monterrey Tech was determined not only to provide quality education to the highest socio-

economic strata, but also to do something about the people with little or no educational access that have been left behind. In order to do this, the university developed a strategy to close this gap between the most privileged and the least privileged people.

The lack of access is mainly centered in the southeast region of Mexico where citizens only achieve about five years of schooling, compared with seven or eight grades on average in other parts of the country. For example, most people achieve a degree in the primary level, but only 22% of the poorest people achieve a secondary level degree, and only 55% of the entire population has the opportunity to advance to higher education. Monterrey Tech and its Virtual University believe that access to education is one of the ways to promote social mobility in a society. Therefore, it strives to provide quality education for people who would not otherwise have an opportunity to study at a higher level. In so doing, the University hopes to reduce inequality not only in the educational aspect, but also in the socio-economic aspect.

President Fox has also thought about this situation and the importance of distance education for a country like Mexico. He has encouraged a program that enables public and private institutions to install tele-centers with internet access in the poorest communities of Mexico. Monterray Tech is participating in this E-Mexico program and has been very active in coordinating the Community Learning Network. We provide not only educational services but also cultural, health, governmental, and productive services through centers with internet access located in marginalized settings. To do this, we have established alliances with different sectors of the government. For example, we have participated very closely with the Secretary of Social Development to create 250 Centers for Community Learning in the poorest places in Mexico. By using statistics, the Secretary identified the poorest locations, revealing that 65% of these places are located in indigenous communities, and all of them are in rural communities. The huge challenge was to bring connectivity and distance education to these regions. Of course, Monterrey Tech has been a pioneer in delivering this opportunity for educational connectivity, and today we have installed 305 centers all over the country with satellite connections. However, by 2006, with all the combined efforts of the different governmental sectors, we are hoping to have 20,000 Community Learning Centers throughout the country.

Now I am going to talk a little bit more about the actual functioning of this network that we are creating. The model that we are using has four stages. First of all, we create educational opportunities with the Community Learning Centers. Second, we help the people develop skills in three ways -- human, social, and productive skills. A third stage is to have the people develop a project that can improve the conditions of their community. Fourth, the graduates will receive certificates that hopefully will help them earn better jobs and better salaries that can be translated into a better life, helping the community to be self-sustainable. We call this a cycle for social

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inclusion because more than simply bridging a digital gap, we like to see distance education as something in motion, like a verb, including technology in this whole process of involving people in development.

We began providing literacy courses for people who wanted to learn how to read and write and we are developing these courses with the National Institute of Adult Education. We have also created courses in computer literacy for indigenous communities. Here the courses are presented in local dialects, the ones more people use. After this introduction in dialect, they understand the computer and how to use it, so they can easily advance in basic education courses that are also offered by the National Institute for Adult Education. Once finished, if they do not have access to a secondary school, they can learn through a computer with Monterrey Tech and the Virtual University. Eventually, they can get a certificate and continue advancing into tertiary education.

This process is just getting underway. We have a pilot project of 40 students from rural communities who have started the program in secondary education. It has been wonderful because at first many experts said that the technology shock would be very difficult for these students. However, on the contrary, these 40 people were very used to using technology for education because in Mexico, part of the upper primary school has been transmitted by satellite for many years. Therefore, the students were used to learning with TV and now they are easily transferring that experience to a computer. Because the results of the pilot project were very good, we are extending this secondary school opportunity to all the centers that we have created so far. Students from Monterrey Tech are tutoring these students in the rural communities. To succeed in this undertaking, we are combining the efforts of the private sector, the governmental sector, and community organizations -- all working together to improve the educational opportunities for people.

Each of the Learning Centers is organized in the same way. In the center, there is a council that is basically formed by Monterrey Tech and by strategic partners, along with federal authorities or local authorities. Each center also has a locally based committee that is comprised of community leaders such as teachers or people having moral authority within the community. At each Learning Center, there is a coordinator who provides support to the students, training them and helping them advance in the different courses they choose. Through these coordinators, we are able to assess the impact made by each Center upon the social, economic and development opportunities in the targeted rural communities.

The technical environment to which students have access is a platform through which they can enter and can manage their courses. The platform also allows us to closely follow the advancement of each student, providing them with feedback, evaluations, and assessments during the process. The students have access to online contents, and as of now, we have 26 courses of study. The most popular courses that people always ask for are the computer basic skills course and the high school or secondary

education course. Some of the strategies that we use in the development of these courses include problem-based learning or project-oriented learning, case method, collaborative work, and simulations.

The tutors I mentioned earlier are located in different parts of Mexico near the various campuses of Monterrey Tech, and each one works with about 50 students located in rural communities. These tutors also have access to special databases such as libraries, digital libraries, and discussion groups, where they can access information and resources. While students do receive extensive online support from Monterrey Tech, the tutors visit them in their communities to see how they are advancing in the learning and in all the new projects they are developing.

The long-term, target goal of the Community Learning Center initiative is to develop a core group of community leaders in each rural area, including teachers, municipal authorities, small entrepreneurs, etc., and to provide them with skills or information that can help them improve the conditions of their respective communities. It is hoped that the Learning Center in each community will grow into a self-sustainable center where local people can manage and administer all the processes. Over time, what we would like to do is give local people the computers, etc. and let them manage the centers themselves rather than create a dependency on Monterrey Tech or the government. The plan is that we would train the coordinators of the centers and would continue to provide the educational content and the tutoring, all in a distance learning manner. Monterrey Tech's Virtual University has much educational content to offer. That includes the community high school degree, the bachelor's degree, the computer skills program, the management skills program, and the community development program.

As I mentioned earlier, there are now 305 centers in operation, and it is planned that there will be 500 centers by December, 2003. Also, we have 11 centers in the United States where we provide courses for migrants or Hispanic communities, in coordination with consulate offices or with Hispanic organizations. We now have centers in Florida and Texas, and also at this moment, we are in talks with the University of North Carolina and other organizations in Arizona to create new centers. In the United States, the Learning Centers develop very fast due to existing infrastructure and high connectivity. As the Hispanic communities are growing so fast here in the U.S., online educational content is very important for people so they can find better jobs and improve their life conditions.

To conclude, this is the Community Learning Center project we have been working on. The project involves a lot of challenges because there are many things that are not resolved yet, and we have to work very closely with the communities so they can integrate the technology into their own development process. We do not want to come into a rural community and impose our point of view. These people have to decide what is related to their particular context and then find the strategies to improve their life

conditions, using technology as a means to overcome the poverty and isolation in which they live.

African Virtual University: Challenges and Prospects

Presented by Dr. Magdallen Juma
Senior Manager of Academic Programs
The African Virtual University
Nairobi, Kenya

Before I talk about the African Virtual University (AVU), I want to share with you a little bit of the overall context of that university. Right now within an historical perspective, higher education in Africa is undergoing a crisis. This situation has resulted from the various policies and practices of many different governments. But all in all, most African governments, particularly those of sub-Saharan Africa, have ignored the needs of higher education, and that attitude has had the following drastic effects. First of all, the facilities are not up to standard. Some universities cannot afford to subscribe to the latest journals or buy textbooks for students, and you will find that many of the libraries do not have quality, updated publications. Another negative effect is the fact that most of our scholars have migrated. Yet the biggest problem of all we are facing is the fact that in most of our countries, our universities cannot meet the demand for higher education. For example, last year we had 42,000 students qualifying for our six public universities. Only 10,000 were admitted. Also during 2002, 400 students qualified for the faculty of computer science, but the number admitted was only fifty. The tragic fact is that our universities cannot meet the demand. And certainly governments today cannot afford to put up more buildings to accommodate this huge demand. Even with regard to the demand, there are many disparities among the various academic areas. For example, take computer engineering. In a country like ours, like Kenya, for example, we only have five Ph.D.'s in computer science.

As a result of this situation, you find across sub-Saharan Africa a tremendous demand for higher education coupled with a drastic lack of qualified people. Within this context, the African Virtual University comes as an initiative aiming not to solve all the problems of higher education in Africa, but attempting to address some of the pressing issues, particularly the issue of access. So what is the African Virtual University? To me it is an initiative in higher education, one that operates via technology-based distance education. The African Virtual University leverages the power of information communication technology in order to increase access across the continent to quality education and resources, and also to try to narrow the digital gap that exists in Africa. Therefore our mission is a broad one -- to bridge the knowledge gap and to build

capacity not only within the university, but also across all sectors of development. However, our major focus is on higher education.

The objectives of AVU are many, but I will highlight the most essential ones. As I stated before, a major one is to increase access. The demand for higher education in Africa is great, and we need opportunities or initiatives like AVU to provide avenues to education through distance learning. Not only must we try to increase access, but we must also work to improve the quality of higher education. Those of us educators who have been to university ourselves are accused of providing substandard education to our students due to a tremendous lack of resources and to the fact that our graduates are not meeting industry market demands. In this regard, it is our hope that LINC will contribute to the realization of that quality education. A third objective of AVU is to work to retain African academics and students within our countries by providing them with quality educational opportunities. As you may know, many families spend huge sums of money to educate their children abroad. For example, it costs about $19,000 to education a child in America just for one year, and in Britain, just slightly below that depending of course on the college. Through initiatives like AVU, we hope to keep these students and their funds within African countries. A final objective of African Virtual University is to provide education and training that will help upgrade the skills required by modern professionals.

Since its inception in 1997, the AVU has gone through various stages of development. From 1997-1999, it was an initiative within the World Bank. However, it has since left that incubation stage and is now a full-fledged university headquartered in Nairobi, Kenya. While I will review AVU's pilot phase later on, I now want to discuss the program's operational phase that has just begun. AVU is operating in 17 African countries at seventeen universities -- nine English-speaking and eight French-speaking. Right now we are scattered around the continent, but we hope that by 2007, we will be covering all 53 of the African countries. Now in our operational phase, we are just beginning to offer degree courses.

Recently, the mode of delivery of these courses has undergone a transformation. From the time we started in 1997 up through 2002, the main mode of delivery was satellite, both synchronous and asynchronous. In addition, through 2002 the content of these courses was wholly transferred from the developed world to Africa. As a matter of fact, we have a lovely course from MIT, along with many courses from other Western universities. So how it works via satellite is that a course being taught in a classroom at, say MIT, is uploaded to the main satellite of C-Ban that has footprints covering the entire African continent. The course is then received at our learning centers and presented to students either through a video LCD projector or through a TV. It is a one-way presentation, and the feedback is usually achieved via email or fax, enabling students to send their questions to the lecturer. Up until 2002, this

satellite video broadcast was our mode of delivery, and while it was exciting for some students, it was extremely expensive for AVU. For this reason, although 25% of our delivery is still done through this mode, we have started to employ more web-based lessons. In short, AVU's mode of delivery is now broken down as follows: synchronous, satellite video broadcast; asynchronous videotapes; CD Roms; DVDs; and web-based online teaching. The web- based online teaching will be very much in use for our new degree programs. We are using the Web City platform and, of course, we have the Digital Library providing a lot of resources for African universities.

Now I would like to review the pilot phase of the African Virtual University, to present what was achieved during that phase. Over 23,000 students participated during that phase -- 40% being women, a remarkable statistic. Therefore, despite the typical challenges of such an undertaking, this pilot phase was viewed as a success. Then in 2001, we had to stop to take stock of our successes, to evaluate ourselves, and to undertake a strategic review. During that strategic review, we examined our problems and refocused our initiative to improve African higher education. From that time through the present, AVU is concentrating on four main products, of which the following three are currently in progress: the Digital Library; the internet connectivity; and, of course, the degree courses we are offering.

So as of today, AVU provides the following products. We have credited degree programs that began operating on Monday, 5 February, 2003. Just this week, we are beginning a computer science course to 365 students in four countries, including students at the University of Addis Ababa, the University of Cape Coast in Uganda, the University of Dar Es Salaam and the University of Science and Technology in Burundi. We have MIT providing a portion of the content for this computer science course via the Web City platform. This platform is hosted in South Africa, and the computer science course material is received at each of the four learning centers I mentioned earlier. MIT will accredit the degree after four years for those of the 365 students who complete the program. Recently a new twist in this arrangement has developed, one that will do much to build capacity in Africa. Now the University of Dar Es Salaam has become the lead partner-university. During the next four years, MIT will build capacity and walk together with the professors of Dar Es Salaam University. At the end of four years, the whole transmission will be from Dar Es Salaam for the computer science degree program to the entire African continent. There also will be a business degree program starting in July, 2003, and the partner-university for that will be Addis Ababa University.

Thus, as you can see, considerable progress has been made for the African continent in the area of higher education. There has been progress in establishing degree programs, progress in developing the Digital Library, progress in providing internet connectivity to the four universities

mentioned, as well as to other universities since the portal is under preparation. This portal will provide a marketplace for African universities to market themselves. So far, so good.

However, there are still many challenges, as there are with any initiative on the continent and in other parts of the world. One of the greatest challenges is the slow internet connectivity in all our learning centers at universities throughout African. In addition to this connectivity problem, we also have a serious scarcity of computer resources because universities cannot afford to keep up with the changing technology in the world. Furthermore, there is also a lack of capacity in IT skills among our professors. As a matter of fact, some of them have very negative attitude towards ICT and asynchronous learning, and they simply do not want to change. They do not want to use the Digital Library because they have been professors and believe they are better at what they do.

Finally, the whole essence of slow internet connectivity is embedded in our African communications policies. Of course, many of our countries in Africa are now liberalizing the communications sector. Yet many of them, of course, are not up to it. Kenya, for example, has been very reluctant to do this, but with the new government, they are now in the process of freeing the airwaves and liberalizing the communications networks. Unfortunately, however, there are many African governments that are a stumbling block to initiatives like this one in the education sector.

Finally, what will be the outcomes of the AVU initiative in Africa? One will be increased enrollment in higher education, and a second will be increased opportunities in continuing education through distance learning. A third outcome will be a growing venue through which women's education in Africa can be dramatically enhanced. Other beneficial outcomes include provision of both learning and teaching resources, as well as improvement of job opportunities. Ladies and Gentlemen, AVU is now poised and well positioned to increase access to quality education in Africa.

THE SYRIAN VIRTUAL UNIVERSITY

Presented by Dr. Milad Fares Sebaaly
Doctor of Engineering
Provost of the Syrian Virtual University

The Syrian Virtual University is the first and only accredited state virtual university in the Middle East. It was launched in September, 2002, and today we have approximately 500 enrolled students. We chose Syria as the location in which to undertake such a new project because most of the other Arab Ministries of Higher Education have not yet established criteria for online programs accreditation, while the Syrian government was eager to initiate the appropriate measures in order to set web-based academic education standards that comply with international norms.

When we began talking about virtual education in the Middle East, our first goal was to identify certain particular problems related to the region in terms of educational needs and requirements, problems very similar to the ones discussed by others here this morning. We emphasized particularly the limitations of existing local universities in terms of capacity, quality, specializations, etc., contrasted with the increasing number of high school students eager to pursue quality, higher education yet unable to find suitable educational solutions locally. In addition to these constraints, in most Arab countries there are no existing universities with reputable professional courses or continuing education programs targeted to professionals in the marketplace. Although today there is much discussion about the necessity for Human Resource Development and clinical development in the Arab region, most people looking for such programs cannot find what they need from local educational providers. There is no real mechanism to reach professionals through the marketplace with new certificate or graduate degree programs designed to renew their knowledge and keep them up-to-date with worldwide developments in their fields.

Before I start talking about how the Syrian Virtual University started, I would like to highlight some points regarding the terminology I will use. Many people these days speak in general about "distance learning," while this type of education delivery can have many forms. The Syrian Virtual University is fully dedicated to web-based, virtual education, which we consider to be the third generation of distance learning. The first generation appeared in the mid-1980s. The content was physical (books, notes, etc.) and the interaction between student and faculty took place via traditional methods (postal mail, fax, etc.). The student was to learn in isolation and the administration of the learning process was run by traditional methods. With the rise of the Internet in the mid-1990's, it became possible to put some of the content online, but still

in a very preliminary format. At that time, people started to talk about E-Learning, which remains a very broad concept and can be delivered in several forms as well. This E-Learning content was indeed web-based or web-enabled, making it accessible to all students anytime, anywhere, and enriching teacher/student interaction through the use of email, chat, and other basic collaborative tools. Finally in the late 1990's, -- with the advances of broadband, simulations, multimedia, and other technologies -- distance learning content became even more enhanced, and the interaction between students and professors took on new dynamic dimensions. This enrichment came about especially as the result of numerous new collaborative tools in the virtual classroom and on the virtual campus, making the new web-based experiences similar in design to traditional ones in brick and mortar universities.

All these developments brought about a significant increase in the effectiveness of virtual education. Furthermore, the involvement within the same virtual classroom of more people coming from diverse backgrounds resulted in the creation of a new kind of peer-to-peer learning environment, one that allows students to learn from their classmates as well as from the faculty and from an enriched, self-explanatory, interactive content. This is where virtual education differs from the traditional classroom environment in which most of the teaching is done by the professor who must make the best out of a more or less static content. Understandably, however, the main academic concern about this new approach will remain the same everywhere: "Is virtual education equivalent to traditional education?"

In order to answer that question in the best possible way, I must point out that a number of existing traditional universities in the U.S., Canada, Europe, and Australia already have converted hundreds or thousands of traditional curricula into online programs at all levels, including Bachelors, Masters, and Doctorates. For most of these universities, discrimination between the online student and the on-campus student is forbidden, not only in the quality of the education and services delivered, but also in the degree awarded which does not indicate that it was earned online. The experience of these virtual education pioneers has made it possible today to reach a state where web-based academic learning meets traditional educational standards, and even in some areas, goes beyond the limitations of the "physical environment" in more effectively explaining abstract concepts or irreproducible events/occurrences. Consider, for example, computer simulations of the blood path in the human body or chemical reactions.

Now, returning to the learning process itself, I would like to compare a traditional classroom with an online classroom. The five major components in any learning process are: the student; the teacher or professor; the content; the interaction between these three elements; and a system of evaluation or assessment criteria. In a conventional classroom, interaction between the student and the content is usually dry because the content is mainly static. There is a necessity for the teacher to grasp the content and deliver it via face-to-face interaction with the students in a classroom session. In this

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situation, the teacher is a transmitter of knowledge and most of the time the student remains only a receiver. This morning, Dr. Youcef Toumi mentioned the transformation of learning that will lead in the future to the teacher becoming a facilitator and the student an active learner. However, for a student to become an active learner, it is necessary to develop an enriched, interactive content that the learner can comprehend on his/her own. These days, it no longer seems that students are willing to read a 1,000-page book overnight or even a 100-page chapter. Today interactivity of content is required to appeal to the attention of young learners characterized by a modern, shrinking attention span. Furthermore, new technologies will allow us to include much of the teacher's experience and expertise in explaining specific abstract concepts to the student by using virtual, multimedia simulations and other new learning techniques that by their very nature engender a richer and more dynamic interaction between the student and the content.

However, this virtual interaction still requires supervision, control, and facilitation by a teacher. In order for a virtual learning experience to be successful, the interaction between tutor and learner remains crucial. Yet it is worth mentioning that synchronous, collaborative tools have now reached such high levels of communication potential via both video and audio interaction that the importance of "location" in an educational experience is unquestionably diminished. Nevertheless, web-based interaction may sometimes not be as rich as face-to-face interaction in a traditional class, especially when it is asynchronous (at different times), via email, or involving discussion forums, for example. In my opinion, this is why it is so necessary to develop enriched, interactive E-Learning content. Otherwise, a considerable question mark is bound to arise about the outcomes and effectiveness of such virtual learning if the interaction between students and content remains slim and static, and the rich "in class" face-to-face interaction is replaced with some kind of distance interaction, environment. These are the main pedagogical issues that we take into consideration when designing our content at the Syrian Virtual University.

Moving back to the Arab World now, we must again ask the question: why do we need virtual education? As I said at the beginning, several factors provoke a strong demand for international or world-class, quality higher education in that part of the world. Extensive statistics are available that track the considerable numbers of Arab students traveling abroad for higher education who do not return to the Middle East., resulting in brain drain. Statistics also highlight the large numbers of students graduating from high school who are unable to find places in their existing, local universities. Syria, with a population of 18 million, is an excellent case study. There are 4.5 million students in the elementary and high school system and only 200,000 students in higher studies. To welcome all these students, the country has four state universities other than the Syrian Virtual University and no private universities. Every year, more than 160,000 students graduate from high school, but the existing universities can only

accommodate half that number. The other half has to travel abroad or is left without any alternative. Egypt is another powerful example with more than 300,000 students left every year without options for higher education.

Increasing the capacity for higher education is one major goal of the Syrian Virtual University. The other goal, as I said earlier, is to provide continuing education for the many people already in the marketplace who badly need knowledge updating. Such a situation is inevitable for countries like Syria, which chose to align itself with the Eastern Block and now suffer with many older graduates, proficient only in Arabic and Russian, who are in severe need of knowledge updating. The existing local and international universities cannot offer adequate continuing education solutions for these people. Possible solutions to these regional problems include encouraging international universities to move into the region or increasing the capacity of local universities. However, both options are very expensive. A third alternative is the introduction of virtual education.

However, how do you introduce into the Arab world virtual programs that must be up-to-date with the latest developments worldwide, while knowing that virtual education in the U.S. and the West evolved from curricula developed by existing universities? Local universities in the Arab world are not ready to have their programs converted online because of numerous serious shortcomings, including lack of quality, diversity of specialization, expertise in online program development, and so on. Given these difficult issues, what could be the options for students in the Middle East? After analyzing the possibilities at hand, we at the Syrian Virtual University decided that we do not need to reinvent the wheel. Since there are large numbers of online programs available worldwide, why not start by using these same programs with some kind of localization and local support? Partnerships with internationally accredited universities have been concluded for that purpose, and others are in the pipeline. Over time, the Syrian Virtual University aims to transfer expertise and technology to the Arab universities, enabling them eventually to develop their own content online.

Another difficulty in setting up the Syrian Virtual University appeared when considering international programs that were available through our partnerships. We examined the number of Arab students already enrolled in the thousands of existing web-based programs worldwide and realized that this figure was extremely low. From there, we began asking students why they did not choose this online option, especially since there were no local alternative and no travel possibilities for those without funds. Why were these students not choosing online education or virtual education? We classified feedback into two sections. The first one gathered trivial factors such as students who do not have a P.C. or access to the Internet; students who do not know a foreign language, or students who cannot afford online education. Interestingly enough in this regard, the latest statistics we have indicate that 78 percent of Arab students of university age do not know any language other than Arabic.

The second section looked at more complicated reasons given by students who do indeed have all the requirements for virtual international education (money, English proficiency, technology, etc.). For them, the major issue turned out to be accountability and trust. For example, although the international online programs are offered by well-known universities, they are not recognized in the Middle-East because Ministries of Higher Education there have not established criteria to accredit such programs. Administrative difficulties due to differences in educational systems along with academic complications due to differences in academic systems are inevitable in such cases. Furthermore, we learned that cultural obstacles sometimes result from differences between the backgrounds/social environments of students and professors.

Based on all these challenges, the Syrian Virtual University model was designed to provide international education with some kind of significant local support in order to overcome the majority of barriers stated above. For instance, in a country like Syria with low or weak infrastructure, we have built 25-30 virtual learning centers throughout the nation with high level Internet connectivity and large numbers of PC's, all available free of charge to SVU students. We have also built virtual communities of Arab professors -- some still living in the U.S., Canada or Europe -- to provide academic and cultural support to online Arab students. Most importantly, because we are a public institution created by the Syrian government, all the degrees awarded by, or earned through, the SVU (international degrees) are fully accredited and endorsed by the Ministry of Higher Education, thus building the necessary trust and credibility we needed to act as a valuable educational option.

In conclusion, even though we have established a concrete and realistic environment for the implementation of virtual education in the Arab Worlds, the SVU remains a new undertaking with many challenges ahead.

A Tradition Turned Modern: E-Learning in China

Presented by Dr. Kai-Ming Cheng
Chair Professor of Education and Pro-Vice-Chancellor
University of Hong Kong

Fifteen minutes is too short for a vast country like China, so I will try to fast forward and present whatever I have, while still leaving time for discussion. I am involved in hosting a Center whose goal is to bridge China with the outside world in terms of education. I am the chairman of one of the Center's committees, and Gerry Postigleone, an American, is the Center's director. One part of our efforts is to publish a bi-weekly newsletter in English providing snap-shots of what is happening in Mainland China in the area of education. You can visit our web-site for that at: http://www.hku.hk/chinaed

First of all I want to provide a general profile of education in China, a task that could take at least two hours in itself. The population of China is 1.3 billion, with a student population of over 220 million. Numbers are always the game in China, and that is why a lot of commercial providers are very, very interested in China since just 1/100 of that market would give you a fortune. In terms of enrollment, the rate in compulsory education (9 years) is 98%, although there are small pockets of minorities in remote areas where the attendance is extremely low. Otherwise, however, compulsory education in China is basically universal. The enrollment in senior secondary education is about 50%, but for China any figure like this would mask the disparity across the whole country. In large cities like Shanghai and Beijing, the enrollment ratio of all types of higher education is over 75% -- very high. But in remote provinces, it is quite different, could be as low as 5%.

During the past four years, there has been a huge expansion of higher education in China. From 1999 to 2002, the basic enrollment in higher education doubled. There is one very interesting reason for this doubling. When the government was launching this expansion, one item on its hidden agenda was to use higher education as an efficient means to mobilize citizens' savings, which otherwise would be lying idol in the banks. This doubling phenomenon has also contributed to the development of E-Learning in China because parents are more than willing to pay for higher education in whatever form it takes. The student population in the formal educational sector is about 7 million, which is relatively small for a country of this size. However, the student population in the informal sector was 4.6 million, according to figures for 2001, and was slightly higher in 2002.

There is Self-study Examination in China, which is a system with only examinations. Learners are provided just with the examination syllabuses, and they sit for the examination when they are ready. There are about 13 million candidates every year for these examinations. In China, many E-learning or distance education programs are actually geared to these self-learning examinations. As you can imagine, these examinations have been a pulling force and have provided fertile ground for E-Learning expansion in China.

When we talk about E-Learning in China, have to recognize the changing societal needs there. First of all, there has been a tremendous expansion of the service sector in major cities, particularly in Shanghai, Beijing and Guangzhou. About three or four years ago, there was a huge tide of unemployment among the 40 and 50-year old citizens due to a disappearance of the jobs they were in. Their jobs moved to poorer parts of the country, and they became unemployed because their skills were no longer sufficient for the new sectors. Now this same trend is beginning to creep into the 30 and 40 year olds because the service sector is expanding more quickly than the next generation of learners. This societal trend has become a critical issue in major cities. For example, because the manufacturing sector is rapidly moving further and further inland, the major cities have become basically cities of white collars workers, even though the population is not equipped for that type of employment. Therefore, there is now a basic contradiction in Mainland China when it comes to development. A second societal trend in China is the growing disparity among regions. GDP now for Shanghai is about 25 to 30 times that of the poorest province. The internal disparity of China is very high. There are 30 provinces, which could be viewed as 30 countries if you compare them with Europe.

However, the Chinese government, in terms of technology, does not seem to believe in a digital divide. To the contrary, they seem to believe that technology is the way to overcome this disparity, particularly when it comes to education. Even in the 1980s when computers were not that common, television broadcasts were quite widespread through central government funding in order to make sure that every corner of the country could receive TV broadcasts. The main distance education institution is the Radio/TV University, which over a 20 years period has awarded about 2.6 million diplomas. Of course, that is a small number within the context of China. Right now, this institution oversees 44 provincial colleges, 841 branch colleges and 1,700 teaching sites. This Radio/TV University is a formal institution, which means it receives government funding and government recognition.

This distinction between formal and informal education is very significant when it comes to E-Learning. The informal sector is actually much larger than the formal sector, but in China you still have to look at the formal structure. In 1999, four leading universities were assigned by the government to run pilot programs of online education. In addition,

online education programs were started by private, non-university organizations. However, in 2000 after a period of trial, the Ministry of Education gave permission only to universities to run E-learning programs. That first year, there were 240,000 students in the government-sponsored university online programs, a small number in a country like China. In 2001, one year later, there were 43 universities involved, and by now they have produced the first graduates. This is about the formal sector of E-Education in China. By "formal," I am also referring to the fact that although China has opened up in many areas, in terms of education, the central control is still very strong. This central control is not so much a political control as it is a tradition of centralized organizational control. Whatever is owned and run by the Government is seen as proper, and otherwise it can only be peripheral.

In 2001, a study was conducted that looked at the student population in Mainland China. The study found that more than half of the students involved in higher education came from the major cities, with only 4% from the rural areas. These findings are very reflective of a disparity in the economy. This study also reported that 88% of the student population was full-time workers. This has been a tradition in China. It is still the case that all workers are given mandated hours for study -- kind of sabbatical hours, as well as sabbatical years or months. There continues to be a provision for major employers -- even the private sector and foreign joint ventures have to follow this tradition -- requiring that employees be given hours to study while at work.

There are several issues that must be considered when it comes to E-Learning in Mainland China. One is the question of recognition. The Chinese Ministry of Education is only keen to recognize formal degrees, and less keen on informal programs, including the huge adult education sector. A second issue is the market. The central government now does allow a market in education -- which is very different from 15 or 20 years ago. However, in terms of the degree of comfort, the government is still very skeptical about these informal, non-government degrees, and subsequently, the general population shares the same skepticism.

Another issue is the fact that E-Learning courses in China are unfortunately very examination oriented. The network and the general technology is not a problem, but when you look at even the TV-broadcasted courses themselves, they are extremely didactic. What you have is a professor sitting there, reading a book or reading his notes, and it is basically boring. Yet people do not seem to mind as long as the course leads them through an examination to a degree or some credential. A final issue involves the difficulty of actually introducing a new E-Learning degree program in China. A lot of people would like to do this, but do not know where to turn to, because there are so many actors in China who can claim some authority over education.

In conclusion, when it comes to E-Learning in China, technology is not a problem because of the adaptive nature of the culture. E-learning

spreads very rapidly because of a culture of self-learning. This is understandable if you look at ancient China, where scholars did their study as distance learners at low cost. There was no school, no teacher, only commonly available classics as textbooks. Then as now, it was only about examination. Today, because of the high-reward examination system, there is high motivation for education, including E-Education. However, because the system is examination-oriented, it is also very limiting in terms of genuine learning.

**Features of Distant Engineering Learning in Russia
From the Experience of the Faculty of UNESCO**

**Presented by Dr. Anatoly A. Ovodenko, Dr. Alexander A.
Bobovitch, and Dr. Dmitry V. Tigin
The State University of Aerospace Instrumentation
Saint Petersburg, Russia**

The events that have taken place in Russia in the last decades have resulted in vast changes in the position of our country within the world community. The continued rapprochement of Russia with the countries of the West will require more significant time. One of the effective ways to speed up the solution of this very complicated problem is movement towards unification and harmonization of educational systems in the various countries. In the countries of Western Europe this process of unifying educational systems is named the Bologna process. The goals of this LINC symposium demonstrate that the USA understands the important role of education in unifying the world.

The events in higher education in Russia today speak about the fact that Russian universities and the Russian government do not remain indifferent observers of this unifying process. Our university, the State University of Aerospace Instrumentation (SUAI), is one of 49 higher educational institutions in Saint Petersburg. It was founded in 1941 and today it carries out the training of specialists in more than 50 educational programs. About 12 thousand students attend SUAI now, including about 6 thousand students of quasi-distance education. SUAI has 7 branches and 23 local educational centers located throughout the territory of Russia from Kaliningrad in the west over to Kamchatka in the east, from Murmansk and Norilsk in the north down to the city of Temrjuk in the south. For more than forty years, SUAI, as well as other Russian universities, has conducted the training of engineers by correspondence, and today by distance learning. By the end of the 1980's, the number of correspondence-course students at SUAI was equal to 300 persons per year. At present, the technical preconditions for distance learning technology at SUAI are being developed (such as Internet, E-mail, optical fiber channel, ISDN and so on).

This active role of SUAI in distance learning resulted in the 1998 decision by UNESCO to establish at SUAI the UNESCO Chair on Distance Education in Engineering. The long-term UNESCO Chair objective is the concentration and practical testing of distance education methods aimed to involve youth from the remote regions of Russia. This objective includes the establishment of a Distance Learning University, which will provide specialist training in engineering and will organize an

exchange of research and information in the area of engineering between Russia and its neighboring countries.

The expected results of this UNESCO Chair activity are:

Extension of the network of universities within Russia offering the possibility of multi-language training, including the languages of neighboring countries;

Organization of international conferences and seminars on the problem of distance education;

Transfer of different disciplines and training technologies through an exchange of professors;

Creation of unified curriculums and common certificates;

Foundation of a National Center of Distance Education in Russia which will realize the practical UNESCO objective, that is, the transfer of distance education technologies to Russian higher education and to developing countries.

In accordance with the UNESCO Chair working program, the creative contacts on distance learning problems have already been established among the many technical universities of Saint Petersburg. Similar contacts have been established with about 20 foreign universities all over the world.

At SUAI, a number of projects for distance learning technology have already been realized. The thrust of those projects has been towards the solution of problems such as the following: the Russification of educational computer technology and the poor quality of telecommunication channels, etc.

Examples of some completed projects are:

Working out methods, algorithms and software that will allow qualitative video-conferences using regional archives of audio and video information;

Elaboration and presentation on the Internet of a training course for teachers about "Preparation and Creation of Textbooks";

Development and introduction on the Internet of a program that encourages more efficient use of time on the Internet for students and teacher;

Working out the electronic manual for learning Russian as a foreign language; this project is implemented with the use of the modern computer and telecommunication technologies based on the impression of a person in an environment simulating real life conditions in Russia;

Creation of the software for developing virtual presentations of the educational universities in Saint Petersburg via the Internet;

Working out the method and software for digital watermarking of diverse information (audio, video, text etc., which is used in distance educational process) to protect materials from illegal copying.

- We have also organized a project called "Virtual Space University" which brings together SUAI, BUAA (China), and one of the branches of Bordeaux University (France).

- In 1999, the first video-conference between SUAI and MIT CAES was conducted.

Also within the framework of the program of the UNESCO Chair, two international conferences have taken place:
International Workshop "Computer Technologies for Aerospace Specialists Training" (Saint Petersburg, 2001, 100 participants);
International Seminar "Higher Education in the XXI Century: Problems and Perspectives" (Saint Petersburg, 2002, 200 participants).

We feel a great honor to be participants of this international forum – the LINC Workshop. We share the vision of symposium organizers on the special importance of educational problems in developing countries for the future of the whole world. We feel especially sharply the importance of the solution of these problems in modern Russia and we shall be active contributors of LINC ideas. From our side, as some contribution from SUAI to the realization of the LINC project, we invite organizers and participants of this symposium to a conference in Saint Petersburg to continue a discussion of distance learning in developing countries. This International Conference will be called "Integration of Science and Education in the XXI Century" and will take place September 7-11, 2003. This forum will be held on board a comfortable motor ship cruising from Saint Petersburg along the Neva and Svir Rivers, and the Ladoga and Onega Lakes. We promise you a very friendly reception and enjoyable journey.

Distance Education in Algeria

Presented by Dr. Abderrazak Henni , Director General
The National Institute of Computer Science
Alger, Algeria

At the start, I would like provide a little background on Algeria. This is a country of 2,381,741 square kilometers with a population of 30 million, of which 75% are 25 years or under. With regard to education, we have 9 million pupils in primary and secondary education, 300,000 in professional education, and 600,000 in undergraduate or graduate education. These 600,000 university students are instructed by17,000 university lecturers. While today we have 600,000 university students, it is said that in five years we will have more than a million university students. Therefore we will have to practically double the educational infrastructure, both human and material. If by 2008, one can build the necessary infrastructure, recruit qualified personnel and acquire adequate materials, will one be able to double the amount of education? The answer is "no" unless one can receive the cooperation of foreigners and the means necessary to do the work.

The solution for us is the development of distance education. Distance education will provide a quality education to a very large number of students and will also develop teachers who are more skillful in their prospective fields. It will also enable persons who work to update their professional skills, allowing them to take the courses at different times and in different places. For this reason, the Ministry of Higher Education and Scientific Research has decided to create an academic computer research network that connects all the established universities and research centers. This network includes 47 operational sites and 12 currently under construction. The sites termed "operational" are those with adequate equipment, specialized telecommunications lines, and skilled local teams providing technical and informational follow-up. Most of the Algerian professionals helping in this important effort have been trained at the Algerian National Institute of Computer Science (L'INI). This engineering school of computer science was established in 1969 and offers the following degrees: Engineer (5 years); Masters (Engineer plus 2 years); and Doctorate (Masters plus 2 years).

Now I would like to present the Algerian University of Continuing Education (UFC), which was established in May of 1990. The structure of UFC includes a master dean or rector, a vice rector in charge of pedagogy, a vice rector in charge of communications, a computer science center and an administrator. UFC operates 10 learning centers in the central region

of Algeria, 13 in the western region, 16 in the eastern region, and 14 in the southern region. UFC has four guiding missions: 1) to prepare senior high school students for the national university entrance exams; 2) to provide undergraduate evening studies for high school graduate; 3) to offer courses for university graduate students providing them with modern tools for the new economy; and 4) to offer specialized courses for professional continuous education. UFC students can follow studies in technical languages, science, business, and management. Courses are also taught in the fields of computer science, electronics, biological analysis and industrial chemistry. In addition, there is a specialization in the field of education.

During the academic year 2001/2002, UFC had 56, 842 students, of which 8,236 were studying via distance education. During that time period, the university had 2400 lecturers, of which 12% had doctorate degrees, 68% masters degrees, and 20% undergraduate degrees.

UFC has many foreign partners in the distance education work it undertakes. These partners include; Group A6 (France); the National Center of Distance Education (France); M. I. T. (USA); ROBOTEL (Canada); the Open University El Quods (Jordan); the University of Jean Moulin (France); and the "Avicenna" Virtual University (UNESCO/European Commission). The Virtual University of "Avicenna" is comprised of 15 countries located around the Mediterranean Sea and is financed by the European Union with coordination by UNESCO. UFC is the focal point for Avicenna in Algeria.

On the Development of Sharif Virtual University

Presented by Dr. Ali Meghdari
Professor and Vice-President of Academic Affairs
Sharif University of Technology
Advanced Information and Communications Technology Center
Tehran, Iran

I am happy to be here attending LINC's first workshop for the establishment of a new international consortium to bring world-class education to developing countries and to promote world peace through education. On behalf of the Sharif University of Technology in Iran, I wish to thank and congratulate Professor Larson and his colleagues at MIT for their initiatives and efforts in making dreams come closer to reality. Now let me tell you a little bit about Sharif University of Technology in Iran. Sharif University of Technology offers the strongest engineering and science programs in Iran. Currently we have about 7,500 students: 5,000 at the B.S.C. level; 2,100 at the M.S.C. level, and 400 at the Ph.D. level. About 30 percent of all our students are women. Iran has a population of about 70 million, and over 60 percent of the population is under the age of 25. Every year about one and a half million applicants apply and take a nationwide examination to enter Iranian universities, and only the top 10 percent will get in due to the current capacities. I am happy to inform you that last year over 52 percent of all who got into universities across Iran were women. Generally, the top 1,000 of all applicants choose Sharif University. In the current school year, from the top 100 of all applicants, 95 chose Sharif, and from the first 200, 176 came to Sharif. Furthermore, all Iranian recipients of gold and silver medals at the World Student Olympiads -- in Physics, Chemistry, and Mathematics -- chose to study at Sharif.

As you can see by the numbers I give, there is a high demand for education in Iran, and we can only provide services to the top 10 percent. Of course, when I compare these numbers with the numbers given in a previous lecture about China, Iran's numbers may not be so shocking. However, we feel that Sharif and all the universities in Iran have a serious responsibility to many of those well-qualified applicants who cannot get in due to our limited space. Therefore, during the past two years, the idea of a virtual university and E-Learning has been well received in Iran by academicians at the Ministry of Science, Research, and Technology, as well as by politicians. As Dr. Larson mentioned, two years ago when he visited Iran and the Sharif University, there was no mention of virtual education or distance learning in our country.

We are new to this effort. For this purpose, a reasonable budget has been allocated to promote IT programs and related issues in Iran. As I said, we are at a learning stage and the program that I am going to talk about here today will not be new to you. However, when you want to bring these E-Learning ideas to a community or to a country that has been providing traditional education, it is necessary to define terms such as "virtual education," and "distance learning," and to explain the value of such educational initiatives. Through careful discussions in Iran, a proposal was eventually written and a real virtual university project was defined as a national undertaking supported by the Ministry of Science, Research and Technology. Sharif University of Technology was chosen to work on the project and to develop a national consortium for the required strategies and necessary tools to establish virtual universities in Iran.

Of course, you are all familiar with the terms I will present here: distance learning, E-Learning, technology-based learning, online learning, and web-based learning. After I returned from my sabbatical two years ago, I initially undertook to put the lectures from my Robotics course on my website. Simultaneously, some other colleagues also presented a few other courses on the web. Once we began to offer these courses on the Web simultaneously with our traditional classroom courses, we had begun the job of introducing this new concept to all the people, including colleagues, students, and others. This is the process through which word originally spread, and this process eventually led to the establishment of the Advanced Information and Communication Technology Center (AICTC). A large part of the work of this center is to develop the necessary tools for building virtual universities in Iran.

In Iran, we had to come up with a definition of "virtual university" as it is defined elsewhere, and we also had to come up with a learning management system and learning objectives for the virtual university. As you know, distance learning, online learning, computer-based learning are all subsets of the virtual university. In our view, the reasons for developing a strong capability in distance education are numerous, including: on-demand learning; learner-control; increased motivation; achievement; reduced learning time; better quality control; greater flexibility; improved accountability; faster revision; and reduced delivery costs. These are the learning objectives we had to explain to our colleagues in Iran in order to change their perspective from the traditional model of instruction where instructors or professors cover materials from commonly shared books and resources. In a better model of instruction, the professors and a team of specialists offer courses through the Internet to spatially distributed students, allowing local students to use the actual classrooms. Throughout the world, we are all faced with a new era in education, and we try to make the best of it. In Iran, convincing people who are used to the old or traditional system was a challenge. However, we have been able to do this and we continue to do this by putting on workshops, seminars, and training programs on how to transform university courses through multi-media contents. These are the

issues that we have had to worry about. The first step was to develop the online courses, and we have succeeded in doing that. Now, as a second step, we are working on developing virtual classrooms.

In closing, I would like to review the building blocks of a virtual university. In May, 2003, Iran is hosting the first seminar on virtual education in order to promote this new concept among our colleagues from different universities across the country. This seminar will also provide training on how to make the educational transition smooth as well as training on how to transform courses for E-Learning with a multi-media content. A template has been designed in the Persian language so that instructors or professors can offer courses in Persian. In addition, several centers for distance education have been mobilized and have been established at Sharif University and at Kish University located on Kish Island at the Persian Gulf. We have actually started our first E-Learning experience by teaching a class jointly with the Kish University, Sharif University of Technology, and Payame-Nour University in Tehran.   In Iran, we believe that virtual universities, through E-learning standards, remove the barriers of time and space to educational accessibility, while at the same time supporting new, more effective models of teaching. Virtual education will enable more organizations to leverage knowledge, thus fostering innovation and maintaining a competitive edge. In Iran, it is definitely the time to E-Learn.

Higher Education in Pakistan

Presented by S. Sohail Naqvi
Member, Human Resource Development
Ministry of Information Technology and Telecommunications
Islambad, Pakistan

I am going to be covering three topics that will merge into what is written here as my topic, Higher Education in Pakistan. I am going to talk about higher education reform and give you some idea of the higher education sector in Pakistan. What is going on and what we are trying to do to fix the current system. Then I will talk about the telecom revolution that has just begun to occur in Pakistan, and how it applies to distance education in that country.

The higher education system in Pakistan is quite a hodgepodge of many different systems. Pakistan has inherited many of its systems from the UK and Europe, but now with the world being dominated by, or moving toward, the U.S. educational system, today there is quite a mixture of systems in Pakistan. We have colleges and universities. Colleges cover grades 10 through 14, and that is where the majority of higher education in Pakistan occurs. Then there is university, which takes place for the most part after grade 14, but in a few cases, after grade 12. So as you can see, it is all mixed up. In this educational system, engineering is the same as the U.S., so you finish high school and then go on to engineering school. One enters law school two years after high school and medical school five years after high school. There also is an [inaudible] which closely equates to a masters degree over here.

Now turning to the delivery of education, we have 40 universities with about 130,000 students. There are also institutes of higher learning, but I do not know how many students are enrolled there. I have purposely left this a question mark because that is one of the issues we must deal with now - - the fact that these statistics, these numbers, these basic educational facts are simply not available. Most of the higher education in Pakistan actually occurs in the public sector, which are called affiliated colleges. Most of them take students after the 10th grade. There are 635 of these affiliated colleges, serving 300,000 students. Now it is important to view all of this with the perspective that there are about 140 million people in Pakistan, and the population growth today is one of the highest in the world. It is about 2.4% or so. There are approximately 3 million people turning 18 every year in Pakistan, while 130,000 is the total enrollment in all of the universities.

These statistics give you a dramatic understanding of why technology in distance education will have to come to Pakistan in a major manner. In recent years, the private sector has started to come into play. There now are numerous private universities, but many of these are of dubious quality, with total enrollment at about 25,000 students. In addition, there are some foreign universities, and lately some online schools have started. The Open University is actually one of the oldest in the world, starting from the 1970s, but it is primarily for continuing education, and the degree programs it offers are of questionable quality. Of course, in this hodgepodge, there are also mom and pop universities opening billboards all over the place, unchartered universities with fly by night operators. Since I am representing the Pakistani government here today, I will be discussing at length a very exciting new initiative, the Virtual University in Pakistan, now about a year old.

Now I would like to talk about some of the specifics of higher education in Pakistan. The public universities are focused on particular disciplines, so, for example, there are engineering universities that just do engineering and nothing else. In these universities, there is a big variety in terms of enrollment. One program might have a minimum of 400 students in an engineering university, with only one Ph.D. on the faculty. Two larger universities might have 13,000 to 14,000 students, which is not really large given the population of the country. Now let us turn to the allocation per student. We are talking about public universities so these are supposed to be 100% funded by the government. In this regard, the government allocation per student varies tremendously from about $250.00 to $1,200.00. There is no real system by which these numbers have come into play. They just are there.

Therefore, as part of the current reform, we are trying to bring some sense into why this allocation is the way it is. Moving on to the next line, allocation vs. expenditure, the expenditure is now the allocation of the government plus what the university has raised itself. The universities are raising money primarily by charging fees instead of tuition. They charge for special programs and then there are fees, along with all the self-finance schemes. So there is a certain percentage of people who pay to get in. Many universities are raising anywhere from 50% to 70% of the money they are actually spending. So you see, the actual governmental allocation is very, very small, and typically, the larger the university, the smaller the allocation. Also, the better the university, then the smaller the allocation. The larger governmental allocation goes towards new universities that they are trying to build in isolated rural areas. There you have to spend a lot of money to make something happen. Turning now to faculty quality, that is the percentage of the faculty that has a terminal degree, you will see that in the case of engineering, which is the weakest discipline in Pakistan, the percentage with these degrees ranges from 3% at worst to 30% at best. So what I have presented here is aimed at giving you a snapshot of the structure of universities in Pakistan.

However, it is in the affiliated colleges where most of the higher education occurs. These are post 12-year educational institutions, and they offer a two-year degree called a Bachelor's degree. This has caused confusion due to the U.S. system of Bachelor's degree that is given post the 16th year. The curriculum taught in these affiliated colleges is set by the university, and there is also a higher education commission which has control over the curriculum. The Bachelor degree is granted by the university. The financial responsibility of running these colleges is that of the provincial government, while the universities are run by the federal government and they have federal allocations. So you have a federal and a state issue at play here. The employees of the colleges are provincial civil servants. In order to get something done on the ground, you have many different grounds to cover. Allocations for these colleges come from different departments, different ministries, and there are state vs. central government issues as well.

Again, here I have tried to give you a snapshot of the situation of these affiliated colleges. Regarding the universities and the colleges, I have presented figures collected from different places in order to show you that the state of higher education in Pakistan is in extremely bad shape. That is the reality in Pakistan, and until one can accept that reality, one can not move ahead to change the situation. For example, looking at financial indicators, the average allocation per student by the government is $350.00, while in the U.S. it is on the order of $6,000.00 to $7,000.00. Faculty salaries range from $3,600.00 for an assistant professor per year to $6,200.00 per year. This fact brings to mind a comment made last year at MIT, that faculty members are now global commodities. This is certainly true in Pakistan where you see the faculty moving out, all the best ones leaving and going anywhere in the world where there is a good opportunity.

In Pakistan, there has been a huge effort in higher education reform to understand what the problem is and how to tackle it in order to come up with a solution. The Higher Education Commission was created a few months back and is responsible for looking at all issues related to higher education. The focus is on human capital development for a knowledge-based economy. The goal is to use educational funds wisely in order to impact [GDP] growth. However, first the Commission must deal with all the issues I have highlighted.

Now comes the issue of E-learning. We are all aware of the E-learning paradigm. You have seen the numbers, the poor quality, the many challenges we have, so you will agree that such a paradigm is urgently required for Pakistan. Until we bring technology to leverage our educational capacity, we will not be able to do anything. In recognition of that, the Virtual University was formed last year. It is a flagship project of the Ministry of Information Technology and Telecom. Originally, it was the Ministry of Science and Technology. Now it is divided up and is the Ministry of Information Technology. The first enrollment occurred in

March, 2000 with 500 students doing a Bachelor Degree of Science and a Bachelor Degree of Information Technology, both four-year degree programs. Since then, there has been a second enrollment of 2,000 students, and now it seems that the program is beginning to ramp up. The telecom revolution that has occurred in Pakistan has resulted in about 90% of the country now being accessible to the Internet. Even villages now have at least dial-up facilities available, and high speed internet is now being made available in various parts of the country, especially the major cities. The other initiative is the satellite that has come into position for Pakistan. Four channels have been dedicated to education. This satellite has a footprint all across the region.

Now I would like to discuss the mode of operation of the Pakistan Virtual University. It is video delivery broadcast over television with a return pack via Internet. It involves a sophisticated learning management system covering lecture notes, discussion boards, as well as a virtual community of graders, including some in the U.S., who grade assignments for the students. These graders come from all over the world. The other important part of the Virtual University is that it works through virtual campuses. This university is a public/private partnership. So there were many small places that sprang up as Information Technology Institutes, but as the IT balloon deflated, you had these locations with 30, 40, 50 computers. They were ideal settings for the virtual classrooms. You simply set up a television and you bring the students together in one location. They hear the lecture in a group, and then they have the computers available for the return part of the educational interaction, if they do not have this facility at home. With the satellite, you have a very powerful infrastructure in place for the Virtual University. Pakistan is also in the process of linking up all the universities via a relatively high-speed internet connection.

Moving on, what the Virtual University is concentrating on now is content development, and that is where this LINC collaboration could really leverage our efforts. We need the video content as well as all the related materials to develop the courses in order to move on into other disciplines. At this stage, everything is ready for us to move on into any number of different areas if we can get the content together.

Armenia and Plans for Distance Learning

Presented by Jora Manoucherian
Owner and President of J.M. Software Engineering and Consulting

My presentation will include a brief introduction to Armenia and that country's implementation of distance learning. This will include the challenges that Armenia is facing for implementation of distance learning projects and activities. I will also describe Armenia's objectives for participating in the LINC Consortium.

Armenia is a small country located between Iran, Georgia, Turkey and Azerbaijan. It is about 30,000 square kilometers. The language is Armenian and the race is Caucasian. The population was estimated in 1995 at around 3.6 million, but is less now because of the migration of Armenians to Europe, the United States, and Russia. The growth rate of this nation is one percent per annum. There is a very strong Diaspora growing mainly in Russia, in the United States, and in European countries. The Armenian alphabet was created in the 4th century by St. Mesrob Mashtotz. The literacy rate was 99 percent in the 1990s, but now is less because of the socio-economic problems. The system of government is democratic, and the official head of the country is the President. The secular system of government is divided into executive, legislative, and judicial branches. The seat of government is in the capitol city of Yerevan which has a population of about 1.2 million, more than one-third of the nation's population. Yerevan is one of the oldest cities in the world and can trace its origin to the city of Yerebuni, built in 783 BC.

Now let us turn our attention to the education system. Today Yerevan is the cultural center for the country. The Ministry of Education and Science is in charge of the elementary and secondary school programs, and oversees the academic activities of the universities. There are 1,450 elementary and secondary schools. The National Academy of Sciences of Armenia (NASA) is the highest academic resource in Armenia. American University of Armenia (AUA), founded about 10 years ago, is the youngest university. It has close links with U.C. Berkeley in the United States. It was founded with help from the philanthropic entities of the Armenian Diaspora. Yerevan state universities were all established approximately 70-75 years ago during the soviet era. Yerevan State University (YSU) primarily offers scientific and humanitarian education. Yerevan State Medical University (YSMU), one

of the three major universities of the Soviet era, has a capacity of approximately 7,000 students. The State Engineering University of Armenia, is in charge of the preparation of engineering and industrial cadres for the country. The State Architecture University, which was originally part of the engineering university, is now a separate educational entity.

In 2001, according to a decree by the President of the Republic of Armenia, the IT Development Support Council (ITDSC) was established. Among the objectives of this Council is promotion of the use of information technologies in all realms of life. The vision of this IT master strategy is creation of an industry that promotes the widespread development and application of information technologies by Armenian citizens, businesses, and government. The goal here is to improve the Armenian quality of life and to advance every facet of the Armenian society, including homes, businesses, schools and the community. The IT master strategy identifies two goals that are major focuses of this vision: to create a vibrant and sustainable ICT industry that promotes growth in other sectors of the Armenian economy and to position Armenia in the knowledge-based global economy. These strategic goals are highly dependent on higher education and a continual in-flow of new ideas and leading-edge technologies. In the process of achieving these objectives, Armenia needs to maintain a balance between basic and applied research, and also to support technology commercialization initiatives.

To support these goals, the Ministry of Education and Sciences of Armenia, along with a majority of the universities, has already made strategic plans to accelerate in a short period of time the upgrading and refinement of the country's educational system, while at the same time addressing the lack of required educational resources. The new educational system has to provide everyone with an opportunity to build new competencies in using ICT effectively. Accelerating advances in technology, globalization, and growing diversity demand the continuous renewal of obtained skills. Life-Long Distance Learning, coupled with Self-Assessment, has become the new educational standard in Armenia for the 21st century.

Current Armenian plans and projects related to distance learning are developing in diverse arenas. The Ministry of Education received a grant from the World Bank for integration of ICT into Armenian general education, with the aim of increasing the quality, effectiveness, and efficiency of learning in the schools through computer technology. The main goals and objectives can be summarized in the establishment of the ICT infrastructure for all schools, including hardware/software networks and Internet connectivity, along with teachers' training and curriculum and content development. In addition, the Ministry of Education and Science of Armenia implemented the Universities Network Development Project in order to connect universities and educational institutions in different regions of Armenia to the Ministry's computer network and also to

develop web sites for universities and other educational institutions.

USAID and SETA Corporation, together with the three public universities, AUA, YSA, and SEUA, are implementing the Computer Learning Center Projects. This Project consists of three main components: Curriculum Reform, Adult and Continuing Education/ Certification Programs, and Consortium/Outreach Programs. The Project has already created online computer science classes and labs, career initiatives, and highly recognized certification programs at each university. The major part of this program will use distance- learning technology. The Ministry, with the support of the US Department of Education and Cultural Affairs and the Eurasia Foundation, has started several online school and library network projects for promoting the Internet as a communications and educational tool.

The National Academy of Sciences of Armenia has many IT initiatives and projects, mainly in the following areas: policymaking; democracy and participation; public administration and services; ICT infrastructure and facilities; and education. During the last two years, the Academy, in cooperation with other educational entities, has succeeded in establishing an integrated, wide-area network (WAN)that connects major educational institutions/research centers of Armenia, governmental agencies and some of the ministries. This network currently is connected to the Internet through two major ISPs of Armenia, the Yerevan Physics Institute and the Arminco (via Armentel). Last year the Academy installed a 3.8-meter antenna with a C-Band RFT and 10 Watt transceiver, for establishing a direct connection to the Internet. The monthly cost for a 512K-leased line is about $7000, due to the monopoly of Armentel/OTEnet, which is the only provider of domestic commercial landline-based and mobile services, as well as international connectivity. This network is ready for use by the universities located in Yerevan for sharing distance learning resources. During the second phase of the project, this network will be expanded to connect university campuses in different parts of Armenia to provide required educational programs via distance learning.

The State Engineering University of Armenia (SEUA) also has a lot of distance learning projects. I am not going to go through the details because of time constraints. Briefly, let me mention that they have created a number of SISCO-based Academy programs and have also created a multi-lingual, web-authoring software that works with the Armenia language. In addition, Yerevan State University (YSU) has initiated a large number of projects and is using WebCT as their web-authoring tool. YSU has many pilot courses in the planning stage, and these can be viewed via the following link: http://www.distancelearning.am/courses.html. Furthermore, a very important undertaking-- development of a web-based authoring software that runs on low bandwidth lines-- is taking place at the American University of Armenia (AUA). This undertaking is very important due to

the poor communications lines of the country. The American University of Armenia also has a project for educating 10,000 elderly and knowledge-based workers via distance learning.

In Armenia, the main objectives for the development of technology-enhanced distance education is as follows: access to global information; transfer and exchange of information and new technologies; enhancement of education by training the trainers; addressing the shortage of instructors in rural areas; new Web-based curriculum development; access to global learning resources; incubation of businesses; and creation of knowledge-based workers. Now what are the available resources? Armenia is a center of highly educated engineers, scholars, and scientists, all of whom can be used for implementation of distance learning projects. Also in the country, there is a significant network of educational entities, with a great interest in utilization of ICT in their educational programs. There are also strong ties among the Armenian academic, industrial, and philanthropic entities and resources in the homeland and in the Diaspora. Still other resources that can be used are international academic links-- already established or in the process of being established-- along with foreign foundations and donors for financial support.

Now I will turn to the shortcomings and challenges. Armenia's communications infrastructure is very poor and the usage cost is very high. In addition, we have a serious language barrier in that Russia has been the primary second language, although now we are switching to English and French. Another problem is Armenia's information processing standards, in that we have not been able to establish common, internationally acknowledged standards. We have been working very closely with Unicode and have submitted a proposal to which they agreed. However, the Standardization Body of Armenia has had some problems with the proposal, and for this reason, the proposal has not yet been approved by this Body. The difficulty in developing standards is due in part to the fact that Armenia has different language dialects and different character set requirements. A final problem is the drain of IT specialists from Armenia due to the poor economy and subsequent unemployment. In conclusion, a lack of necessary funds is the major shortcoming and challenge when it comes to Armenia's plans for distance education.

From our participation in LINC, we are hoping for the following: the sharing of experience and results of best practices in distance learning; the sharing of educational content and resources; the initiation of joint projects and research activities; and the acquisition of financial support whenever possible. In summary, to support the economic growth and betterment of Armenia, the Ministry of Education and the higher education institutes of Armenia plan to develop and implement a national distance educational system in order to bridge the gap created while shifting from a Soviet economy to a knowledge-based market economy. To that end, Armenia would like to share in the technical and financial resources available to the members of the LINC Consortium and

contribute towards the development and utilization of distance learning technology throughout the world.

SECTION TWO

DISTANCE/VIRTUAL EDUCATION IN

DEVELOPED COUNTRIES

The Singapore-MIT Alliance

Presented by Dr. Steven Lerman, Director
Center for Educational Computing Initiatives (CECI) at MIT

Today I am going to give you a broad overview of an initiative that is the largest single activity MIT has ongoing in distance learning. It is called the Singapore-MIT Alliance, or SMA for short.. This is an alliance of three leading universities: the National University of Singapore; Nanyang Technological University; and MIT. The alliance focuses on graduate education, particularly in five selected areas that I will discuss below.

There are two types of educational programs operated under the auspices of the Singapore-MIT Alliance. There is a Master's level engineering-oriented program intended for completion by most students in one year of full time study. In our terminology at MIT, we would call it roughly equivalent to the Master's of Engineering program. Students in the SMA program receive degrees from the Singaporean universities with an accompanying certificate indicating that their degree program was part of the Singapore-MIT Alliance.

By way of background, I should note that at MIT we have both a Master's of Science degree, which is more research-oriented, and a Master's in Engineering degree, which is more geared to preparation of practicing engineers who will go into industry. Our Singaporean counterparts have those two degrees as well, but they reverse the terminology. As you can imagine, this creates endless opportunities for miscommunication!

The delivery of the courses in the SMA program is synchronous to students in Singapore and also fully interactive. For the most part, we design this distance education experience to replicate as much of the traditional classroom teaching format as we can. There is also a much smaller Ph.D. program in which a limited number of students go on for a doctorate in the five designated subject areas. Coupled with the Ph.D. program is a substantial collaborative research program. When I say "substantial," I mean that it is a $10 million per year or more research program that brings MIT and Singaporean faculty together, working on joint research initiatives.

The five selected program areas are as follows: Advanced Materials for Micro- and Nano-Systems (AMMNS); High Performance Computation for Engineered Systems; (HPCES); Innovation in Manufacturing Systems and Technology (IMST); Molecular Engineering of Biological and Chemical Systems (MEBCS); and Computer Science (CS). There were many criteria for selecting these five areas. They were mutually agreed upon by MIT and the Singaporean sponsors, which includes governmental agencies in Singapore as well as the universities there. The criteria for this mutual selection were multiple. Singapore and MIT both had to have a significant faculty presence in each of the five

areas. In addition, from the Singaporean end, these were areas deemed important for the continued economic development of that nation. As Singapore looks ahead in its economic planning, these are five areas where they believe there will be new industries or the expansion of existing industries. The Singaporean sponsors have the explicit goal of building a highly educated, leadership-oriented cohort of young professionals in these five designated program areas. In addition, of course, MIT had to be interested. That meant that we at MIT wanted to expand our research activities in each of these five areas.   The areas are predominantly in engineering, although faculty from the School of Science and the Sloan School of Management do participate in the programs. However, I would say 80 to 85 percent of the MIT faculty directly involved in the Alliance are from the School of Engineering.

We do have statistics for the 2003 academic year that reflect the performance and educational experiences of the SMA cohort that entered the program in June of 2002. The program is highly selective, and we had close to 2,000 applicants for approximately 180 positions. This year we actually have more applicants for the same number of positions. The applicants come predominantly from Southeast Asia. The four major countries represented in the student body are Singapore, providing over a third of admitted students, with the next three listed in order of the number of students they send: China, India, and Malaysia. In the rest of Southeast Asia and some non-Southeast Asian countries, the numbers are few -- one, two, three, or four students at most from each country.

The students enrolled in the Master's program are in physical attendance for a whole year. Initially they go to Singapore, and then in the first month they come to MIT for a 2 - 3 week MIT-based program known as the Summer Conference. The goals of this conference are, first of all, to meet the faculty face-to-face. Therefore, before they have any distance education experience, they spend time with the faculty who will be teaching them and who will co-supervise their research in Singapore. While at MIT, they participate in both social and educational activities. They also have a group session in techno-entrepreneurship, which is relatively new to the Singaporean economy and something the Singaporean government wants to build on.

The Singaporean sponsors of SMA want the students to hear from techno-entrepreneurs, many of whom are MIT alumni who come to talk to them. After the Summer Conference, they return to Singapore where most of their subsequent coursework is based. Last fall, we had synchronous distance sessions going on for a total of 40 hours per week. There were 19 courses being taught across the five programs, 13 of which were what we call "beamed" We use that term to denote a course synchronously managed by videoconferencing. The other six were some mix of asynchronous, pre-recorded materials and synchronous tutorials or recitation sections.

The technology base for these programs provides very high quality communications capabilities. We use the Internet 2 backbone, and the Singaporeans connect by a leased portion of a trans-Pacific fiber. With

that connection, we are able to run multiple, concurrent two-way video sessions at full 30 frames per second at a quality essentially comparable to VHS video, similar to what most people watch regularly on their TV screens. There is a separate data stream, in which PowerPoint slides or other visual materials are carried; this stream is independent of the two-way videoconferencing. In addition, for those students who do not get to class, every class session is available for a period of 12 hours in digital video from two servers -- one at MIT and one in Singapore. These digital video files include full motion video of the entire class session linked to whatever other materials the faculty member used in the presentation.

We have spent a considerable amount of time assessing the quality of this experience for the students and also for the faculty. We have done several evaluation studies, and I will give you some of the highlights. The first highlight is that students in this program do as well as their MIT counterparts as measured by course grades on exams and other such metrics. If you look at test scores for a group of students, there is no way to tell whether they are from Singaporean or MIT students in the course. The differences in most of the courses are a small fraction of a standard deviation of the variability in scores throughout the two populations combined. Therefore, at least in terms of coursework, it appears that the educational accomplishments of SMA participants do not differ from those of the MIT students, who have the faculty member physically present.

The Singaporean students believe that they learn the material as well or better than if they were physically present at MIT. Seventy-five percent of them find asking questions of faculty at a distance to be as easy, or easier, than it would be in a standard classroom setting. Of course, that leaves the 30% who do not feel that way.

A second factor I would like to discuss is the historic evolution of the technical and organizational infrastructure for the SMA initiative. As I already mentioned, the program uses high-end, relatively expensive technology. Over the past few years, we have gotten skilled at reliably obtaining high-quality video transmissions over the Internet-2 backbone. There is a whole group of technicians at MIT who manage sessions like this, and over the years, we have developed a detailed quality improvement process to enhance the quality and reliability of class sessions. In every session, there is a form filled out by the technicians, and every week someone reviews those forms. This has been a continuous quality improvement process that has yielded spectacular results. If we look at when we started the program, the fraction of class sessions that were interrupted because of technology breakdowns was fairly high. We have reduced this percentage continually over the course of the program to the point where interrupted classes are quite rare.

I also want to discuss the very hard work and attention to detail provided by the MIT faculty who participate in this alliance. The faculty members invest more time in the preparation of SMA course materials than they might in regular courses because they understand that the visual materials they use have to be transmitted to a remote audience and viewed

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on video screens. Therefore, the typical class session presented by an MIT faculty member in this program is done with a great degree of attention to detail. Undoubtedly, that is in part why students find the experience as good, or better than, being in an actual class. It is not so much that they like being 12,000 miles away better than being in a classroom. However, the limitations imposed by distance learning are compensated for by the fact that faculty has invested more time and energy in preparing materials for the course. In addition, faculty who teach SMA courses get an extra teaching assistant.

It is interesting to note that of the 137 MIT students who registered for SMA courses last year, 90 of them selected the course as an elective, rather than as a required course. That is, even though students were aware that the courses would include a remote audience in Singapore, and even though there were occasional technological problems in the delivery of the courses, most MIT students who registered for them took them because they thought the experience would be a good one.

In closing, let me quickly give you an update on where we are in the evolution of SMA. This program was initially funded to run for five years, but because each of the Master's programs did not start on the same year, and each of the programs is funded for five years, the entire experience for MIT in Singapore will be seven years long. Also, we have an agreement in principle, documented by a Memorandum of Understanding, to renew this agreement albeit in a somewhat different form. The different form will probably include more emphasis on Ph.D. students, while not abandoning programs for Master's students. In addition, there will be some shift in the five designated programs since Singapore has reformulated some of the areas it wants to emphasize in its economic development. In particular, the Singapore sponsors want to introduce some programs in the fields of bio-engineering and bio-medical engineering. These are areas in which they see tremendous potential for economic growth and interest by multi-national corporations who want to invest in Singapore. Finally, at least some of the new programs in SMA will have a component in which students admitted to both MIT and a Singaporean university can obtain an MIT degree provided they meet all the degree requirements of both institutions.

Anyone seeking further information is encouraged to look at the SMA website, which not surprisingly is http://web.mit.edu/sma. There you will find additional information about the program. Those of you from countries in Southeast Asia might want to encourage students to apply for this program. It is a full fellowship program, meaning that the admitted students are funded by the Singaporean government for their entire educational experience, including their travel to Singapore and their travel to MIT.

The Distance Education Network of The University of Southern California

Presented by Herbert Schorr
Executive Director of the Information Sciences Institute
The High Performance Computing Center
University of Southern California

What is the relevance of distance education to the Third World? Before offering my thoughts, I'd like to talk about distance education as it developed at my academic home, the University of Southern California. The USC School of Engineering, of which I am associate dean, is one the oldest purveyors of distance engineering education in the United States. At USC we started with our "Instructional Television" (ITV) operation in 1972, using microwave towers. We moved on in the 90s to digital video and nationwide distribution of our signals via satellite, and at the turn of the century moved to the Internet.

Because of the switch, in 2000 ITV changed its name from to the USC Distance Education Network, or DEN. And we have, I can say modestly, been highly successful. At DEN, we specialize in Master's Degree programs. We are now educating more than 800 students, mostly employees of large corporation, who are mature and self motivated. Our programs do not require any on-campus time, and many of our students receive their degrees without ever having set foot on our campus.

DEN students include employees of some of the most prominent companies in the nation, including Boeing, Qualcomm, United Technologies Corporation, Intel, Aerospace Corporation, Raytheon, Ericsson, SAIC, Northrop-Grumman, TRW, and Lockheed Martin, in addition to some active-duty armed forces personnel. At USC's commencement in May, 2003, 99 DEN students received Masters Degrees; we expect to award more than 100 this may.

Employers typically pay DEN students' tuition, though we have begun to admit and educate qualified individuals who are financing their own continuing education without corporate help. We offer thirteen Master's Degree programs online right now, and will be adding at least six more this year, a pace we expect to continue, because our dean will not approve a new program unless it goes onto the distance education network.

From the beginning, we have been determined that all DEN degrees be backed by the full faith and credibility of the USC Engineering School. Prospective DEN students apply to the School of Engineering graduate school precisely as candidates for on-campus study do, submitting the same documentation; and must meet precisely the same admission standards, and, to receive their degree, complete precisely the same course material, including carefully proctored examinations.

As DEN students, they take the same courses on-campus students do, through the unique web interface that we have developed. Our methods capture all the course and classroom material. We do not require the professors to change their normal way of teaching. Instead, we work with it, placing a video camera in the classroom along with whiteboards and capture the slides — whatever is most convenient for the professor.

Our goal is to make it as easy as possible for professors to participate, and to provide the distance students with a full educational experience. To broaden our reach, we last year began developing something we call a "web in a box:" a tool kit of equipment that can roll in a large suitcase into any classroom on campus with an Internet connection to do a live transmission/recording. We prefer this approach: we believe that placing technical equipment in any one room is not a good investment because of the likelihood that it will be obsolete in three years, or even less. Once captured, we archive all lectures almost instantaneously so that students may access it "asynchronously" – whenever their schedule (and time zone) allows.

An indicator of our success is that over time the on-campus, engineering students, demanded full access to the online resources as well. (As a side effect, we discover how good a lecturer is because the good lecturers get ninety percent attendance in their classes, and the ones who are not such good lecturers, attendance falls off to fifty percent or sixty percent; the students catch the lectures at their asynchronously,) Stanford, who like us was a very early and successful entrant in distance learning, has, I have been told, has similar results.

We have also found professors who, when they must be away due to an off-campus engagement, just replay the lecture they did last year rather than line up a graduate student to take over. We permit this only infrequently and reluctantly, because a key element in DEN is allowing full two-way communication for students who are viewing the lecture in real time.. We have gone to great lengths to try to assure that students have access to instructors. The remote students' questions come in now by phone or by chat rooms. We are now adding Internet phone access to facilitate immediate access for the distant students, and have still more ambitious plans I will discuss below. We also have ambitious plans to for two-way communication for students who must view DEN asynchronously, which I will also touch on.

While the lessons we webcast are existing ones, incurring no new costs, DEN is still not inexpensive to put on. To service our 800 enrollees, we must pay the salaries of twenty dedicated people to run DEN operations. We require a web-knowledgeable technical staff, a marketing staff to find corporations looking to improve their technical work force's skills, and student representatives and advisors to make sure that our remote masters candidates have the same access to important academic resources that students on campus do. We work hard to keep our current

customers happy while at the same time selling the program to new customers.

Given the pace of change, we have to be in a position to change our technology quickly. We use as much commercial software as is suitable to our purposes. For example, we have licensed the Blackboard system. To make modification/add items to the program, Blackboard™ provides an API called the Building Block™. This allows us to add our Course Management System (CMS) to Blackboard™. We expect this system will allow us to add things such as quizzing engines, simulations, etc.

But we also develop much of the technology we use ourselves. The vision we pursue is to put the newest, best work in IT to work at DEN. And we are well situated to do this. I also run the Information Sciences Institute (ISI), which has long been a leader in moving much farther beyond pure research toward applications than is usual in a university research environment. We are sometimes known as "the plumbers of the internet." We were founded as an institution to run the ARPAnet. We invented the domain name system as well as quite a bit of the other associated technology; every minute 1 trillion institutions written by ISI are executed.

Along the way, ISI developed the directory service that AOL is using, and we stopped counting after they took thirty thousand copies of it. USC is also the home of the NSF-funded Integrated Media System Center (IMSC) which has become a world leader in what are called "immersive technologies" – next generation virtual reality environments of startling realism. ISI technology is aiding the two-way communication between teacher and student – however distant – we regard as crucial. We hope to follow up the Internet phone connections we are introducing with what we call a digital amphitheater, which will allow the professor to see everyone who is taking the course wherever they are. In addition, we are experimenting with speech transcription commercial packages so that we can record the lectures and transcribe them into written material as quickly as possible.

For our asynchronous students, we are developing web-tutoring agent technology, using the resources of our Center for Advanced Research in Technology in Education (CARTE), a national leader in using artificial intelligence in pedagogy. The vision is offer always-available resources, driven by AI, that can intelligently respond and answer student questions in multi-modal presentations. We are developing AI "tutors," individualized AI agents who can carry on unscripted interactions with students, guiding them through the course, noting the difficulties that each student is experiencing for the benefit of the human professor, who will be able to follow up. We originally developed this technology in training for the Navy, which proved adaptable to both standard PCs, or to advanced, virtual reality environments, or the immersive systems being perfected by IMSC.

CARTE also developed the innovative Virtual Factory, a tool is designed to help engineering and business students grasp complex factory dynamics that are difficult to teach in chalkboard lectures and impossible to experiment with in real factories. The system allows students, working alone or in teams, to build factories, forecast demand for products, plan production, establish release rules for new work into the factory, and set scheduling rules for workstations. They can run simulations, and an animated panel displays jobs progressing through their factory, with queue counts, finished goods counts, graphs, and reporting functions all available. We expect systems like the Virtual Factory to be part of the DEN of the future.

IMSC immersive systems also offer possibilities for us to add laboratory work, which is crucial for many branches of engineering – allowing students to remotely perform experiments from anywhere in the world.

In sum, I think we are looking at a revolution in education. But how accessible will this revolution be? Let me conclude by discussing the economics of all of this and particularly vis-à-vis LINC. At DEN, as noted, we definitely have a great advantage because we are getting free content — which is wonderful; and with them we also have human resources, in the form of professors and teaching assistants.

But we also have 20 DEN employees and considerable costs and we still don't know how well it scales.   For instance, we know we are at the limit of what courses we can offer in E.E. and computer science. Those courses are fully subscribed to, so now we are going to other engineering disciplines. Scale-up will involve costs. Super computers and high speed Internet will be required. But also, it will at some point almost certainly require more than just reproducing classroom lectures. It will increasingly involve special authoring of content – which is extremely expensive, as you probably know.

What is necessary is the ability to tell a story. We ran into problems many times when students lost interest looking at the screen, so we employed Hollywood people who understood how to make things engrossing and interesting. Here I am not talking about the Hollywood gloss, but the Hollywood ability to keep people interested. This will be critical to the success not just of the laboratory exercises, but also the AI tutors I discussed.

The bottom line is quality will not be cheap, and it will not get cheaper. Perhaps we will be creating an even bigger gap between the developed and underdeveloped countries when it comes to distance education. Still, what we do see as economically possible in underdeveloped countries is to have an interactive textbook level education at some central facility, and that has been talked about here today. That involves distant professors in actual university classrooms with local TAs, leading to a degree from the university. There's a

problem from the university side; keeping the value of their brand intact. And unless the standards are kept high, people may not want to pay private university tuition.

So the question is where does the money come from for all this? Well, I think for the very underdeveloped countries, there will need to be outside financing. There is the expense of content purchasing or development, of training teachers and technicians, etc. For these reasons, I do not think we are in for a three-year goal at this, but rather, I think we better start thinking in terms of decades. If you look at some of the counties that have progressed from underdeveloped to developed, it did not take five years. It tends to be a long haul. But USC is definitely in this for the long haul.

Online Learning with Hibernia College

Presented by Sean Rowland
Executive Chairman
Hibernia College
Dublin, Ireland

First of all, let me say thank you very much to MIT and to Dick Larson for inviting me here, and also to Professor John Williams. Both Dick Larson and John Williams have helped us immensely at Hibernia College. Indeed, I think that without their help we would not be anywhere near the place we are today. We started out two and a half years ago with the idea of introducing E-Learning to Ireland through an independent college. We did a lot of research and we worked with Price Waterhouse for almost a year. We also worked with other institutions in Ireland and here. I was based in Boston for 12 years, so I had the good fortune to be able to work with MIT and with Harvard, and I also got a lot of help from Boston College.

Originally, we were involved in international education, bringing people from around the world to Boston. In doing that, we found we were spending more than half our money on hotels and travel! We initially looked at E-Learning in 1994 and 1995, but the penetration was not really there yet. People were not wired, and the technologies were not as developed. So we came back to look at it again in 1998. The Irish Minister of Education agreed to host a conference with us in Ireland to look at the whole area of technologies and what was going on in technology and education. Diana Oblinger, who is here with us today from Microsoft, spoke at that 1998 conference as well, and we were delighted to have her input at the time.

Since then, what we have done is establish Hibernia College as a for-profit corporation in Ireland. By the way, Hibernia is the Latin word for Ireland, and if you look at HiberniaCollege.net, you can have a look at our E-Learning system. We brought together a group of investors and leading academics. We have been very fortunate in the group of people whom we have brought together because they are all *working*. There are no honorary positions where people just lend their names. They are quite an impressive group of people.

We have been into it now for two and a half years, and this year, we will have 350 students online by October. We offer programs that do not compete necessarily with those of other institutions. For example, in Ireland at the moment, there is no criminal justice degree. Therefore, police officers and those working in the area of detention, etc., do not have a professional degree to pursue. That lack of a professional degree is due in part to the fact that police officers do not have much time for attending classes and studying, with schedules that change from week to week. For this reason, E-Learning is a great solution. Another area is a graduate program in hospitality management. Irish hoteliers tend to own hotels in Britain and in the United States as well. They have found that if they pay for their managers to go to

school here in the States and bring them back to Ireland, then they have a whole different set of skills. If they pay for them to go to school in Ireland, they do not develop the skills they need to work successfully here. So they came to us and said, "If you can offer a degree to our people, then we would very much support it internationally and we will fill the classes for you." Of course, the underlying factor in all of this was whether we would get accreditation. Therefore, we went to the government, meeting with a whole array of government officials, and then with the Accreditation Board. We worked with them for perhaps a year and a half before being prepared to earn accreditation.

A common theme that has come up here today is the issue of setting up an E-Learning institution in a country where people are not very familiar even with distance learning. In Ireland, we have had some experience with the Open University from Britain, but very little experience with distance learning. Anyone dealing with this issue has a huge credibility issue. So for us, being associated with the professors from MIT was certainly of great help. In addition, being associated with some of the Irish institutions helped us. However, we needed the icing on the cake. So, we went out to identify who might be able to lead us. The President of Trinity College in Dublin, Dr. Mitchell, was stepping down after his tenure-period. We asked him if he would join us as the Academic Chairman of the Hibernia Academic Committee, which would set the standards for the institution. We were absolutely delighted when he did agree. Once word got out into the academic community that Dr. Mitchell was accepting a position as Academic Chairman of Hibernia, people really started paying attention. In Ireland, it meant that one of their own leading names in academia was now going to continue his career in the area of E-Learning. This gives you some background on Hibernia's development..

What do we do? Basically, we provide third-level education using a learning management system designed and delivered by Professor John Williams and his team. We provide the education and we also offer the system to other institutions. As in many countries, one of the major issues in Irish higher-education is not that some of the best and the brightest can not get accepted into college, but it is the additional cost of paying for a second home or apartment or whatever, such as traveling, etc. For this reason, we have found that the idea of distance learning is extremely attractive.

The initial step we try to take is to identify a marketplace, find the leader or the opinion maker in that marketplace, and eventually partner with them in the delivery of coursework. So, for example, we do a Master's in Public Administration. The leaders in that field will be the national and local government party. Here I am referring to over all the local governments. These local governments give a nod to the program or not, and they also fund people to go through it. The Irish Hotel Federation is the partner for the hospitality management program. The police forces, along with the head of the prison service, are the partners for the criminology program. In this way, we are working within the system from the beginning. We are not trying to develop programs and sell them afterwards. We do not make any programs or educational classes without having a contract in advance because we are

simply not capitalized to the extent that we can afford that luxury. We are constantly, constantly having cash flow issues. People say every new business does, and it is true. However, were we to go out there and start investing in programs that might or might not sell, then I know that we would pretty much go out of business.

In the initial stages, we worked with John Williams and we worked on getting the system in place. We call our system HELMS, Higher Education Learning Management System. After that, we went out and secured a number of contracts. Then we appointed, of course, directors and officers. Some of these individuals are from institutions, some from industry, but all are working in their prospective fields. They are responsible for designing the programs for us, and then we have tutors who work with them to create the programs and courses. We have developed a proprietary course based primarily on the idea of a summer school. You can go online where we tutor you through the whole E-Learning experience for 25 hours. After that, we hope you will be up and running for the for-credit part of the program. This 25-hour course has cost much less than the for-credit course.

But as you can imagine, we are constantly negotiating for additional contracts, so just let it be very clear that we are open for business if any of you want to look at what we can do for you. We try to stay to 25 people per class. The students have a tutor and they have an online synchronous session every week, along with E-office hours. The idea is that we handhold as much as possible because people do not learn in isolation. We really believe that this model works best. We go back to the basic principles of learning, if you like, that elementary school teachers use. I believe that the idea of having hundreds of people around the world taking one class is not here yet by any means. I think we need to have small groups and we need to take great care to teach our students properly, because it is after all teaching and learning. At the end of the day, it is not about the technology.

The European market for E-Learning is estimated to be growing at an annual rate of about 50 percent. There is a huge demand. We have people phoning every day asking us to work with them on programming. Our main concern at times is that some of the programs they want will never be accredited. Therefore, we are working primarily on accredited programs at the moment. However, there are two major international corporations that have asked us to do work for them. In this instance, they do not want accreditation, but we are happy to do get involved because of the volume of work. Now in Ireland, if you look at the employment statistics, the reason we went after public administration is because of the very large numbers working in that sector. We have also just appointed a British representative out of London to sell our programs there. This is another area in which the E-Learning solution has been very helpful.

In Ireland, as you may know, we have six counties that are part of the United Kingdom in Northern Ireland and 26 southern counties that are part of the Republic of Ireland. However, for the purpose of E-Learning, there are no borders. Therefore, we can offer, say a police course, and it does no matter whether the police student is from the North or the South. They can simply learn, taking the same course online. This can be very

helpful in a country with problems like those of Ireland. Furthermore, we are marketing to EEU candidate countries because a lot of their criminal justice programs require upgrading as part of their applications for membership.

The marketing strategy we have used is very simple. Our team has been working in the field of higher education for a total of 30 years between us, and initially, we used our combined contacts. Now, as our budget increased a little bit last year, we have employed sales representatives for both Ireland and Britain. The goal we set for our first year of operation was 200 students. Actually, we will have 350 in year one starting this October because of a particular contract that came in with the numbers specified to us. However, because of this number, 350, we have stopped enrollment for the time being. We are not going to be looking for more students unless they want to sign up for next year. Yet we do expect a pretty rapid ramp-up over five years, to 5,000 students. As you can see, we are pretty aggressive.

Let me just conclude by saying that there are 9 universities in Ireland and 15 institutes of technology. For the past three or four years, we at Hibernia have lobbied the government to invest in E-Learning. Finally, they have just announced a $10 million Euro grant that will be put out to bid. The winning consortium will be given the task of developing a nationwide strategy for higher-level E-Learning solutions. Of course Hibernia will be very pleased to be involved in that consortium, whichever bidding group wins.

**Program for Internet Learning
Through the Harvard-MIT Division of Health
Sciences and Technology**

**Presented by Dr. Robert Rubin
Osborne Professor of Health Sciences and Technology and
Professor of Medicine at Harvard Medical School**

What I am is first and foremost a bedside clinician specializing in the care of those critically ill from infectious disease. This work is carried out at the Brigham and Women's Hospital where I help run the infectious disease service. My research comes from the bedside, an effort to solve problems that are presently without solution. To increase the chances for this effort, twelve years ago I accepted the opportunity of joining the Harvard-MIT Division of Health Sciences and Technology (HST) as Chief of Experimental Pharmacology. In this position, I am a teacher of clinical medicine as well as a consumer of new technology. Over the years I have had the privilege of working internationally as well as locally, helping to run medical relief in West Africa and, increasingly, as an educator in Latin America.

Here in Boston, I work with thirty medical fellows, twenty of whom are being trained in the area of clinical investigation. It has been recognized that throughout the world there is a shortage of people medically trained who are capable of taking advances from the bench to the bedside, translating research into practice. Recognizing this need, we were fortunate to form a collaboration with Pfizer, Inc. to develop a training program for clinical investigators. Currently, we have twenty fellows in this program, and their accomplishments are most encouraging. So far, we have graduated fifty-six people from the program, and forty-seven of them are running research programs around the world. In the process of working with these young people, we have learned a great deal about what needs to be taught, and how best to do it. Educational materials developed in this process were also found to be useful in a variety of other settings: in training medical students, residents and fellows, and with young physicians anxious to take advantage of opportunities to carry out clinical research.

It also became clear to us that these programs could have a far greater use than we were making of them. Indeed, we felt they could be the basis of educational programs exported around the world. We were in an enviable position because we did not need to sell these programs for profit. Due to the farsightedness of our corporate partner, Pfizer, we had an unrestricted educational grant to develop the program, along with the freedom to make resulting materials available throughout the world at no cost to persons or organizations wanting to train their own people in the philosophy, ethics, and mechanics of clinical research.

Sitting in the audience here today is Dr. Honorio Silva, a senior executive at Pfizer, who was our collaborator in this project. His wisdom,

generosity of spirit, and commitment to this effort are the foundation for everything we have done. With Dr. Silva's help, we organized a program in which we would build upon our Boston experience to work with medical leaders in Latin America to provide training for clinical investigators in Latin America. Our first efforts led to the development of a week-long program which we gave throughout Latin America on more than ten occasions. From the beginning, we attempted not only to teach but also to provide a certification exam and the opportunity for local physicians to stay in contact with us. Indeed it became apparent that there was a great need for such ongoing communication, and that there was a perceived need that. The feedback from participants indicated that they wanted more. One of the common feedback responses we received from international participants in the courses was the fact that they wanted to stay in touch with us. They had questions. They had ideas they wanted to check out with us. It was very clear that if we were going to build an infrastructure of clinical investigators that could make contributions anyplace in the world, we had to have a way of continuing education and contact. I have to be honest here that I was also influenced by my wife who informed me that I could only make a limited number of trips to Latin America in a given year and still keep my day job and my family!

At about this time, I was exposed to Professor Larson and watched the technologically- enabled physics experiments, particularly the PIVOT Project, that he and his center had developed. I was blown away by what was accomplished! At about that same time, we were undergoing some self-examination, since to be truthful, medical education has not changed very much in the last fifty years. You sit in a room, and somebody lectures to you. You may or may not pay attention, because it is completely a passive learning experience, something I do not believe in. I want students to be excited and to have control over their learning processes because we all learn in different ways. To make a long story short, with Dr. Silva's help, Dick and I became friends, and we started trying to develop programs for web-based medical educational programs. First of all, we started with a group clinical practices educational program that we had used in live classrooms, a course deemed by a variety of people to be very successful. Could we deliver an equal or better product on the Web that would accomplish the same thing?

So we moved ahead to answer this question. In the first module, we give the history of clinical research. We talk a great deal about the ethics of human experimentation, developing the concept that the highest responsibility a physician bears is when he asks someone to participate in a trial involving human beings. As a doctor, that is the gravest responsibility I have. There are many complex issues involved here such as: what is the right way; what are responsibilities of the physician; what are the responsibilities of the patient, etc. We spend a long time discussing medical research disasters, medical research crimes, if you will, from the Nazi experiments to the Tuskegee experiments. In Tuskegee, American medical researchers were guilty of gross malpractice and evil

doing by depriving men of therapy for syphilis when such therapy was easily available. We attempted to include important background information in that module. The program's format includes a series of lectures and a series of workshops. We also provide the opportunity for people to interact with the speakers and to ask questions. Finally, we offer a certification exam with the reward that after passing the exam, a person becomes part of a specialized network whose members have most favorite son access to new trials. Those passing the exam also are given ongoing access to us here in Boston.

This online program has been extremely successful, and I get about ten to twenty e-mails a week from people who have been exposed to it. So that was our first online experiment, and it taught us that this is a wonderful way to learn. You can do it at your own speed. You can go back and review. If a problem comes up when you are doing clinical research, you can refer back to the internet-based program. What we gave them is an introduction to the subject of clinical research, as well as extensive references so there is easy access to a library. In addition, there are people whom they can call or e-mail for further information. To us, it seems to be an ideal way to deliver learning.

The second thing that Dick and I worked on was development of a module on a factual medical subject - fungal infections. That is my particular area of infectious disease, and it is an area that has changed extensively in recent years. Most physicians are ignorant about seven new drugs for these infections that have come on market in the past three years. Also, those of us with specialized knowledge about these infections are now working with new diagnostics and with a different approach to managing these patients. What I did with Dick in this area was to create a program that I call "Grand Rounds." Grand Rounds is the name of the weekly conference at a hospital where an expert is invited to speak. We divided this online program into three parts. The first part includes state of the art lectures given by literally the best experts in the world on their particular topics. In addition, the lecture slides can be downloaded, and there are hotlinks to references that the speakers highly recommend.

The second part of "Grand Rounds," a part that I think is extremely important, presents fifteen or twenty cases of possible or probable fungal infections, with case information presented in the way a doctor would receive it from a patient. Someone working with this online program is required to analyze information and make decisions. What do we learn when the patient is first encountered in the Emergency Room and background information is collected? Do I treat? Do I not treat? What do I treat with? Do I operate or something of that sort? Anyone using this program is told very bluntly that he or she just killed the patient if the wrong decision was made. One definitely sits up and pays more attention when shown that your approach is so wrong that a patient will suffer. These cases are interactive and complex, evolving over time just as a real patient's case does. I think these online cases result in far more learning because the student is required to return to the factual information needed to solve the problem. So it is very clear that highly specialized information

can be most expeditiously disseminated to the medical community through this asynchronous learning method.

The third part of this online program involves the basic tools that doctors need such as statistics, study design, clinical pharmacology, etc. We are developing online programs for these areas too, with the idea that there is specific, basic information that can be presented in a lecture format. I teach Clinical Pharmacology and Therapeutics, and we are filming my lectures for the program. We have five more on the drawing boards, and we are looking to raise some money, which I do not think we will have difficulty doing because these topics are so rare and valuable. Our plan for this is to get money from the usual sources, but to make the completed online programs available free of charge. We will go to the medical schools in Latin America and say, "Here we have what we think is a very good approach to clinical pharmacology. Can you look at it?" Then we will say, "If it is useful, we would like you to use it as a gift from us."

In summing up what we have done in "Grand Rounds," I think that the most important information is contained in the case examples. By the time they get as old as I am, physicians learn best when there is a case through which they can gain new knowledge or renew old knowledge. We see physicians who use the online cases going back and forth between two reactions: "Oh, I know this stuff. Wait a minute, I messed up that case. I had better go back and take another look, or learn about this infection the first time."

When I think more broadly, the possibilities with this educational technology are even greater than what I have discussed. I believe there is someone here today from the World Bank. Some time ago, the World Bank figured out that doing things to enhance the health of a community or a region makes incredible economic sense. There is absolutely no reason why you cannot develop an educational program like this for public health. I can remember working in West Africa where we failed in trying to introduce certain sanitary practices in terms of how to deal with litter. There was a huge amount of litter-borne disease in the community where we were working. However, if you could educate people through a movie or an online demonstration, and cover the topic much more expertly this way, I bet that your educational efforts would be far more successful.

People have talked about the need to build logistical support for public health or medical programs in newly emerging countries. I think that is true, but I would make an argument that you can develop this infrastructure by interacting on the Web with the chief medical and public health principles in a particular developing nation. For this reason, I think that the issue of improving the health of different countries lends itself very well to this kind of technology-enabled education, whether it is obstetrical practices, nutrition, water safety, etc. Our experience has been an extremely positive one. We would like to work with whoever is interested in what I am talking about because I think there is an opportunity to make a real contribution. We think this is a remarkable addition to the educational armamentarium in medicine and public health.

Recent E-Learning Activities in Japan and Asia Pacific Countries

Presented by Dr. Yoshiyori Urano, Professor
Graduate School of Global Information and Telecommunication Studies
Global Information and Telecommunication Institute
Waseda University
Tokyo, Japan

This afternoon I would like to talk about the recent activity of our university, Waseda University, one of the largest in Japan with more than 50,000 students and 4,000 faculty members. Since we have a variety of E-Learning programs in each department and graduate school, I will focus on three interesting projects at our graduate school, GITS.

The first is an on-line lecture project, supported by three Japanese foundations, where on-line lectures on recent ICT are transmitted to people in Hanoi, in cooperation with the Post and Telecommunications Institute of Technology in Vietnam. In this project, we use a simple PC-based conferencing system over the ISDN network to realize synchronized E-Learning. This distance education project has greatly promoted cooperation in the field of education between Vietnam and Japan. However, we found that there were lots of problems to be solved. For example, there are urgent needs to develop the information infrastructure suitable for E-Learning in Vietnam, including upgrading of the conferencing system and reduction of line-costs, which is critical for us to continue this project. Through these on-line lectures, we have faced the fact that the interactive communication between lecturers and students in the class is not active enough. The students appear to be extremely shy and often hesitate to ask lecturers a question, which could simply be due to the Asian culture. Of course, language barriers could be another factor for this difficulty. Facilitators should play an important role to promote interactive communication between lecturers and students.

The second project, sponsored by the Japanese Ministry of Economy, Trade and Industry, has been carried out with the Malaysian people in the area of E-Learning. Multimedia University of Malaysia (MMU), Waseda University and Kyoto University have jointly developed an E-Learning platform, including the design, the creation, and the operation of platforms and materials based on E-Learning technology standards such as SCORM (Sharable Content Object Reference Model). The interoperability experiment was conducted to test if the contents developed could run on both MMU's and Japan's platform. Through trials on Web-based lessons, usability of the system and effectiveness of the contents have been evaluated; we have found there is a need for teaching assistants or mentors when students are having difficulty with the self-paced learning. We are now trying to implement so-called "virtual assistants" to effectively promote Web-based learning/training for this project.

The last project I want to mention is sponsored by the A.I.C. (Asian Info-Communications Council) with nine member countries working jointly to develop web-based courses. The finding through the A.I.C. project is that the style of E-Learning should be different with each country. For example, in Japan and Korea, we will have a new educational paradigm, M-Learning where learners could learn in Mobile Communications environments -- anytime and anywhere they want to learn. It is envisioned that out of this Ubiquitous Learning (U-Learning) would emerge. On the other hand, in some rural areas, in Bario, Malaysia, for example, we have to find another solution. When we talk about E-Learning in developed countries, E stands for Electronic. However, in rural areas, E stands for not only Electronic but also Electrical, Economical, Ecological and so on.

In conclusion, I would like to emphasize the importance of sharing the experience and knowledge on E-Learning, such as how to develop advanced information infrastructures, how to develop teaching/learning materials, and how to train teachers and mentors. For the further sustainable development of E-Learning projects in the Asian area, we have to have financial supports and win-win partnerships or cooperation/collaboration among the members of consortia like LINC.

INTRODUCING DIGITAL CONTENTS IN UNIVERSITIES

Presented by Claude Moreau
Professor of Engineering and Director of Continuing Education
University of Technology of Compiègne (UTC)
Compiegne, France

Today I want to discuss the work we are doing at my university in France, the University of Technology of Compiegne or UTC. We have been developing E-Learning, or rather web-based teaching, since 1995-1996. We put the first Master Degree program on line in 1996, and have been increasing the number of on-line programs over the years since then. However, we are not an "Open University." Rather, we are a traditional university that runs some experimental distance programs on the side, trying to experiment with new ways of teaching. Yet this is not our main business because our main business is to be a traditional university.

What we have developed over the past seven years is really a series of pilot projects, experimenting with pedagogical and organizational models for teaching at a distance or for using electronic media to teach. In most of the programs that we now run, we have a few physical meetings, comprising about 20 to 25 percent of the total time. The other 75 to 80 percent of the teaching or learning time is based on asynchronous exchange through the Internet. The main emphasis of our work has really been to develop content production, along with management systems and methods. We have tried to move from the simple, craftsman-like way of producing one course at a time to a more industrial production, a more rational production system. In addition, we developed something called a "Learning Content Management System" that today is used widely by others.

So to summarize, we are interested in producing electronic content or content for teaching at a distance. We "manufacture" it using a rational method and we store the content in the Learning Content Management System, using XML standards, IMS and alike. The content in this repository or database is very easy to change, enabling us to update the contents and put it into an LMS system for teaching a course, yet still easily maintaining it over time. This is something that we at UTC are very proud of. It is a rather simple system to produce content for university teachers.

A second major emphasis of our initiatives is the coaching of the "distant" students. How do you deal with students when they are not physically present ? How do you help them not to fall behind in their work, and such? To this end, we defined a few roles or a few functions in the whole system and these have been widely developed and tested over the years. Special people are running groups of students at a distance and dealing with what we call "psycho-sociological" problems. We are not simply interested in E-Learning for the technical content of one course. Instead, we are interested in the overall life of the student, and our program

tries to help him even when he has difficulties beyond the learning itself. So, these are the types of things we have been doing in E-Learning at UTC.

There is another line of work that we also do. In the French system of higher education, there is a student-based organization called "Ingénieurs Sans Frontieres," Engineers Without Borders"(ISF). It is based on the same concept as Doctors Without Borders. It involves engineers who want to spend some of their time helping countries implement appropriate technologies for their development. ISF is actually run by students at the national level. I understand from a discussion this morning that there is also a branch in Canada. In France, this non-profit association has 38 groups in 80 universities. You can see that it is really a nationwide organization, involving about 900 volunteer members. Most of the members are engineers or Ph.D. engineering students. They have a small national office with four permanent people working for the organization to run the projects and the connections. The ISF has been working with developing countries mostly in Africa. They send about 30 to 40 missions per year into different countries and last year they sent approximately 100 volunteers on different missions to Africa. Overall, they have run about 200 projects since they were founded in the 1980's.

In France, the ISF also runs some programs to help students understand intercultural differences and to understand the concept of sustainable development. Then when the engineering students go on a mission abroad, they have some conceptual basis before working on the ground or in the field. I will give you an example of a project that was run by this organization. In 1994, an immigrant Association in France asked ISF to think about building a health center in Moudéry, a small town in Senegal. The organization put the project together in two years, 1995-1997. They made the feasibility study, visited the site, and made a cost evaluation. Then from 1997 to 2001, after having found the funding for this project, they built the health center using local people and ISF student help in the summer or in between semesters. The center itself was opened in 2001. The global budget for this project was about 450,000 Euros, so that would be about $450,000. It is a small budget, but I think it is a big impact for this small town.

The second example I will describe is not student-led. It is a project led by faculties, involving several European countries around the Mediterranean and financed by the European Union. It involves 19 European partners working in 10 developing countries, and it is devoted to improving public health in those 10 countries. The project leaders identified three sub-projects on special diseases. I will not go into the details of these diseases, but I want to mention that our university is doing the content production for this project as well as providing training management for the users. We are operating a dynamic portal, an information exchange portal, as well as establishing a connection to a geographic information system. The latter is critical because when you talk about the spreading of a disease, you want to know how it relates to the geography. We have found this to be an interesting technical connection between the portal and the geographic information system.

At UTC, we have an idea for a proposal that we would like to bring to LINC for collaboration. We propose a joint effort to provide access to technologies for digital content design introduction and higher education in developing countries. At UTC, we would like to build a network of African universities involved in science and technology because these are the subjects we know the best. Our proposed network would introduce digital learning systems into these universities, increase the range of action of each university and complement their traditional teaching by adding electronic means. To do that, we would like to transfer E-Learning methodologies to specific sites and install learning management systems in those universities, while also facilitating access to existing information and knowledge, relating for instance to the Open Courseware from MIT. It would be interesting to have these universities look at the OCW content and see how they can use it and transform it, perhaps changing the language and changing a few other things. However, we want to help them gain access to this information, allowing them to transform it for their own use in their own environment. We already have quite a few contacts with some African universities. Obviously, we would like to pilot the project because students from ISF, Ingenieurs Sans Frontieres, would be part of the project. We would like the students to go into the field, visiting these universities and seeing what there is to do in each specific environment.

So relating this to the LINC initiative, we received a paper from Dick Larson a few months ago outlining just what LINC hopes to accomplish. At UTC, we made a specific analysis of what we could do at each level of the LINC initiative. One example of what we would like to do involves having our students, already experienced through their ISF projects, work on the planning for links between our university and African universities. We see a 24-month pilot phase starting with a needs analysis for which we would send students to a particular African university to assess their situation in the area of Teaching and Learning. This would lead to building an exchange on a one-to-one basis, with that particular university. Then from this first experience, we could expand to other universities from the North and the South, building some leverage effect, as we like to say. In the process, universities in Africa could connect among themselves, and there would be a strong rippling effect from the single, simple project with one university at the beginning. This is how we would like to work together with LINC to bring higher distance education, particularly to French- speaking universities in Africa.

Web-based Learning at the Technion and MIT

Presented by
Yehudit Judy Dori, Associate Professor
Department of Education in Technology and Science
and by
Dov Dori, Associate Professor
Information Systems Engineering
Faculty of Industrial Engineering and Management
Technion - Israel Institute of Technology
Haifa, Israel

We only have fifteen minutes for two presenters, so we will have to do it twice as fast as the rest of you. I will spend the first five minutes describing the Technion, Israel Institute of Technology where we are associate professors, in addition to our affiliation with M.I.T. The Technion is Israel's oldest and premier institute of science and technology. It is a vibrant, active participant in the establishment and development of Israel as relates to all things technological. Due to this strong technological development, Israel is now recognized as one of the world's most prominent high tech innovators. The mission of the Technion is to offer degrees in science and engineering, and in the related fields of architecture, medicine, industrial engineering and management education. The concentration of faculties and departments at the Technion is quite similar to that at M.I.T. in the sense that the emphasis is really on science and engineering, with courses in humanities and the arts offered in lesser numbers. However, the Technion does place emphasis on the humanities and social sciences as well, and scientific instruction at the Technion is interwoven with professional ethics. We produce leaders who are sensitive to social and environmental issues. The Technion is committed to its role as the county's top facility for science and education, and this is a role which is necessary for the future of Israel and, in fact, of all of humanity.

The Technion is almost eighty years old, which is quite old in Middle Eastern terms. It was originally established in downtown Haifa and moved further outside the city center in 1953. The student population is roughly twelve or thirteen thousand as of 2000, with a faculty of over eight hundred. It is about the same size as M.I.T., with more undergraduate students and fewer graduate students, but similar in size overall. Now I will turn over the podium to Judy who will introduce and describe the TEAL Physics Project.

As Dov explained, we both are also affiliated with MIT. We spent two years here on sabbatical, and we continue to travel here as research scholars. As part of the research I conducted and continue to conduct, I am the Assessment Leader of the Technology Enabled Active Learning Project (TEAL), involving a new, active way to teach and learn physics. The challenge of this project was to transform a class of about three hundred students into a more active and engaging environment by

accessing much new technology. The goal also was to move away from the passive lecture format into a more active educational approach, one employing knowledge-based and concept-based learning. Even in this very large physics class, small groups of students get to perform their own experiments and discuss their ideas through the involvement of mentoring instructors.

There were two objectives in my research of assessing this project. The first was to assess the students' conceptual understanding in the study of electromagnetism, and the second was to examine the effect of students' academic levels as relates to their achievement. In this research, we employed very efficient instruments, both analytical standard testing and conceptual testing, as well as surveys and focus groups to check the aptitudes of the students. We studied different populations in two rounds of experiments. The first experimental group was in fall, 2000, and the second one was in fall, 2001, with the control groups tested in spring, 2001 and spring, 2002. I would like to mention that this spring, in 2003, we will begin the large-scale implementation of TEAL with more than six hundred students.

However, the first and second pilot studies included only 176 experimental students and 121 control students who volunteered to take part in the comparison. We discovered that all the students in the experimental group achieved much better academically than the control group, and also significantly higher in a statistical analysis. The control group had a well-known professor of physics, but the class was a traditional lecture and the students tended to sleep in the class even though the professor was very charismatic and did many demonstrations. However, because they were sleeping in class for two hours, they sometimes stopped coming to the lecture and sometimes attended but did not listen. In contrast, in the active learning environment of the TEAL Project, the students had to be involved because they were conducting experiments during class and they had to create visualizations of the abstract concepts. In addition, they got points for every assignment they completed, so we actually forced them to be involved, to be engaged, and to study.

In assessing the TEAL Project, we measured not only the intellectual gain of the students but also their relative improvement, namely, how much each student gained in relation to the number of grade points he or she could potentially earn. We discovered that the top students in the experimental group achieved not only significantly higher grades than the top students in the control group, but also significantly higher than the intermediate and low students in the experimental group. These top students taught their peers in their particular groups and explained the material to low and intermediate level students. By doing so, they gained the most from this project. What is interesting about these results is the fact that at the beginning, some members of the physics faculty were not in favor of the project. They believed it watered down the content of the course, not covering as much material as a traditional class,

because students spent more time on visualization, on active learning, and on experiments.

In the evaluation, we also collected students' opinions regarding the several teaching methods used in TEAL. They were exposed to many options, including lectures, demonstrations, peer discussions, hands-on activities, technology, etc. We learned that they still preferred the lecture, but in the TEAL classroom, the lectures were far shorter, lasting fifteen or twenty minutes. After these short lectures, students conducted hands-on experiments and demonstrations, and then towards the end of the class, they received another ten minutes of discussion and summarizing. So actually, their preference for lecture is only in relation to the short-time lectures. In the focus group, TEAL students said that the comparison between the short lectures with the other methods used in the same course was not posed properly. They believed we should have asked them to compare the TEAL methods against the traditional method of two-hour lectures in other physics courses. They mentioned that for two hours they would sometimes sleep or would not come to class, while a TEAL short-time lecture helped them understand what was going on in the experiments and visualizations.

At the Technion, we conducted another project in an undergraduate chemistry course, in which we investigated the effect of computerized molecular modeling and Web-based assignments on students' conceptual understanding and their perceptions of 3D molecular structures.

In conclusion, I would like to summarize that both at the Technion and at M.I.T. there are many recent innovations to develop and assess technology-based learning and to engage students in active participation, experiments, visualization, etc. We believe that this approach is the best way for science students to acquire both visualization skills and conceptual understanding, especially in the basic undergraduate courses that often are large and compulsory. With the new technology, we encourage and motivate these students to become involved in their learning and thus to retain most of the knowledge. I would like to close with some acknowledgements to the people who have helped me in this project. Professor John Belcher, the Principal Investigator, and Professor Steve Lerman who invited me to the Center for Educational Computer Initiatives (CECI) and provided the appropriate academic environment.

On Technology Enhanced Learning

Presented by Kamal Youcef-Toumi
Professor of Mechanical Engineering at MIT

What I would like to do today is, first, speak a little bit about technology-enhanced education -- particularly emphasizing a few points -- and then look at those particular points from the perspective of our limited experience here on MIT's campus and also our experience with the distance education program we operate with Singapore, namely the Singapore MIT Alliance Program (SMA).

One important thing I am sure most of you are aware of is the distinction between distance education and technology-enabled education. I think distance education should be considered as a subset of technology-enabled education. Among other things, I think we want to look at course delivery procedures or methods and also at the use of materials either offline without support, or at web-based materials that may be used in conjunction with classroom or laboratory activities. We also want to consider other materials that can be used either offline or online, again, with a classroom and laboratory activities. Now, in all of this, we are trying to look into how these technologies, particularly the web-based technologies, can be used to enhance our way of communicating information to students. It is a new paradigm of education with new terms I am sure you have heard. For example, talking about students as "learners" and teachers as "mentors," or discussing "active" versus "passive" learning. With this new paradigm, we also speak of "accomplishing goals" in the course, rather than "delivering material." And of course, we all are familiar with the terms "asynchronous" verses "synchronous" learning.

Another thing we should consider while teaching is just how much information a student can retain. I think this is an important issue because in many cases I have seen -- in a few European countries and also here in the States -- the courses are very much overloaded with too much information. Sometimes we simply try to push material through the students, with no consideration as to how much of the information is actually retained. Perhaps some of you also have seen this kind of information overload. On average, a person will retain only about 10 percent of what they read. Of course, there are the extremes -- somebody who can just read it once and then memorize the whole thing. Or students for whom, no matter how many times they read it, it simply does not stick. For most students, if they view the information apart from reading it, there will be about a 30 percent retention rate. By combining seeing and hearing, the rate rises to about 60 percent. Now comes the interesting part -- material learned via a discussion with others. In this situation, the retention percentage goes up to about 70. Finally, the retention rate goes up to 80% in a situation where the students must teach the new material to others.

Now in some of the graduate courses in Systems and Controls I teach here, and also in courses of the Singapore MIT Alliance, we are trying to improve the delivery by following these particular learning precepts so that students can retain more information. In particular, we have focused on the third point -- that is, providing discussion with others during a class or during special sessions. We have also attempted to find ways of enabling students to experience the material personally. In particular, we have been trying to shift the percentage of time from, let us say, the presenter or lecturer controlling 80%, to instead allowing the students, via discussion or presentation formats, to control 80% of the class. This shift is so important because it seems that exciting learning starts to happen once students begin to think about material in terms of teaching it to others. As an aside here, I would like to add that any discussion of education should be a comprehensive one. One should look at K through 12, college, and then post-graduate education as a continuous whole. From an economic perspective, this continuous whole should also be linked to industry-sponsored training programs.

Now I would like to move on to a discussion of how information can be transferred from the teacher to the student. As all of us know, the attention span of students is short so we must understand how we can use that limited time in the most effective way. How do we go about transferring the knowledge? Earlier I was talking about the quantity of information that is being transferred, as well as the way that information is absorbed. As teachers, we want to present the material in a way that will facilitate absorption, so that a student can understand it and then use it in an easy way. This early use of information leads to a better recall of the information, enabling a student later on to use it in trying to address and solve a problem.

For example, in the SMA Program -- and my colleague Steve Lerman will talk to you about that shortly -- we have classrooms like the one you see here at MIT, and then similar classrooms in Singapore. I would like to discuss with you two aspects of the SMA courses -- course design and interactivity with students. Now the SMA course I am involved with has about 40 students here at MIT and also in a classroom in Singapore. The way I have designed the class is through a case study. This is a multi-disciplinary case that the students get access to approximately one week before the course begins. Also prior to the course, students are divided into small groups - about four students per group -- and then in every round, we designate a spokesperson from that small group.

In the first session, I make it clear that I do not want to see any equations. I want the students to write down their thoughts about approaching the problem. Actually, I have had some good students who completed the forms with equations, and I refused to look at their sheets. How it works is that I have overheads that the students can write on, and then I collect all of their completed work and we use their work in class. I always start with the sheets that have some incorrect conceptual thinking, because those are the ones that will lead to discussions. Then I have the group spokesperson explain to the rest of the class how the group came up

with that answer. We do the same thing with the Singapore Program, the distant learners. The class facilitator in Singapore then collects the sheets of those 40 students. Their information is presented to us in Cambridge via overhead TV cameras. It turns out from an educational point of view that this provides a good learning experience because the selected problems are multi-disciplinary involving different challenges and allowing students about a week to think through them and come up with possible solution designs. For example, one of the case studies looks at, let us say, a crack propagation inspection system for aircraft. In a systemic problem like this one, the students should try to understand how to aid the aircraft. We have used many other multidisciplinary courses like this one. For another example, a problem that involved the cleaning of a nuclear power plant.

The design of a distance course like this one, involving students from different continents, requires a great deal of planning. Eight months of planning went into the initial design of my course in Automated Equipment and Manufacturing for SMA, planning from January through September to get everything organized. Now over three years later, we of course continue to update the content. The important thing to keep in mind is the fact that our students are coming from different regions, from India, from Vietnam, from Indonesia, etc. and therefore, they have different backgrounds.   Therefore, sometimes it happens that the students are unevenly prepared for the class and in these situations we have been able to set up separate sessions on the side to bring some of those students up to class level. We have also noticed a big change in the classroom behavior of the Singapore students in relation to the MIT students. Here at MIT, we have very vocal students. They ask questions and they sit down at the front of class with a sandwich and so on. It is very casual atmosphere. However, the students from the other part of the world were not initially asking questions. So I had to call on them, and then it did not take long, maybe a year or so, until the students in Singapore began asking questions, virtually rubbing shoulders with their counterparts at MIT. Although they may be on different continents, these two groups of students are in a sense in the same classroom.

That is basically what I wanted to say. I wanted to mention course content and also the delivery method of that material. I think these two factors are very important whether a course is on the web or whether it is presented live or at distance.

Video Math Lectures: My (Positive) Experience

Presented by Gilbert Strang
Professor of Mathematics at MIT

Mathematics professors do not always have a perfect reputation. If I am at a party and allow myself to become known as a math professor, somebody always says, "Don't give us a test."   It is amusing, but at the same time a little worrying that mathematics, and perhaps other parts of science, are so much associated only with tests and with a deadly serious effort.   Of course I think mathematics is a beautiful subject. I am really happy to have had the chance, thanks to Glenn Strehle, Anne Margulies, and others present here today, to have put some ordinary MIT mathematics lectures originally on the Linear Algebra website (web.mit.edu /18.06), and later on the Open CourseWare website. There really are some terrific lectures at MIT. The effort we all are involved in is so wholesome. It is really the best of life to be helping others learn something that is interesting. I think most scientists are, or should be, pretty humble too, because they understand how truly gifted some scholars are. Yet each of us simply does his or her part.

 I try to show by example how teaching linear algebra can be made a more active and more human effort. Achieving this educational accessibility for mathematics is my overall perspective here. In the near future, I may have a chance to chair the U.S. National Committee on Mathematics. In that role, I hope to expand efforts like those underway at MIT in technology-enabled education for use in the broadest worldwide context. This would involve demonstrating to teachers and students of different nationalities how a subject like mathematics need not be so cut and dried. We can be more open! Bill Mitchell spoke about learning environments other than the classroom, and that is a direction, made possible by the Web, that we are taking here at MIT. I am encouraged in this new endeavor by emails that come back to me, thanking me, thanking MIT. I think the MIT faculty is very pleased that the Institute has chosen to make courseware freely available on the Web, and I believe we are just beginning to see what the fruition from that decision can be. In my case, I had the chance to do linear algebra videos at an earlier date, but the production of these courses will increase and improve, and I hope they will be useful to teachers and students everywhere.

Here is the type of message that comes in to us, one of many examples. It is a letter of warmest appreciation, really meant for MIT. "When I took linear algebra at -- I better not mention the college, but it was definitely a good college -- years ago, I felt bedraggled by endless theorems and proofs that left me with no insight as to what it all meant." This email expresses the feeling of too many students. With the Web, as the opportunity to illustrate how in a real classroom linear algebra can be made active and alive, video courses can change students' experience of mathematics. I do not think that the production values have to be at a

Hollywood level. In fact, better if they are not. The course can be presented just as I am speaking now. The goal is not entertainment, but making a topic come to life for the student. All of you here today involved with distance education are charged with determining how to reach students in your countries. Getting back to the email, the writer concludes by saying that the decision to place these lectures online is absolutely priceless.

Another student writes, "I am a student struggling in the mechanical engineering curriculum at Auburn." Struggling, that is the thing that students do, because "struggling" is actually a good word, would not you agree? It is a word that means they are trying, and the more help we can give to students all over the world, the better. We can pull together and do more and more of this. Thank you for the opportunity to come this morning to express my personal thoughts about the readiness of the MIT faculty to contribute what they can.

The MIT OpenCourseware Initiative

Presented By Anne Margulies
Director of the OpenCourseWare Initiative

Tonight I want to talk with you about MIT OpenCourseWare (OCW) which is a large-scale, web-based electronic publishing initiative first announced in April, 2001. There are two major goals of the OpenCourseWare initiative: 1) to provide free, searchable, coherent access to virtually all MIT course materials for educators, students, and individual learners around the world; and 2) to create an efficient, standards-based model that other universities may emulate to publish their own course materials. The MIT mission is to advance knowledge and educate students in science, technology, and other areas of scholarship that will best serve the nation and the world. OCW is an exemplary manifestation of the MIT faculty's deep commitment to this ideal. Through OCW, anyone may access and freely use MIT course materials for non-commercial educational purposes. This exciting initiative is being developed with generous support from the William and Flora Hewlett Foundation, the Andrew W. Mellon Foundation, Massachusetts Institute of Technology, and the MIT Faculty.

Ultimately, OCW will include the materials for approximately 1,800 undergraduate and graduate-level courses taught in all five of the Institute's schools: School of Architecture and Planning; School of Engineering; School of Humanities, Arts, and Social Sciences; Sloan School of Management; and School of Science. Publication began with the OCW Pilot—50 courses introduced on the web site this past September. Next September will mark the official OCW launch with 500 courses published, and the remaining courses will be published over the next four years. While the total number of MIT courses remains relatively constant over time, faculty do create new courses and retire old courses at the rate of roughly 100 – 150 per year. Of course OCW will continue to publish these new course while maintaining an active, accessible archive of the old courses, permanently into the future. In addition to new courses, faculty members continually revise almost all active courses, and OCW will publish these revised versions as they evolve. This ongoing publication strategy ensures that the MIT course materials available on OCW will always remain timely and relevant.

OCW includes course materials from all of MIT's academic disciplines. The materials for a typical course include at least a syllabus, course calendar, and lecture notes. Most courses also have one or more additional categories of material such as assignments, exams, problem/solution sets, labs, projects, hypertextbooks, simulations, demonstration/learning tools, tutorials, and video lectures. These materials are organized by course within a specific department. However, OCW incorporates a rich "meta-data tagging" scheme so that it is easy to search and retrieve materials across disciplines according to criteria specified by

the user. OCW is designed with educators, students, and self-learners in mind. In building our system, we have endeavored to anticipate the various ways these audiences would use the materials. Along with the official launch of the first 500 courses in September 2003, OCW is implementing a more comprehensive evaluation program to measure and report access, use, and impact in a more structured way.

MIT offers the materials under an open "Creative Commons" license that grants users the right to use and distribute the materials either as-is, or in an adapted form. In addition, this license allows users to create derivative works from the material by editing it, translating it, adding to it, and combining it with, or incorporating it into, other materials. This license also obliges users to meet certain requirements as a condition of use. Any use must be non-commercial, and publication or distribution of all original or derivative materials must be offered freely to others under identical terms. Finally, all materials must be attributed to MIT and to the original author/contributor. Accordingly, educators may adopt whole courses into their curricula, or they may adapt just those parts that fit well with local purposes. Students, self-learners, and researchers may use the materials as a supplement to other educational resources available to them.

Since the first courses were introduced in September, 2003, electronic "visitors" to OCW have come from every corner of the globe. With well over 100 million "hits" since first publication of the pilot in September 2002, traffic has come from 210 countries and city-states around the world. OCW has received thousands of unsolicited messages in support of the initiative. Some examples are the following:

"Let me tell you in this 1st feedback on this Sept 30, 2002 that today is a Historic Day. It's the Big Bang of the Knowledge Universe."
– Algeria

"I think this pilot program is very easy and helpful, especially for those living in developing countries like Vietnam who are unable to study in the land of America."   – Vietnam

"Once completed, the MIT OpenCourseWare will be akin to Gutenberg's creation in importance. It is the boldest thing done in the name of freedom of knowledge in many years."   – Britain

 "Your free-of-charge OCW is something brilliant – and unfortunately, very rare – in this commerce and money driven world of ours… [OCW] is returning to the very fundamental academic values of information open for all!"   – Spain

"I have to say this is one of the most exciting applications of the Internet to date. I look forward to taking advantage of this opportunity to 'take a dip' in MIT's enormous reservoir of human intellect."
– Nigeria

"The OCW site is the coolest thing on the Internet. It may very well be the coolest thing in human history…. This is the start of something big."
– Seattle

In conclusion, OCW provides a new model for the dissemination of knowledge and collaboration among scholars around the world. It contributes to the "shared intellectual commons" in academia, fostering cooperation and synergy across MIT and among scholars everywhere. MIT is publishing the materials for all its courses through OCW because this effort:

Advances MIT's fundamental mission

Reflects and embraces faculty values and provides an instrument for realization of faculty goals

Stimulates innovation

Counters the privatization of knowledge and champions the movement toward greater openness for the benefit of society.

MIT's OCW encourages educators and learners to take full advantage of these materials to support teaching and spread knowledge throughout the world. OCW also encourages other institutions to adopt their own open courseware programs in this same spirit, and we are happy to share information about the systems, methods, and processes we have used to implement OCW at MIT.

SECTION THREE

EMERGING TECHNOLOGY/PEDAGOGY

FOR DISTANCE AND VIRTUAL EDUCATION

The MIT Microelectronics WebLab:
An Online Microelectronics Device Characterization Laboratory

Presented by Dr. Jesus Del Alamo
Professor of Electrical Engineering
Department of Electrical Engineering and Computer Science
MIT

I would like to talk to you today about what we call the MIT Microelectronics WebLab. This is an example of what I believe is the new age for science and engineering education in which students will be able to carry out experiments in a remote fashion through the Internet. Therefore, I ask you to view this as a generalization of a particular case that I am going to describe. First of all, let me give you some basic thoughts. You all know there is enormous educational value in hands-on laboratory experiences, and that is why these experiences play such a key role in science and engineering education. You also know very well that conventional labs are extremely expensive to run and they have very complex equipment. It is unfortunately for these reasons that we simply do not have quite enough of these labs. This is something that has frustrated me as a teacher. So what I hope to be able to show you today is that all my WebLabs are real labs -- not play labs but real labs that can be accessed through the Internet. These labs are carefully maintained and capture many of the benefits of hands-on labs while effectively addressing many of the inefficiencies of those non-virtual labs.

Let me now be more concrete by talking about my own experience in the field of microelectronics, which is my field in which I teach the physics of transistors and other microelectronic devices. In my classes, I have always wanted to give students a chance to take measurements on real transistors in order to compare how they actually work in relation to how I tell them in class that they work. Making such measurements is really not a complicated task. For example, take a transistor. The way you acquire some of the current-voltage characteristics of these devices is by hooking them up to an instrument such as a semiconductor parameter analyzer. Of course, you would like to offer the students access to a tool like the one they will be using later on when they go to industry. Through this tool, they can carry out measurements of the various characteristics of the transistor.

However, something as simple as this is actually quite hard to implement in a classroom situation, particularly if you have over 100 students as we tend to have in our core subject courses. I do not need to go through the details, but you can see that there are serious scheduling issues and cost issues. These tools are rather expensive, and you will need several of them for such a large class. Furthermore, there are space issues, which is a big problem at MIT where space is at a premium. In addition, we have staffing needs to keep everything humming along as well as training needs to help students understand these complex tools. This particular tool, the semiconductor parameter analyzer, typically has a one-inch thick manual, and

therefore it is a rather daunting proposition to instruct the students in how to use it. Finally, of course, there are always some safety issues when you expose students to the actual instruments themselves.

In thinking about this problem, I realized that instruments like the semiconductor parameter analyzer in my discipline -- and I think like instruments in many disciplines -- are rarely used these days from their front panel. Over the last ten years or so, all these instruments have come to be run by a computer that typically sits next to them. So it occurred to me that it ought to be possible to transfer control of this computer through the Internet to a remote user and thus enable the students to carry out all the measurements via their computers. If something like this could be put together, then you can see how it would really address many of the shortcomings of the traditional laboratory.

Such a lab could be accessed from anywhere at any time, once it is on the Internet. A single set-up can be leveraged to many users because the Internet allows you to simply queue all the requests if you build a system properly and execute the jobs as they come in. There are many fewer requirements. You set up the system, turn the lights off, lock the door and go away. The system continues to work and is available with a lot more flexibility and with minimum care. Also, there is a minimum of training for the user because when you program the interface for students to use, you do not have to capture the entire functionality of the complex instrument, but only the part that makes educational sense. All of a sudden, a one-inch manual can become a five-page manual offering a minimum entry-level instruction for a student to start using the system.

Well, we have built this lab. We have been at it since 1998 and are now on version 5.0. I want to show you a few pictures of how it looks to convince you that this is a reality.   This is the instrument at the heart of the lab, called a semiconductor parameter analyzer. Next to it is another instrument, a switching matrix, which is what our students will use when they go to industry. It allows the student to measure eight possible transistors or other microelectronic devices that he or she might want to measure. All of this is run through a Windows 2000 server. The web portal of our system is called the MIT Microelectronics WebLab, and our motto is: "If you can not come to the lab, the lab will come to you".

 In this version of the WebLab, 5.0, we had to completely change the way to define an experiment, and we now use the circuit language of electrical engineering to do this. So what a student sees on the computer monitor is an actual transistor connected to four ports in the instrument. These ports can be programmed through simple interfaces to do whatever you want with the transistor. A typical assignment using a system like this will involve asking the students to take some measurements on transistor characteristics and to extract transistor parameters that describe transistor behavior. Then the students will be asked to compare the measurements obtained through WebLab with the models that I teach in class, commenting on the ways the two readings might fit or not fit. The students write papers in

which they try to match the measurements that they obtained through the WebLab system with the theory taught in class. The students often struggle a bit to make it all work, and as you can imagine, the student discussions are quite interesting when the model does not quite work as it should! I also ask the students to do whatever else they want with the transistor. I think for a laboratory experience to be really meaningful educationally, it should have open-ended components -- curiosity driven components enabling the student to do other things talked about in class, but not actually required. For this, the system is created with great flexibility to allow free interactions with the physical world, something essential for an effective educational experience. Finally, all these experiments can be saved. You can give them names, you can change the names, and you can upload or download them later on.

Now let me give you a brief sense of the educational experiments that we have been carrying out with this system. We have been at it since the fall of 1998, and the system has been used in several courses at MIT that my colleagues and I teach in the area of microelectronics. The classes include both graduate and undergraduates involving sometimes an excess of 100 students. The system itself sits in building 38, not far from here, and the students access it through the Internet from all over campus, from the dormitories and from some fraternities. Right now as we speak, we are carrying out an experiment with Chalmers University in Sweden, which is about six time zones away. This is our biggest distance experiment to date, one in which we have 250 students from Chalmers University accessing our system and taking measurements on a variety of microelectronic devices that we have connected to the system. For the last three years, we have also been carrying out experiments with Singapore within the context of the Singapore-MIT Alliance, which you will learn more about in this workshop. Singapore is thirteen time zones away. We have involved graduate students at the National University of Singapore, with 20 to 30 students from that university taking measurements through our WebLab. What is interesting about this experiment is that not only is the lab at MIT, but also the teacher and the teaching assistant is at MIT. Yet, despite the distance, everything works really well, and I am sure you will get to know more about it in this workshop.

To summarize, looking back over what we have accomplished with WebLab during the last four years, the scenario looks like this. We started modestly in 1998 in my graduate classes, but right away by 1999, we had jumped to accommodate a class of 100 undergraduate students, and we have been growing ever since. To date, we have accommodated as many as 800 students through WebLab. Now I want you to realize that these are paying customers. These are students doing assignments for credit that contributes to a final grade. Therefore, on our side, we had better deliver. We had better make this experience educationally meaningful because these students are not just in the WebLab system for fun to see what it is like. At present, we have ambitious plans for 2003 when we hope to accommodate over 500 students.

**Technologies and Standards for Building the Education Grid –
A Web Service Oriented Approach to Building Learning Systems**

**Presented by John Williams
Associate Professor of Civil and Environmental Engineering and
Engineering Systems,
Director, Intelligent Engineering Systems Laboratory
MIT**

I would like to talk about technologies and standards that will be necessary for building an extended educational grid so that content can be shared by institutions across the globe. We have a group at the Intelligent Engineering Systems Laboratory that is funded by Microsoft to address how one would architect such systems. Today I would like to discuss our experiences in building an online platform to support education, based on a web service-oriented approach to software that might be a first step towards a global education grid.

What Kind of Software Platforms Are Needed in Education?

Some of the people present here today are professors in Mechanical Engineering like Alex Slocum and Marty Culpepper, and they teach a number of large courses here at MIT, such as 2.007, which is a Project Based Design Course that uses a competitive setting to teach design. Outside this room at the MIT Hotel, you will see a picture of MIT Professor Woody Flowers, who started this design competition course back in the eighties, pictured together with hundreds of students clapping and applauding. The photograph well illustrates the enthusiasm that this kind of course generates. If you take this course, you will spend long hours with your peers discussing design ideas, constructing the robots and testing them. Although there are traditional lectures, most of the learning occurs in these other settings. What I would like to talk about today are the kinds of software you need to support the wide range of courses and learning events that you actually see in such university courses. Our experience in mapping out what occurs in design courses leads us to the conclusion that the platforms in use today have deficiencies and can be improved significantly. Present learning platforms are based on the assumption that a course consists of a series of very similar events. Typically there is good support for downloading content but little other workflow to support more complex processes. When we map out what actually occurs in a design course, we have found that it is not at all like that. On the contrary, there are many different kinds of activities that occur in a course, and the online workflow necessary to support these various processes are quite different.

Learning Event Model of Courses

Now I would like to turn to a discussion of our experience in systematically mapping out what we call Learning Events. Good software practices require developing scenarios (Use Cases based on the Unified Modeling Language UML) of how the software will be used. In order to understand the processes, we began making Use Case diagrams for "events" in Prof. Marty Culpepper's 2.000 course. We were surprised both by the variety of events and by the complexity of each event. As an illustrative example, I would like to include below an example of an internet learning situation, namely, the International Robot Competition held at MIT.

For thirteen years, the International Robot Competition has brought together the best and brightest engineering students from around the world. They have built robots from scratch with items ranging from windshield wiper motors to rubber bands. Today at the Massachusetts Institute of Technology, the students and their robots went head-to-head in a World Cup style format to see which robot could move the most objects in forty-five seconds. Germany, Brazil, France, Korea, Japan, the UK, and the US all had students in the contest this year. The competitors worked eight hours over the course of a week and a half, working not just on the design of their creations, but also on speaking the same language. That is because the teams were randomly mixed. According to Professor Alexander Slocum, the director of the event this year at MIT, the only common language the students shared was a tablet PC they used to design the creations. And that fits right into the mission of the competition. Professor Slocum told *Hot Wired* that the main thing the students take away from the process is how to work together with creative people from different backgrounds. He told us that this event is designed to put future leaders in touch with other future leaders.

I include a description of this because it is a good example of project-based learning. In this particular learning experience, there were weekly checkpoints through which students from around the world needed to pass. In order to get to those checkpoints, there were certain bundles of knowledge they needed to learn. The course staff acted as advisors to keep them on track. Ideally, we would like to move as much of this process online as possible. For example, we would like to have a model of the student's progress that would allow us to assess if they need extra resources and what would be the most appropriate resources to help them. I have to say that right now, we do not have a very good loop for figuring out a student's state other than by quizzes. Even then the loop is extended in time and takes up several days between when a student actually takes a quiz to having it graded and finally returning it with comments back to students.

We are striving now to develop a mass customized model of education in which we tailor the content to a student's state. In order to be able to customize the content to the individual student's needs, we require a method to assess the progress of an individual student within a course; i.e. we need to build a model of the student. At the moment, we are able to do that only by

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human intervention with instructors looking at a student's design notebooks or looking at their quiz results. However, if we could systematize this process, then based on the learning requirements of the student, we should be able to assess what resources he or she requires. We can then search our library of content and pull out the appropriate content for this individual student.

The Use Case maps provide us with the requirements of what is needed to support the learning events. Sometimes a learning event may look simple, for example a laboratory event. We have mapped out perhaps twenty of these, and in so doing, have found that there is a lot of workflow going on in the simplest event and this workflow varies widely between events. Programming customized workflow is very time consuming, and it became clear to us that we needed a Learning Platform from which customized products could be deployed, rather than a single monolithic product that tried to do everything. Based on our work with the Microsoft I-Campus Project, we realized that a Web Service based platform architecture could provide this flexibility.

Using such architecture, we designed a Portal Factory that could produce multiple Web Sites or Web Spaces from a single code base, using dynamic page building techniques. The key to building dynamic sites is to generate the HTML based on the user's profile and their particular search request. When a user requests a URL from a dynamic site, the application examines the name of the site, examines the user's credentials, and then constructs the HTML on-the-fly. So we are saying to the platform, "Build me site Number 9, Page 5," but only show the components that I am permitted to see. By this means many different portals can be built by the same code base. In fact, we can potentially build and manage the majority of the web sites across a university. At the moment, we have built a number of portals (around 30), including portals for courses, team spaces, project groups and even sports facilities management. What this means is that from this single code base, we can give the impression of there being multiple portals. For example, we can give the Sloan School their own portal and we can push down certain management capabilities to them at that level. They do not have full power, but we can push down certain paths. What this demonstrates is that we now are able to flexibly manage the majority of Web sites across the university.

We have decided to build our Web Services on Microsoft .NET. Web services are a standard now supported by IBM, Microsoft and Sun. There are good standards for GRID computing based on Web Services. There are also global XML standards called WS-Security, WS-Coordination etc. When you build as we have done on top of Web services, then these Web services can reside on different machines and therefore, the content store can be located at one or more different universities. The system does not care if the content store is sitting locally at MIT or is across the country at Stanford. All we require is a Web Service interface and a WSDL contract that specifies how to programmatically interact with the service.

The Role of Standards in Building Learning Platforms

There are several sets of standards that need to be considered in building learning systems that support the sharing of content across institutions. Once set refers to the meta-tags that describe the content and that make that content machine processable, allowing smart searching, specification of relationships between content, and the construction of dynamic views. The tags used at present are based on IMS, Dublin Core, IEEE/LOM, DAML-S and RDF. There is also a packaging standard specified by so called Sharable Courseware Object Reference Model (SCORM) that allows one machine to exchange content with another. The other set of standards not addressed by SCORM, IMS or OKI concerns the protocols used by one machine to talk to another and are based on the Simple Object Access Protocol (SOAP) and the Web Service Description Language (WSDL). These standards allow a much broader set of functionalities to be deployed than merely sending zipped files across the network.

The Web Service model of distributed programming allows one platform to make its functionality available to other machines even though they may be of different architectures and run different operating systems. Using Web Services for a learning platform could use a remote content management system as easily as its own local file store. A Service Oriented Architecture requires a different design style than traditional programming. It is very different from an API based architecture that is common today. In a Service Oriented Architecture the "contract" between machines is specified in WSDL. However, each side of the contract can "relax" or "broaden" the contract without impacting the other machine. It allows for flexible interfaces that can evolve over time. The API based approach which was the basis of COM and CORBA requires great care in maintaining interfaces. It has proved to be rather difficult to implement and scales poorly.

The technology and standards for building an international education grid are largely in place. We believe that Web services and the associated standards allow us to do this now. If Web services are exposed using the WSDL standard, then it does not matter what language you are programming in because you can arrange to send messages to that service. It can be a Linux computer or a Windows machine. Either way, you can access the Web service. I would argue that we know how to make computers to talk to each other. We know how to send messages from one computer to another. We also know how to do security and authorization across computers. The only thing we do not have in place is general agreement on the meta-tagging of content. At the moment, we do not have general agreement on this. RDF and DAML-S look promising but these are relatively young in terms of the standards process.

On-line Laboratory Brokerage System for Education and Research

Presented by Hamadou Saliah-Hassane, Professor
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Montreal, Canada

The presentation by Prof. del Alamo will help me to move faster, hopefully. I am presenting on behalf of myself and on behalf of some colleagues at the Tele-University in Quebec. I am very interested in hearing from each of you later on today. The objective of my presentation is to present our Online Laboratory System for Education and Research. This system is based both on remotely access to real laboratory devices and also on simulation.

First, let me present our institution. Tele-University is the first totally French-speaking university in Canada dedicated exclusively to distance education. Our research lab operates within the framework of this institution of technology-enabled education. We were members of the former Tele-Learning Network of Excellence in Canada. What is coming very soon to our university is another pan-Canadian project called Learning Object Repository Network (LORNET). Today and tomorrow we have the National Research Council of Canada visiting our labs to determine whether or not they can fund our proposal for such research on the Repository. Given their visit, you can see how very important it was for me to come here to this workshop even when something critical is happening in my lab!

The mission of my center at the Tele-University is to create knowledge transference models, methods, and technologies to help people and organizations in gaining knowledge and skill. This is the same overall mission established by the Tele-University at its creation in 1971. Over the years, this university has been a place of innovation where professors innovate based on their own needs. This means that professors are creating their own environments for learning and teaching instead of using already available, but sometimes expensive and non-suitable systems such as Web City or Learning Space.

Now I come to the specific mission of our research center. First of all, let me discuss my motivation for doing the work of this center. This photograph was given to me by one of my former students who is now a professor at the University of Niamey in Niger. Can you believe that 30 years after its creation, this African university is still using an old power supply, as well as an old low frequency generator and an old voltmeter to teach in the first year physics laboratories? The university is also using a very old and difficult to maintain scope acquired in 1969. This photograph shows the setting when I was there, a young university teacher responsible for the lab in 1985. Here you can see another photograph sent to me a few days ago from the University Abdou Moumouni Dioffo of Niamey. Still the same setting! It

is due to this situation that the mission of much of my research has been to compensate for the lack of real, operational laboratory equipment. As a young university professor in Africa, I used computer-based simulation teaching techniques to demonstrate some concepts thanks to UNESCO and ICTP who enabled me to attend an African Workshop held in 1876 in Sudan about the use of micro- computers in physics and mathematics education.

Over the years, thanks to Internet and computer networks, we have moved forward with distributed and modular measurement interfaces, simulated or linked to real devices. An online laboratory is a space where several people can run experiments based on real or simulated data and materials, while being totally free of geographic constraints. By using an appropriate processing framework, a dedicated management system, and a certain number of software interfaces and materials, it is possible for geographically separated users to have access to real devices at different sites. It is therefore possible to share distributed material and human resources in order to achieve an otherwise unrealisable task within a local context. An example of how an online lab operates is when, through video-conferencing and remote command at Site A, across the Internet network to the GPIB telecommunications bridge (protocol IEEE 488.2) at Site B, one is able to remotely manipulate an articulated robot arm. In this same way, it is possible to have access to an electronic circuit from Site A via the video conference station B, in this case, the real oscilloscope connected to the electronic circuit at Site B.

. A solid management system is required to set up an online laboratory. Let us take the example of an online laboratory setting where geographically separated participants are synchronously performing interactive laboratory tasks. Each team member plays a role based on a given learning scenario. A controller's user interface allows him to access a remote laboratory device. An observer can see what is going on through his own interface. In this same way, we can have measurement instrument interfaces or process control or monitoring interfaces. To design a relevant learning scenario, we have used the learning systems engineering method (MISA) and a Learning Object Modeling Tool (MOT), developed at the Research Center LICEF at Tele-University.

The system determines who will do what, when, and with whom in order to manage all the work undertaken by the online lab. Let us say that the identified roles are represented by three teams of three students who are geographically dispersed, one from the other. For example, one of the simple experiments has as its goal to have the teams distinguish the various types of assemblies of operational amplifiers. In this particular hands-on lab, Team 3 asks Team 1 to modify the incoming signal (variation in the signal amplitude and/or its type that may be sinusoidal, squared, etc.). To do so, the Team 3 utilizes communication tools (mainly chat sessions, E-mail or a synchronous multi-point video communication tool) together with a virtual instrument representing an oscilloscope, a function generator, or any other equipment. Team 1 responds to the request by utilizing the virtual instrument interface

corresponding to a signal generator to transmit the signal across the computer networks through a data acquisition adapter.

In addition, we provide the lab technician with an interface designer we have developed, a software tool that presents a canvas on which controls are dropped from a list. Instead of giving the technician real instruments, we provide him with various tools to draw, drag and drop interfaces. Therefore, the lab technician is not restricted only to preparing the real lab devices, but is also thinking of how to provide an appropriate interface for a student or the professor given that student's or professor's role during a lab session. This system of a remote, online laboratory with distributed user interfaces can also be used for environmental or medical teaching or research.

In conclusion, I want to say that our proposal for LINC is to promote a project for an online laboratory brokerage system where we have to take into account a number of functions allowing sharing equipment and human resources through computer networks. I also believe in leap-frogging. By that I mean that we do not need to reinvent the wheel, we do not need to start from scratch, because we can benefit from each other's experience and knowledge through LINC. Also I like the idea of a participatory research action to construct a learning object repository where the whole world can take part. One thing that is very, very important to me is that we must work to decrease the digital gap between developed and developing nations - if we do not want to be part of the problem. We have to thank Prof. Larson and his team for providing part of the solution through the LINC initiative. Many students in developing countries need some way to participate along with the rest of the world. Everyone around the world has the inalienable right to participate in this new technology. We do not want to divide and leave parts of the world behind. For this reason, many of my colleagues in Canada and Africa will be very happy to participate in the LINC Consortium.

An Open Sustainable Pathway for Educational Transformation

Presented by M. S. Vijay Kumar
Assistant Provost and Director of Academic Computing
MIT

First of all, welcome. It is really wonderful to see you all over here. I am going to talk to you about something very boring, something that people do not like to talk about, and that something is infrastructure. You say, "Agh! Infrastructure! No!" Infrastructure is boring. It is sluggish. It is the kind of stuff that we all think gets between us and the interesting, innovative things we do. However, infrastructure is important. Its importance was explored earlier by John Williams in his talk. This afternoon, I first want to talk about infrastructure and a few facets of infrastructure. Then I want to give you a quick overview of a significant project called the Open Knowledge Initiative (O.K.I.) that MIT is leading in collaboration with a group of institutions. Afterwards, I hope that you all will challenge the notions I present and engage me in any way that you see fit.

Why do we need to think about infrastructure? Today you have heard or will hear about many of the wonderful educational initiatives that MIT has launched. This morning, Jesus del Alamo opened up with an exciting talk on the I-Lab Initiative. You also heard about the Singapore-MIT Alliance, and at dinner tonight you will hear about Open CourseWare. A great number of wonderful initiatives have been launched from M.I.T. - small, medium-sized, and large - each one directed towards active learning, towards amplification of MIT's educational value and the extension of that value to communities beyond this campus. In all of these initiatives, there have been some very interesting corporate and international partners, helping to formulate the projects and hoping to enjoy their fruits. Every one of these projects has been driven by a strong determination to look carefully at the process of education at MIT, and exploring how technology can transform that educational process. While some of these initiatives address current problems, others take education to completely new levels.

As we began to launch these high investment projects, it became necessary to think deeply about infrastructure. Why? Because we started worrying about sustainability. We wanted to develop the kind of technical capability that would allow these initiatives to be conducted not only in the project stage, but also so they would have an afterlife and endure over time. We wanted them to continue despite variations in technology, which there are bound to be. We wanted to develop the kind of technical capability that would allow these projects to take advantage of other projects being conducted elsewhere, able to take advantage of tools that are being built in other institutions. Here we were looking for interoperability. As many of you know, it may be easy to move content to your institutions, but will that content actually work once installed? Can it operate in your infrastructure?

So here at M.I.T. we wanted to build an infrastructure with those kinds of features of sustainability that would enable state-of-the-art experimentation, along with interoperability, financial viability and an afterlife.

There are two basic premises to this work. One is the fact that the development of applications is very heterogeneous and ever-changing. There will always be many wonderful new applications that people are developing, and that is the way it is going to be. The other premise is that the technology substrate is always going to change, and that too is the way it is going to be. However, as new technologies come along, ones that you will necessarily want to take advantage of, it is important to insure that all the educational value you have built on top of these technologies is not disrupted. That could be termed educational sustainability, and the infrastructure work we are doing is also directed towards that end.

Today when I talk about infrastructure I want you to think about the most extensive sense of the term. We are not just talking about the technical substrate, but beyond the technology to the organization, etc. For example, Dick Larson created the Center for Advanced Educational Services (C.A.E.S.), a critical organization built in order to support the development of applications. - So when we discuss infrastructure, we are talking not just about the technical substrate, but about the overall organization of the institution.

Now let us turn to a discussion of the Open Knowledge Initiative (O.K.I.). It is a two-year Mellon Foundation-funded initiative led by MIT, and involving a whole host of other institutions. The goal of O.K.I. is to define a software architecture for educational applications, using a layered, component-based approach. For example, it has been created to accommodate various kinds of functionalities that learning management systems need to deliver; learning management systems such as the Blackboards, the Web C.Ts., MIT's Stellar, Stanford's Coursework, etc. When O.K.I. first started, it had the modest ambition of developing an extensible learning management system. However, as we started building it, we had to ask ourselves a central question. "Just what is a learning management system?" We concluded that it is an arbitrary constellation of tools that deliver various kinds of functionality for supporting courses- some administrative, some pedagogical. Of course, there will always be additional tools that you would want to bring into this suite of tools. So what we really want to create is an infrastructure that allows all kinds of educational tools and enables these tools to interoperate with each other. In addition, we wanted to make them integrate with the infrastructure that we have in our respective institutions.

The products of O.K.I. are all going to be open source, and as a matter of fact, much of it is already in open source. Everything is open and accessible including the definitions, the service specifications, as well as what we call reference implementations, so that people who want to adopt it have some models to work from. There is a community operating here, involving a group of institutions and individuals who are starting to build

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around O.K.I. specifications. Because of this community process, these specifications that we call the O.K.I. Interface Definitions can actually begin to move into the realm of being standards. There is a very important distinction I want to point out here because we keep referring to O.K.I. as standards. Standards, in the technology business, are always created in hindsight. You have some consensual agreement on some definitions and then you have a large degree of best practice. People build tools, and then a large group of people agrees that the tools' implementations work well in a variety of situations. After such a process, the specifications are considered to be standards. Of course, it is necessary to go through the rigmarole of proposing it to the standards groups for ratification, etc. However, O.K.I. is already on the path to becoming a standard if the marketplace bears out in terms of applications and best practices.

One of the inherent features of the O.K.I. architecture is that it is layered and there is explicit separation between the layers. At one level, it is comprised of interfaces to infrastructure services such as authentication, authorization, database access, file services, etc. Next there is a layer of educational services that we are defining, and on top of that, a layer of tools. The methodology employed by O.K.I. is to view these layers as being explicitly separate, with all the communication between layers taking place through Application Programming Interfaces (A.P.I.s). Above all, O.K.I. is largely about interface definitions. Often people will want to know which technology O.K.I. is based on. They are surprised to learn that any number of implementation technologies can be used to implement it, since O.K.I. is not about implementation but rather about definition. Right now at MIT, a lot of our reference implementation is through Java, but that does not have to be the case.

So just what do we mean when we talk about the "layered approach" of O.K.I.? For a moment, let us consider an application that your enterprise might have, for example a learning management system. If you were to look at it, you would see that a lot of stuff is baked into it, including all the services that I talked about - content management services, authentication services, assessment services, authorization services, etc. O.K.I. essentially looked at these many services, and said, "You know, there are a whole bunch of these common services that applications don't need to have baked in, on a case-by-case basis. Let us pull them out, codify them, describe them, and then suggest ways in which applications can invoke those services." The result of this process is that the learning management system application actually shrinks in size. Another feature of the O.K.I. approach is that applications left in one place can be ported to another place. The two "places" could even be two different points in time at the same place. For example, an application could be ported at a later date when there are different technologies because all you have to do is change what you write to those interfaces. That essentially is the O.K.I. approach -- pulling out these common services, codifying them, and then defining these A.P.I.s to which applications can write. I should also mention briefly here another interesting

feature of O.K.I. Its services are agnostic as to whether it is a web-based interface or a desktop interface. It can accommodate a whole host of applications that just require desktop client, for example, laboratory experiments. We are packaging a number of these services together, called "O.K.I. in a Box."

Already with O.K.I., we have had many implementations, and there is a wide array of application activities actually underway. The community vision is slowly being realized and some of our partners participating in this effort include Stanford University, Dartmouth College, North Carolina State University, University of Michigan, University of Pennsylvania, University of Wisconsin-Madison, University of Cambridge and Indiana University. These are just the co-partners who are helping with their influence in the design and development. In addition, there are many other people who are actually doing application development around this initiative. Our latest partner is Indiana University. Indiana's statewide system has decided to do enterprise application development entirely on O.K.I. services. As we expand even further, the question becomes how to help institutions that want to adopt O.K.I.? Adoption is not just a matter of technology. There are a number of issues regarding technical support. Also, what is the overall strategy for maintaining and supporting the open source product? So these are the many complex but exciting issues that we are facing right now as we move into further implementation of O.K.I.

SECTION FOUR

GLOBAL COMMUNITIES OF LEARNING

The Structure of Learning Communities for
Distance and Technology-Enabled Education

Presented by Dr. William J. Mitchell
Professor of Architecture and Media Arts and Sciences,
Academic Head of Media Arts and Sciences, and
Dean of the School of Architecture and Planning at MIT

Let me first welcome you here, adding my welcome to that of Chuck Vest. Also, in the few minutes I have, let me take the opportunity to introduce one point I think will be useful as a starting off place for some of the discussions that will go on here today. It is a simple point, but I think a fundamentally important one and one well worth keeping in mind. I suppose it comes from my bias as an architect and an urban designer. When I think of education, I tend to think of learning communities. How can you create and sustain learning communities on different sorts of scales, and what technologies can you use, what kinds of design strategies can you use to support such learning communities?

Let me give you a small-scale, but fairly typical, example of a traditional learning community. I dug out from my archives at the School of Architecture and Planning this photograph of the MIT design studios sometime in the 1950's. You can tell it is the 1950's from the way the students are dressed. You do not see too many of them in jackets and ties these days in the studio! How does this work as a community? Well, it is a physical space, first, where the activities of the community are intensively aggregated. Everybody comes here together in order to conduct business. Second, it contains individual work places. So in the case of this design studio, it contains drawing boards and drafting instruments and materials, such as pencils and paper, that you can use to explore design ideas. Yet here there are not only places to get your work done. The space also contains reference materials of various kinds, including drawings pinned on the walls, filing cabinets of resources, and previously designed projects lying around.

The material needed to sustain the discourse of this community is readily available in the surrounding environment. The final thing to look at is the kind of interaction taking place here. It is not just the production of work or the transfer of information, but fundamentally what is going on here is discussion over the work, discussion structured around the work. There is a drawing, a design proposition, laid out on the table among the participants and the teacher. In this case, it is the great architect, Louis Kahn, who was a design critic at that time. He is picking up the pencil, passing the pencil back and forth to the students, working through a problem directly, face-to-face with the students across the drawing boards. Of course, this is an immensely effective form of education. With this form, you are able to structure a community that encourages learning by doing, a community that structures dialogue, critical discussion, and exploration of ideas.

Now I want to show you a picture of exactly the same design studio taken just a few weeks ago. Many of the same sorts of activities are going on in this more recent photograph. It is still a small-scale learning community and it still contains many of the same sorts of capabilities that we saw in the earlier version. However, today these capabilities are being supported in different ways. You can see a traditional drawing board there, but you can also see laptop computers. In fact, the actual design work is being done, not by drawing by hand, but by working on these laptop computers. If you look closely, you can see that these devices are wirelessly networked. Such technology breaks down the walls of the studio because the dialogue taking place is not just among the people who are physically present, but instead is a much broader kind of interaction. Another change you can see here -- well you can not really see it -- is that the reference material consists not only of the physical reference materials arrayed around the students' desks, but also of material coming in electronically through the laptop computers.

In this recent picture, you can observe still another new aspect of the studio as it exists today. There is a design presentation and discussion going on. One of the critics happens to be a remote critic, the guy on the television monitor there.   He is participating in the discussion, in the same sort of role that Louie Kahn played in the face-to-face discussion mode of the earlier version. However, here the critic is doing it remotely. This has certain advantages. If you do not like what a critic is saying, you can just switch him off, which is not very difficult as I have discovered many times in the more traditional kind of mode. Let me mention a final activity that is taking place in this modern studio, although you cannot see it from the photographs. Today any support material for the design work is mostly provided through the Web. Tens of thousands of images are delivered directly and wirelessly into the studio from an image archive. In addition, cooperative work that is done with geographically distributed partners is also distributed in that web-based fashion.

 So what we have in fact is a mixed environment, and what I would like to suggest to you is that in fact there is no real distinction these days between what we often call distance education and what we think of as more traditional forms of education. Today we have reached a situation where learning communities are supported in general by a mix of capabilities that are partially traditional and partially electronic. Now let me quickly summarize these concepts by laying out for you this simple table. Along one axis, I drew a distinction between local and remote interaction, with remote interaction being supported by telecommunication capabilities. Along the other access, I drew a distinction between synchronous and asynchronous interaction, with synchronous referring to face-to-face interaction, while asynchronous involves the introduction of some sort of storage technology. With this table, you can array the sorts of possibilities available now by looking at various different combinations. The traditional design studio fits in the upper left corner, the corner of local synchronous, face-to-face interaction. The technology that supports this is traditional architectural technology, like that of the ancient Greek agora. It is the technology of the

seminar room, the technology of the lecture room. If you introduce remote interaction, remote synchronous interaction, then you get the possibilities of video conferencing and wireless simultaneous connection. When I was a young child in the outback of Australia, one of the modes of education was the school of the air that was supported by short wave radio transmissions from places like Alice Springs. The kids came together in a virtual classroom, but their presence had to be coordinated with everyone else at the same 8 AM starting time, just like the 8 o'clock morning starting time here.

Now if we move across to the other axis, with the introduction of storage technology, there is the possibility of transferring information by inscription. For example, my wife leaves little yellow stickers on the refrigerator door, and when I come to that particular location, I discover instructions that I need to follow, like walking the dog or picking up some groceries. On a much larger scale, the Ancient Library of Alexandria was the same kind of thing, a repository of inscriptions that structured the learning community, a particular location you needed to visit in order to gain access to that information. If you put all of these things together, you get the sorts of capabilities that have emerged over the last several decades - the possibility of remote, asynchronous interaction involving both telecommunications and storage technology, a learning community in which we get packet switching, the Internet, the Worldwide Web, web logs and so on.

What I would like to suggest to you is that these sorts of capabilities do not simply substitute for each other. They each have different cost structures and they each have different advantages and different disadvantages. Today in our daily lives, we continually make decisions, we continually make choices among these various modes of interaction. We use all of these modes of interaction to support and engage in the communities that are parts of our lives. I would like to suggest to you that it is the same now with learning communities. The task that faces us in general - whether we are designing a university campus, dealing with a distributed community, working in the developed world, or working in the developing world - is to find the right kind of mix of these capabilities. What we need to find is the mix that makes sense within a particular context to serve our stated educational goals.

The Digital Nations Consortium

Presented by Dr. Alex "Sandy" Pentland
Toshiba Professor of Media Arts and Sciences
M.I.T.

The Digital Nations Consortium is intended to connect with universities in countries around the world to demonstrate how new technology can change education, can change healthcare, and can change other sorts of problems or concerns that a developing country might have. The Media Lab has a hands-on approach very much like that of architecture or medicine, where a lot of what we do is not in classrooms but rather in creative workshops. Typically, therefore, what we do is not distance education. We believe more in having hands-on workshops with face-to-face work, augmented by asynchronous interaction, with occasional video conferencing and synchronous distance learning. So it is much more of a heterogeneous interaction that we are trying to create, with the core being face-to-face connections.

Digital Nations, and more recently some newer programs, for instance, Media Lab Asia which I set up last year, are based around a number of ideas. One of these ideas is the notion of face-to-face interaction enabling distance connections, and so we have established this type of relationship in more than a dozen countries involved in the consortium. Typically the relationship is with a university and with a not-for-profit public/private organization set up within the country. As a result, we have some dozens of graduate students within the Media Lab that have come to MIT through these connections with developing nations. And, in fact, we actually teach some courses in those countries (and in the process burn up a lot of jet fuel). For instance, I have a course that I co-teach called Global Entrepreneurship Lab where we take 125 graduate students, and we send them to every corner of the world over January semester break. In the last year, due to the Media Lab Asia project, I have had more than 40 students in India and about half that number from India at MIT. This reciprocity is the basis for our longer-term relationships.

A second grounding idea of Digital Nations is that this is an effort to recognize the unique resources of each of these countries and to try to capitalize on those resources by building relationships where the flow of people, ideas and connections is much more bi-directional than unidirectional. The goal here, of course, is to build local expertise. For example, last year I took my whole family to India to set up a series of laboratories. These laboratories are now at five of the Indian Institutes of Technology, and have more than 200 students involved with them. Many of those students have come to MIT over the summer, and many of our students have gone there. I believe the relationship is beginning to work in a number of ways. We have had several of those students win international prizes. Also, we are beginning to see many of them building relationships with MIT. Some do come to MIT as students, but through the Digital Nations program they also maintain connections back in their home country and actually,

many of them have gone and started businesses back home, which I think is particularly good.   Now I will mention another twist to this, which I think is different than LINC as a whole. The best way for our country, of course, to increase the GDP is to invest in innovation. In some sense, this is the idea that universities are founded on. However, if you look at the research done at most universities - and in fact, people have done surveys of this - something like 98% of the papers published or the projects done principally address the problems of places like New York City and Seattle. Consequently, if you look, for example, at the research budget in India, what is happening is that they are investing to profit the U.S, and not to profit India. The same is true of Costa Rica and the same is true of Brazil.

It is obviously a silly situation so our goal is to try to determine what sort of research opportunities there are that could address the problems of the developing countries more directly. For example, look at technology like cell phones. Cell phones are little wireless Internet computers, and in merging them with PDA's, this whole notion of computation on the fly through the Internet is moving to this ubiquitous technology. Where is the market for these? I will tell you that it is not in the developed world. It is in the developing world. More cell phones are sold in places like China and India than are sold in the U.S., Europe or Japan. The question now is who is going to be designing the next generation of cell phones, given that the market is in developing countries?   The hope is that places like India and China will take the lead in defining what technologies will best benefit their markets.   By building up local technological capacity, we hope to capitalize on such changes in access to technology in order to create changes in markets and changes in the way business is done.

Let me tell you a few specifics about some of our research programs. I will draw mostly from the program that I set up in India because it is easy for me to talk about, but the same is roughly true of the programs that we have in many of the Latin American countries. Our technology program is organized into three overlapping areas. The first research area concerns the **tools** that you use: how the computers and interfaces should look in order to serve illiterate people, in order to serve people in other languages, in order to serve people virtually anywhere. Of course, this involves issues like how do you power the tools. The second research area is about **connections.** Many of the opportunities presented by digital technology depend on first connecting people, and as we all know, this can be pretty expensive. So how do you actually connect lots of these people inexpensively? The third research area has to do with **measurement**. We are focused particularly on measurement in rural areas, such as water quality measurements, environmental measurements, health measurements, and things of that sort. Finally, there has to be something in the center of this technology pyramid, and I call it **digital village**. That is where we are primarily focused because that determines how the three bases of the pyramid come together within the local context. How do you empower people locally to design their own solutions? What solutions do they design for their culture, for their language, for their problems? So there you have it, the three parts of the pyramid and its peak.

In the research arena of **connection**, we have done a number of interesting things, so let me give you a sampling of the research we have undertaken. We have been looking for some time at the wireless LAN connections such as those that are here in this room. It turns out that if you put this same wireless LAN in a rural area, it can extend for many kilometers, so one of the first things we did was to put wireless throughout a large village area in the Dominican Republic. This can be done for an extraordinarily low price: because of the consumer market in this country, the hardware is very cheap. That means that in the Dominican Republic, schools, local governments and local businesses can all have broadband connectivity for very low prices. We have used this same approach in the Uttar Pradesh state in central India, where a hundred-kilometer area of some of the most rural parts of India now has broadband service. As a matter of fact, on Christmas day, I had the Secretary of the Indian Information Ministry call me from a place that you cannot get to without a four-wheel drive Jeep. He was using an IP telephone to place a VoIP call, which is pretty amazing. This sort of research has some really interesting potential, and I think that this is going to end up being an export market for India.

We have also developed some other things that I think are enormously clever and surprisingly functional. For instance, even the examples above are too expensive for most developing countries, so we had to come up with something else. How could we get the Internet into schools for the price of pocket change? The obvious answer that nobody else had ever thought about is the fact that almost everywhere there is some vehicle that goes by once a day or perhaps several times a day. One just has to put the little LAN transmitter on the vehicle so that as it goes by the school, it drops off bits and picks up other bits. In this way, you can get a couple hundred megabytes up and down as the bus goes by. Certainly, having a couple hundred megabytes up and down once or twice a day is a lot better than having nothing. In fact, this kind of connectivity is a lot better than I have when I am traveling. If I am lucky, I might get 56 kilobits in my hotel room. However, the best part of this traveling vehicle idea is the fact that the physical transport infrastructure is already in place, and the cost of the wireless is quite low. Therefore, the cost to deliver this asynchronous broadband connectivity is extraordinarily low. We are trying this in Cambodia and Jordan, as well as in India. We have a number of schools in both countries where we are delivering content asynchronously, using some software developed at MIT's Laboratory of Computer Science.

In the research area of **measurement**, there are also some interesting developments. The one I want to mention involves PDAs -- those little handheld computers. With those you can do quite a lot in healthcare, building little healthcare systems that increase the effectiveness of rural health workers. There are many things that are difficult about rural healthcare, and these difficulties are arguably the major impediments to GDP growth and quality of life in developing countries. We found that we could build a little expert system into the PDA and give it to rural healthcare workers, who incidentally could learn to use it in about four hours and then

go off to train other healthcare workers. These are people who do not have a high school education and do not necessarily speak English very well at all. With this project, we were able to get order of magnitude reductions in costs and an increase in accuracy for rural healthcare services.

The third area I would like to talk about is the area of **tools** and a project I call World Computer. Unfortunately, this topic is a little frustrating to me because we are not doing what I think we ought to do in this area. However, I do want to open up people's minds. What we are looking at for Digital Nations is something that actually exists in stores around here and also in your countries. I am referring to these sophisticated computer-like devices that are usually sold as toys for rich pre-teen children.   These minicomputers are extraordinarily cheap, and although they are not PCs, they are multimedia.   Some of them come with Internet connections and have prices around $50.00. I gave my child one that has 104 educational applications in five different languages for $60.00. It runs on AA batteries. With this device, you do not need to worry about the power because you can simply charge it up once every week or so. Now universities probably can afford a little more money than this, but there are many places that cannot. I would love to see people taking advantage of the things that have already been built, putting more interesting software in them in place of the American teen educational software. It would be interesting to see what we can do with this sort of technology.

The final research area I would like to talk about is the **digital village**. Digital village is how I think all these pieces come together. We have a variety of projects in this area. For instance, there is a center I set up last year south of New Delhi called the Batchitt Center. You can go take a look at it on the Web. It looks at how various sorts of internet tools -- collaboration, video conferencing and so forth -- can work within a village context. What we actually did is give people little, low cost video tools and the children went off and made movies. These movies have actually been shown on local TV, and the kids have used the cameras to make advertisements for local companies and in a variety of other ways. I think it is quite interesting.

Several years ago, I worked with Jose Maria Figueres, former President of Costa Rica and current head of the World Economic Forum, to put together something called LINCOS, which is intended to be a digital community center. LINCOS won an Alcatel award last year. This project developed out of the same sort of idea: how do you take these digital services and bring them to rural areas? The Computer Clubhouse is another project being done by Mitch Resnick and other folks over at the computer museum. They have been building computer clubhouses all around the world and recently won the Drucker award as the best not-for-profit organization. The idea here is how do you allow kids to explore the potential of digital media outside of a typical school context. Indeed, you find some rather amazing things when you give people the ability to explore rather than putting them in a fixed educational curriculum.

Distance Learning on a Global Scale:
The Global Development Learning Network

Presented by Dr. John Middleton
Operations Director
The World Bank Institute

Well, there have been several lead-ins during the last few minutes for the few things I want to say to you about adult professional and continuing education situations and the potential of various distance-learning systems to support them. Before beginning, however, let me explain that I work at a place called the World Bank Institute. We will have our 60th anniversary in a couple of years, and during those many years, we have provided adult continuing education to professionals in developing countries covering all aspects of development policy and practice. In the mid-1990s, we decided that our "airplane education technology" needed to change and that we needed to look into some alternative approaches to foster professional learning in a more cost-effective way. The scale of our operations encompasses roughly 20,000 to 30,000 people a year who are involved in our learning programs. This number has been rising quite significantly since we began employing various distance learning approaches. Today I would like to share with you a few elements of our story focusing on four specific areas: 1) what we are trying to do; 2) what has worked best, in terms of technology, for the kinds of teaching we are expected to do; 3) what is the distance-learning system that enables the pedagogy; and 4) what are the two or three very preliminary lessons we have learned that might be relevant for LINC.

So starting out, what is it that we do? In many ways, it is very simple. The record of international development is quite mixed, and we know with certainty that the answer is not money alone, nor is it infrastructure alone. Rather, it is the capacity of individuals and organizations to do good work. This is the very simple conceptual framework that we work within. If, for example, we are going to improve capacity in a rural school system or in an urban university, learning is very much a part of that process. Learning in a capacity-building situation needs to be spread out over time and needs to be done in teams because most development work is not done by individuals. Such learning needs to be applied to daily work and should be outcome based. To achieve our objective of capacity -building, it is crucial to develop communities of practice that will make this learning process an ongoing feature of the work of professionals. We do accomplish this in actuality. The Global Development Learning Network that the World Bank supports implements this pedagogical model through a variety of media, including video-conferencing, face-to-face learning, self-study, Internet, and paper. We work with anywhere from two to eight country sites simultaneously. Out of 50 distance-learning centers, we have found that we can work with as many as eight teams in eight countries

working on common problems. However, eight is stretching it a bit, and we find four much more comfortable to work with.

One of the interesting aspects of the Global Development Learning Network is that we do not own any of the distance-learning centers. These centers are all locally owned by education and training institutions. Centers are associated with the Network to the extent that they get useful content through us, along with the opportunity to market their own content on the network. Through these centers, we employ a pedagogical approach that achieves our objectives by providing a moderate to high level of interactivity. For example, countries in Southern Africa worked together for 12 weeks on various legislative policies against corruption. Uganda works with the Tanzanians and the Kenyans sharing experiences over the Web, video-conferencing with each other, calling in expertise from around the network to advise them on specific issues, outcomes, documents, legislative changes, failures and successes. As you can see, the learning process is rich and tends to continue way beyond the period of time that we are involved. This is an example of a transnational learning community leading to a community of practice.

So how is the Global Development Learning Network set up? We started off to be fully satellite based, but that turned out to be costly, impractical, and slow. So now we operate in a number of different ways. We continue to have the satellite network, which grows steadily. Where there is fiber, we go fiber. Where there is no fiber, but there is ISDN connectivity, we go that way with some caution about the quality and reliability of service delivery over public networks. We are also working increasingly with national research networks. For example, China's CERNET, the Chinese Educational Research Network, is a broadband fiber optic network connecting the whole country. Using our technological and pedagogical approach, the Chinese government is building 17 centers, which because they are on CERNET can connect globally to any of the other sites in the world.

Now to sum it all up, what does our Global Learning Network system consist of? There are distance-learning centers, independent country-owned institutions and program partners mostly in Europe, Canada, and Australia that use the network because of its favorable costs and because it matches the kinds of objectives they have. The network also consists of donor agencies that provide both intellectual and financial support and, of course, the learners and the learning activities that are at the heart of the network. However, if you add up all of our partnerships, you find some 80 affiliated centers of various levels of technological capacity, but all capable of broadband Internet and some level of video-conferencing. All these centers are in institutions that are respected by anyone's standards, and they are providing non-degree, continuing education with content increasingly flowing around the network and not from one single source.

In conclusion, let me review some of the lessons we have learned that might be useful to LINC. Today we have talked quite a bit about learners. Our learners are very difficult to motivate in many ways because we are asking them to do difficult things in new ways. That is the nature of the change process. In addition, our learners do not benefit personally from learning in such areas as

how to do trade policy better, for example. So the possibility of financing a network like this through payments of individual learners simply does not work. Our context is quite different from a university setting, in which people pay for certification that has a market value within their countries. This lack of motivation through personal benefit is something we struggle with constantly. Furthermore, our network has to enable people to adapt knowledge, since there is no correct way to do economic development. It is not like, as we saw earlier today, testing a transistor in which a lab model can work anywhere because transistors are transistors. Economic policy is not the same everywhere. And here we find that the synchronous video-conferencing, through which teams across country lines argue with each other, is central to the process of adaptation. Afterwards, participants can all walk away saying, "I don't care how they do it. I understand how they do it. It just doesn't work for us." So this is another lesson that we are learning about our learners, but what does it mean for LINC? Although it may not be applicable for university students, it may be applicable to learning situations in which this kind of problem solving and teamwork is a primary educational objective. Finally, and this is really directed at LINC, we have learned important lessons about the new partnership arrangements coming out of this new world that we are all in, arrangements in which partners come together for mutual advantage, but not on a business model. We are finding these new partnerships very difficult to manage, requiring huge investments of time, energy, and affection.

*"The view expressed herein are those of the author and do not necessarily reflect the opinions or policies of the World Bank or any of its affiliated organizations."

The Internet of Antiquity: A Shared Collaborative Web-based Teaching and Research Environment Focused on the Silk Road

Presented by Peter C. Perdue
Department of History at MIT

We begin our story in 1991, far away from the Silk Road when German hikers found a dead man on a glacier high in the Alps. It turned out that this particular man was five thousand years old, and his body is preserved today in the museum in Bolzano in northern Italy. The body has been carefully investigated, and what we know about him is that he was a traveler. He had a travel kit with him including medicines, a cloak, and a hat. Also, he had an arrowhead embedded in his back, probably indicating how he died. So this man's body draws together all of the themes that we can follow throughout history - violence, travel, trade, medicine, and cultural movements.

Now if we move several thousand miles to the east, there is a mummy who comes from the Tarin Basin in western China, discovered there in the desert about four thousand years ago. Actually, there are quite a lot of these mummies, and scientific analysis indicates that they came from the West. They all tend to be tall, with light hair, blue eyes, and large noses. Analysis of the grain they carried, their clothing and their DNA points to the fact that they had traveled from the west. However, the question remains just how far west? That we do not know. Nor do we know what language they spoke or what exact culture they represent. Yet we are certain that they traveled a very long distance. For example, one thing we do know is that the textile weaving patterns clothing these mummies are the same as patterns found in Celtic tombs in Europe. From this we learn that there is an Irish connection. So ever since the distant past, long before written history, we know that human beings have been traveling long distances and carrying all their cultural baggage along with them.

The Silk Road, as you probably know, begins in China on the Chinese coast where silk is made from silkworms. It moves out from Gansu in northwest China, into central Asia, and around the deserts, traveling through the oases to the Caspian Sea, the Black Sea, the Mediterranean Sea, and the Middle East. This technology of making silk was a Chinese monopoly for a long, long time. No one in the West really knew how silk was made, believing as they did that it grew on trees. The story goes that a Buddhist monk revealed this secret to the rest of the world by carrying cocoons in a bamboo stick that was disguised as his walking staff. Here we have the only intellectual property rights issue involved with the Silk Road! The Chinese, of course, sold silk to nomads for horses, and then from there the product went all the way to the Roman Empire in return for trade, silver, gold and other products. In looking at these types of contacts, there are at least four things to take into

consideration: 1) coercion - military conquests and political domination; 2) commerce - the exchange of goods and ideas; 3) communities - the different social groups involved; and 4) the communication technologies, whether through migration, language, arts, etc.

One example of this movement is Buddhism that came out of India and was brought through central Asia to nomads who eventually conquered northern China and built huge caves carved out of solid rock in fifth century northern China. There are many of these sculptures all along the track that Buddhism followed, including, of course, Bamiyan from this same period, built by the same type of Buddhist believers. Unfortunately, Afghanistan's Taliban destroyed these cult sculptures in order to obliterate any evidence that there had been an earlier, long term mixing of religions and cultures.

Now we move ahead several centuries to the Mongol conquests. We will have this dialectic of conquests and contact again and again. The Mongols, of course, created tremendous destruction, but they also unified the entire continent and made it possible for the silk routes to allow constant interchange back and forth. We know that Marco Polo was not the only traveler who went on these routes because there were also Chinese going the other way, and we have records of a Chinese man who traveled to Europe at the same time as Polo.. Some would argue that, in fact, we had a thirteenth century world system that united this whole vast area of Asia, Europe and the Middle East through a complex set of overlapping trade zones.

After the Mongol empire collapsed in the fourteenth century, we still have evidence that things were being transmitted. For example, plagues. The plague, bacillus, probably appeared first in China and then in Europe. Another possibility is that it appeared first in the Middle East, traveled through the Maritime and overland routes, and then hit southern Europe, France, and eventually all of Europe. At least twenty-five percent of the European population died because of it. In reaction to this devastation, of course, Europe and Asia developed measures like quarantine, so we can even say that there was at least a silver lining to this black cloud. Public health measures began in Europe and around the world at this same time. Today we are well aware that globalization does not have beneficial effects all the time. Anti-bacillus or antiviral techniques are necessary, but not always successful.

There are many ways in which the Silk Road continues to impact our modern world. For example, there is a mosque of the Sufi Saint, Abakh Hoja. in Khasgar that shows that there are Muslims in western China today. As a matter of fact, one of China's greatest economic development projects is to try to raise the economic level of this region where Muslims live. However, in doing this, they have decided to bring in large numbers of Hun Chinese migrants, and the question remains how well these Chinese migrants will get along with the native Turkic and Muslim population. A lot of China's future depends on how that interaction plays out.

To study the Silk Road, collaboration is necessary. There are so many languages and cultures involved that no single person can master them all. International collaboration is absolutely essential. I believe that the best way to move ahead involves onsite testimony of people delivering their own cultural objects and putting them up for others to discuss collaboratively. The virtual experience of seeing landscapes, seeing art, seeing technical accomplishments, etc. within their local context brings the whole process alive. New techniques of presentation like the internet and the Web, combined with interaction over the Web, can create a genuine international dialogue about this topic. In the end, we must realize that the past is in the present whether we are talking about our military, economic, religious, or aesthetic legacies.

Hands-On Learning in a Global Laboratory:
The MIT International Science and Technology Initiatives

Presented by Suzanne Berger, Director
MIT International Science and Technology Initiatives (MISTI)
Raphael Dorman and Helen Starbuck Professor of Political Science
MIT

The MIT International Science and Technology Initiatives, better known as MISTI are a set of MIT international programs designed to enable students and faculty to collaborate with colleagues in laboratories and companies around the world. The first of the MISTI program, the MIT-Japan Program was created in 1983 by Professor Richard Samuels. He realized that even though there were hundreds of Japanese students capable of studying at MIT as post-docs or graduate students in a variety of disciplines, there were no students or faculty members who had the capability to go into a Japanese lab, participate in the work of the laboratory, and come to a real understanding of what knowledge creation in a Japanese scientific team would be like. That led to the first of our MISTI programs. The moral contract with the students was and still is: if the students will commit themselves to learning at least two years of a foreign language and taking a number of courses on history, culture, and preparation for working in a foreign country, then we at MIT will commit ourselves to finding an internship opportunity for three months to a year in a leading foreign laboratory or company. The goal is to match the student up with a research team whose interests are the same as those of the student. In this way, students enter into networks of international colleagues that will continue to develop throughout their professional lives and connect them to knowledge creation outside of the United States.

At MIT, we recognized that one of the weaknesses of the United States, and a weakness of an MIT education, was the fact that we were so self-centered. We were so convinced that the only things you needed to know, the only things being created that were really important in the world, were being created not only in the United States, but most likely at MIT. As a result of this narrow thinking, MIT faculty would say, why should my students go to a laboratory in Japan? Why should they go to Sony? Why should they go to Mitsubishi? People thought that students would get the best possible experience and training by staying in the MIT labs. The MISTI program represents a recognition by MIT that the centers of knowledge creation are going to exist in different locations around the world. For example, a country like China, still is regarded by many Americans simply as a market for American products, is rapidly becoming a leading center of innovation and new ideas in science, technology, and management. Therefore, unless we are able to learn not only in China, but also in Japan, Germany, India, Italy, France, and Singapore, -- unless we are able to learn in societies like these -- we are going to be missing out on many of the most exciting developments in the world over the next decades.

MISTI is a program which in its early years was designed to help our own students and faculty, and through them the American society, learn how to access innovation taking place outside the United States. We believe that leadership in science and technology will increasingly require a broad range of cross-cultural knowledge, including how problems are defined and how people work in teams to define and solve problems in laboratories around the world. Too accomplish this, we needed to develop more courses in language, history, and culture here at MIT, and to look for the best hands-on internship opportunities in laboratories and companies abroad for MISTI students. At the same time, we also tried to develop opportunities for the MIT faculty to participate in international research collaborations. To this end, MISTI seeded small workshops in order to allow MIT faculty to familiarize themselves with activities going on in laboratories outside the United States.

In addition to the Japan Program, we began a program with China in 1995, with Germany in 1997, with India in 1998, with Italy in 1999, with France in 2000, and with Singapore in 2002. We have developed partnerships in each of these countries, and when I refer to partners here I mean companies or laboratories that have been willing over time to accept our students. Examples of our partners in Japan include Mitsubishi Heavy Industries, NTTDoCoMo, and Sony. In China, we have partnered with IBM, Beijing University and Tsinghua University, among others. Examples of partners in Germany include Bayer, B.M.W., Infineon, Daimler-Benz, and VW, Bosch, while in France there is Air Liquide, INRIA, Renault and many others.

By the academic year 2001/2002, we had about 170 students a year participating in a foreign internship, with many more times that number of students in the pipeline training to go. This is the largest international program at MIT. Few MIT students do Junior Year Abroad programs. A new exchange program with the University of Cambridge in England involves fifty students from each university, but still we are looking here at small numbers when you consider the total MIT population of 10,000. We believe that it is vital to the education of our students to broaden their opportunities for participating in these international programs.

The home departments of the MISTI students are a reflection of the MIT population. Sixty-eight percent of the participating students are from the School of Engineering, with about sixteen percent from the School of Science. The remaining participants are distributed throughout the rest of MIT. A MISTI internship has come to be viewed by many of our students as a basic part of the MIT educational experience. We assure the students that if they are accepted for this program, regardless of their family's financial capabilities, that we can provide the necessary funding. We have received very generous support from foundations, private donors, and corporations that allows us to make such a commitment to the students. Above all, we have received support and endowment from foundations, like the Starr Foundation, the Freeman Foundation, and NSF.

Up to this point, we have been interested in using MISTI as a program for improving the education of MIT students. However, there have always been students participating in MISTI who have wanted to develop relationships in

foreign societies that would allow them to share some of what they have gained from an MIT education and to use MISTI as a way of contributing to development and education abroad. Six years ago, a determined group of students came up with a plan for working in Chinese high schools on IT projects. The CETI (Chinese Educational Technology Initiative) project in MISTI involved teams of MIT students, three students in a team, with at least one or two able to speak Chinese well and at least one or two really good at hooking up Internet connections. At this point, we have eleven teams of MIT students every summer going and working in Chinese high schools.

This is an experience on which we want to build in the future, as we ask ourselves how we can combine the opportunities and learning developed through MISTI with possibilities for online distance learning. We have new ideas about forms of collaboration with the Open Course Ware Initiative. Our plan is to try to develop teams of MISTI students who would go to foreign sites and work as teaching assistants with faculty in foreign universities to help the faculty adapt the materials that MIT Open Course Ware is putting online. The aim would be to have these students work to adapt the MIT materials to the needs, interests, and curricular directions of the faculty in a foreign university. We would like to start with two sites: one in Africa, where we have no MISTI programs at this point and a second one in China, where we are already sending about 45 students a year. The first MISTI-OCW team will go to Xinghai University in western China in the summer of 2004 to work with Xinghai faculty and students.

The MISTI-OCW teams will include students who have already taken the courses and are able to work as teaching assistants. These teams of MIT students would work with the faculty at MIT who have developed the OCW courses, and they would also work with the foreign faculty to determine how the materials might be made appropriate for our foreign partner universities. We are still working on trying to understand what kind of relationships we can build with the host institutions in those countries. What would they desire? What kind of relationship with MIT could we build? What kind of contribution could the students involved in these teams make not only to the host institutions, but also to evaluating the use of Open Course Ware at various sites? How could the students help with an evaluation process that would enable MIT, and enable the Open Courseware Initiative, to learn more about the kinds of extensions that would make it more genuinely useful, not only in institutions like Stanford, Berkeley, and Cal Tech, but in institutions around the world?

We are moving MISTI in a new direction. We hope that this initiative will be one of use to people outside our own country. We know that the real sponsors of the program will have to be the local host institutions and that our mutual learning will depend on their initiative and commitment. We are very eager to try. We would value any ideas or suggestions that you may have for us. We are at the beginning of a new venture in international learning at MIT and we need and would gratefully welcome your comments and ideas.

The Global Innovators' Network

Presented by Winthrop Carty
Associate Director for the Global Innovator's Network
The Ash Institute for Democratic Governance and Innovation[1]
Harvard University's John F. Kennedy School of Government

I am Associate Director of the Ash Institute for Democratic Governance and Innovation at the Kennedy School of Government. The Kennedy School is the graduate school at Harvard University that trains people for careers in public policy and government. The Institute where I work is actually an outgrowth of a program that has been in existence at the Kennedy School since 1985 -- the Innovations in American Government Awards Program. That program seeks, through a competitive process, to identify and award the most innovative practices and programs in government around the U.S. Each year we hold a competition and announce a series of winners of this award, a highly prestigious accolade within government circles. Over the fifteen years of sponsoring this program, we have built up a large body of awardees, and through interactions with these many innovators, we have gained a deep understanding of the innovative process, what innovation in the public sector means.

In addition to running the awards program, we also have a research arm that writes up case studies, a number of which have been used at the Kennedy School to teach about some of our award-winning programs. Members of our research arm also have developed substantial theoretical and management literature about innovation in the public sector. Beginning about ten years ago, the Ford Foundation, which started our Institute and continues to fund it, decided to replicate this awards model in a number of other countries. We now have eight partner programs throughout the world that have adopted the Kennedy School model of awards and have replicated it. These programs are located in Brazil, Chile, China, Mexico, Philippines, Peru, South Africa, and a second U.S.-based program for Native American Tribes. More recently, we have begun to work very closely with our eight partners in trying to find ways to leverage this global body of knowledge and this growing network of innovative government programs from around the world.

Some of the things we have learned with respect to public sector innovations is that they involve a shift from the needs of the government administrator, the bureaucrat, the policy maker, to the needs of end users of government programs and policies, namely the citizens. For example, in Brazil there was a voting process called Participatory Budgeting that was started in Porto Alegre in southern Brazil and was an award winner of the Brazilian program. This project found a way to enable citizens to come together and vote on allocations, on how portions of their budget would be spent in their cities, shifting the decision-making power from the administrators and the politicians

to the citizens. We have learned that many of our programs and many public sector innovations are of this same nature. Often these innovations are not grandiose, top-down schemes, but very simple introductions of a new practice or a new idea into an existing activity. For example, let us take Community Voice, a program started in the city of Seattle. This program simply took the problem of homelessness and came up with a way to provide voice mail services so that people who are homeless but are looking for housing and jobs could have a phone number and a voice mail box to mask their homelessness. This program was then replicated in a number of other cities, and is now operating in virtually all major U.S. cities. It has also been introduced, in varying forms, to countries around the world.

Another critical aspect of innovation that we have identified and studied is the element of leadership in innovation. Often innovators in either the public or private sector face significant barriers in introducing new ideas and getting them implemented, getting the political support necessary to sustain them. Of course, a large part of our work is devoted to the replication of innovation, the dissemination of innovation. In a survey conducted last year, we learned that the majority of innovations successfully adopted or adapted in other locations required or involved the personal involvement of the original innovators. For example, had you been one of the people to create the Community Voice Mail Program, it would have been necessary for you to speak directly with people in other interested cities to answer their questions. We learned that it was not sufficient simply to write a nice paper about the innovative program, publish it, or have oneself written up in a newspaper. What was necessary was that kind of interaction Bill Mitchell spoke of this morning, for people to sit around a table or connect by video conferencing, to talk about their problems and to exchange information.

In terms of this dissemination challenge, a couple of years ago the Ford Foundation endowed us, and we went from being a program about innovation in American government to being an Institute with a worldwide focus. Our mandate has been to stimulate dissemination of innovation on a worldwide basis so that an innovator in Porto Alegre who designed and implemented participatory budgeting could communicate with someone, say in Lahore, Pakistan, who was interested in that model, helping to make that transfer occur. So how have we attempted to do that? Clearly, the Internet is how we are going to achieve this. We will continue to have the traditional face-to-face seminars and workshops, as well as visiting scholars and funded research. However, to achieve this worldwide dissemination of innovation, my job is to create what we are calling a Global Innovators' Network. To do this, we are working in very close partnership with the other eight awards programs from nations around the world. In fact, I was just meeting with representatives from each of them last week in Brazil. That was the second meeting we have all held in the last six months.

So let me quickly describe this Global Innovators' Network. I will start with a survey, a thirty thousand feet up view of it , and then we will get down to the specifics. We envision it as having two broad components -- an informational component and an interactive component. The informational

component is along the lines of a traditional portal designed to furnish information, cases, best practice information, articles, papers, and other forms of research about public sector innovation or new ideas. However, as we have been discussing here today, it is not enough simply to post something on the site, enabling people to search, find and read. We want to be able to bring people together around that information, not merely as information consumers, but also as information producers. For this reason, we are adopting the Communities of Practice model, particularly the version of it developed by Etienne Wenger. Some of you may know him or of him. He is one of the people who have done significant work in studying and designing Communities of Practice, particularly in the private sector. In his work, he has tried to integrate the same two components we are trying to integrate, information and interactivity

On the information side, early last year we formed a partnership with the Development Gateway Foundation. Development Gateway was started by the World Bank about three years ago to promote the creation and sharing of knowledge throughout the developing world. Its leading component is a medical portal consisting of many vertically organized and separate sections or portal sites. What we are doing is developing a portal called Innovations for Development that is searchable both horizontally and vertically. In other words, you could search vertically within all the content that we have placed on it, or horizontally across all the other twenty-six specialized topics being developed by other organizations like ours. These other organizations provide content in areas such as ICT for Development, poverty, health, urban development, etc. This portal accommodates multiple languages so, for example, our site has content in Chinese, Spanish, French, Portuguese, and English. You can navigate it in several different languages thus far, configuring it so all the instructions and features are in different languages. Our role in this is to serve as researcher and as a filter, and also to post. We do this in collaboration with others at Harvard and with our eight partner organizations. W continuously struggle with the challenge of how best to organize and present the information. We already have over seven hundred subscribers for our portal, and the overall portal has over sixty thousand subscribers. I would not be surprised if some of you are already subscribers to Development Gateway.

Now the challenge for us in the Global Innovators' Network is to integrate the informational artifact with interactivity. Again, we are working with the Development Gateway Foundation, and they have developed a set of interactivity tools. We will test these tools, bringing people together for discussions around a very discreet, specific topic and using the portal as informational support and as the publishing venue for information produced by these communities. Again, the challenge is to develop and coordinate the relationship between information production and information consumption.

Online Conversations in International Leadership
Institute of International Education

Presented by Judith Babbitts
Assistant Director
Hubert H. Humphrey Fellowship Program
Washington, D.C.

First, let me tell you something about the Institute of International Education (IIE). IIE is one of the oldest and largest international-education exchange organizations in the world. It was founded in 1919 and today has offices in 13 countries around the world. It administers about 250 programs, among them the Fulbright Program, which is probably the best known to all of you. IIE's programs are funded by the U.S. government and governments in other countries, foundations, corporations, and individual donors. Most of the funds go directly to students and professionals for educational exchange opportunities.

As I listen to the rest of you, I believe I am a bit of an anomaly here today because I don't represent a university with students who engage in virtual learning, but an organization that highly values physical mobility and the exchange of people across cultures. IIE, like other such exchange agencies, has been slow to get involved in online education or virtual mobility. We do not have very many initiatives in these areas. At the same time, however, most of our programs have online applications and we do conduct online preparation for exchange experiences. We also have offered virtual conferences in Asia to support our Fulbright scholars there.

We are, however, developing two projects that incorporate the use of the Web for learning and online exchanges. One is in the process of seeking funding, and the other will be launched in a few weeks with the Hubert Humphrey Fellows who are here in the United States.

The first project grew out of an idea that Dick Larson and the Council for the International Exchange of Scholars (CIES), the group within IIE that administers the Fulbright Program, had to assist Fulbrighters who wanted to maintain linkages with their institutions overseas. Some of them wanted to establish collaborative online courses or master's degree programs; others simply wanted to pursue other avenues of exchange with faculty members abroad. IIE has an Alumni Initiatives Award through which Fulbright alumni, both Americans and foreigners, can compete for grant money to establish just these connections. When the awards-selection committee funded a few of these e-learning proposals, they learned that faculty members needed substantial help in developing their collaborative online projects. It was then that LINC and CIES developed the idea of bringing the principal investigators, including the faculty member from the college overseas along with the U. S. faculty person, to M.I.T. to learn about the technology needed to initiate their virtual projects. At M.I.T., the grantees would also explore ways to make their projects

sustainable over the long term. Such sustainability is critical for host universities to embrace such projects, for it provides administrators with some assurance that the project will continue after the initial, two-year seed funding from IIE. As I said earlier, this initiative is still seeking a source of support and has not yet been implemented.

The other project I want to tell you about is one that we designed for the Hubert H. Humphrey Fellows. The Hubert Humphrey Fellowship Program is a division of the Fulbright Program. It was founded in 1978 by President Carter to bring mid-career professionals from the developing world to the United States for one year of non-degree study and practical experience. This year Fellows are placed on 15 different university campuses around the country depending on their professional fields. They take courses to upgrade their skills and knowledge and then spend six weeks learning from and sharing their skills with their U.S. counterparts at a host organization they select, either a governmental agency, a non-profit organization, or a private-sector enterprise. Fellows are placed on campuses in a cohort of seven to fifteen men and women from around the world, and study and interact with each other throughout the year. They repeatedly tell us that one of the most important experiences of their fellowship is working with their international peers, a diverse group like themselves whom they would never encounter back in their own countries.

The initiative IIE developed was designed to capitalize on the Humphrey Fellows' unique experience of living and learning together. Because my previous professional experience had included designing and teaching online courses for the University of Maryland University College, I was able to put together a 10-week online session on leadership for a small group of Fellows. The workshop topic was leadership because that is the overall focus of the Humphrey Fellowship Program, developing national, regional, and international leaders. On their host campuses, Fellows develop leadership skills, but as some of you may know, there is much discussion in academia about whether you can actually teach leadership in a classroom. We want to do something different in this online workshop. We want to create a space for Fellows to reflect on what leadership means in their own national contexts, as opposed to what Americans think about leadership, which often tends to be a perspective from the corporate or executive-management world.

Soon, we will have 27 Fellows, all volunteers, participating in this pilot project of learning asynchronously online. We have several goals for this project. We want the Fellows to feel comfortable taking web-based courses when they return home so they might continue their own professional development in this way. Above all, we want to give them more opportunities to share solutions to common problems from their own cultural backgrounds. In addition to discussions about leadership, they will devise case studies of problems or an issues they foresee when they go home, and have their colleagues serve as "advisory-board members" in helping them explore strategies to tackle them. And finally, some Fellows have told us that they want to implement online learning back home for the people they work with, most of whom have never learned at a distance before. These Fellows would like to acquire the skills of facilitating discussions online. We'll try to incorporate

many low- tech strategies for online learning so that Fellows will feel comfortable working in small groups, having online discussions, and communicating with each other in this new "virtual" way.

Through this program, we hope to learn about transnational, online pedagogies for working with mid-career professionals, as opposed to 18 year-olds in university settings. We also hope to discover ways we might adapt this methodology for other workshops for Humphrey Fellows and alumni. IIE maintains a database of our more than 3,000 alumni around the world, and we would envision offering variations of this leadership workshop for them. We realize that to make this project successful, we will have to think about, and incorporate, different cultural traditions in both learning and teaching. We believe, however, that this kind of cross-cultural experience will give us a great deal of information about how people can collaborate online from many diverse countries.

So as I stated when I began, although IIE has been slow in getting involved with online learning, I do believe that both of these projects hold the promise of teaching us things we might be able to share with other LINC members in the future.

(The Humphrey Leadership Workshop was enormously successful and was offered again to the class of 2003-2004. Several graduates of the first workshop facilitated discussions in the second year. The workshop thus became another way for the Humphrey Program to strengthen the Humphrey alumni network around the world.)

The MIT-Africa Internet Technology Initiative

Presented by Solomon Assefa
Ph.D. Candidate in Electrical Engineering and Computer Science
MIT

      Today I will be talking with you about the MIT-Africa Internet Technology Initiative (AITI). This project, conceived by a couple of us in 1998, was started in 1999 and began sending MIT students to Africa in the summer of 2000. AITI has several goals including an increase in the utilization of technology in African high schools and universities, as well as development of long-term technical collaboration and cultural friendship between MIT and African high schools and colleges. The Initiative also serves to provide MIT students with a chance to serve in an international community -based project that enables them to use their very strong technical backgrounds to enrich educational opportunities in Africa. When we began, we were very lucky to get funding in the amount of $17,000 and were able to implement the program in one school in Kenya, Strathmore College. In the summer of 2001, with the same amount of funding, we decided to sustain the project by returning to the same school. In 2002, we wrote a number of proposals and were very lucky to get $50,000 from the Engineering Information Foundation (E.I.F.). That summer, we were able to implement the project in two schools in Ghana and two schools in Kenya.

      So just how have we implemented this initiative? During the MIT school year, we choose students who qualify and who also have had teaching experience, and we select them from all disciplines or majors. This past summer, we had 18 MIT students, including undergraduates and graduates, who traveled to African schools and taught six-week courses.   We offered a wide variety of courses, such as Java, JSP, ASP.net, and we also offered free-operating systems, such as Linux. The administration of the African schools had a say in what types of courses they would like to have offered. They were given a menu and they chose what they wanted the students to be taught. At the end of the six- week period, we gave exams to the students to see how much they had learned. In addition, we required that they do some community-based projects during the six-week course period, such as building web-sites for their school, or other community initiatives.

      As a result of AITI, we believe that MIT has had a huge impact over the last 3 years in these participating African communities. We have taught over 200 students and we have also made it an imperative to teach the teachers, in order to insure continuity. For this reason, we chose approximately five teachers from each of the colleges or high schools and we taught them at a higher level than the students. We have introduced them to cutting edge technology, and we have also made them familiar with the concept of open software, or free software. Furthermore, we have had a significant impact on the overall community through our work building community-based web pages. Some of our students have even obtained jobs in the local IT industry, and, for

me, that is a very pleasing result. We also provide MIT students with an experience of other cultures and give them the opportunity to use their technical background in the real world. AITI has even inspired alumni of participating African high schools to become involved with the project. For example, some alumni of one of the high schools, currently residing in the U.S., have formed their own group and they are building a database and web pages for their alma mater.

So what are the plans for the future? We have been lucky enough this year to receive funding of about $60,000 after writing a couple of proposals. The money this year is coming from the U.S. government and also from MIT. This coming summer, we actually will be adding one school and one university in Ethiopia, as well as sustaining the projects in Ghana and Kenya. We will have eight new MIT students, along with ten experienced students from last summer. We believe it is important to continue these students in order to insure they use their knowledge gained in Africa to successfully lead and implement community-based projects there. Looking even further ahead, we hope to increase our budget to $100,000 for the summer of 2004.

Many organizations have been involved in the success of AITI. Our mentor has been Professor Paul Gray, former President of MIT. We have had support also from foundations such as the Engineering Information Foundation, as well as from companies such as Africa on Line and 3Com. In addition to some private donors, we have had a tremendous amount of support from MIT, including the offices of the president and the provost, the office of the chancellor, the Graduate Student Office, the Sun Center, the Public Service Center, and the Academic Computing Center.

In summary, I have tried to show you that MIT-AITI is actually a very successful model. It certainly is scalable, in that we started out with one school, expanded to four schools last year, and will work with five schools this year. AITI is also a sustainable model, for we have done it for four years and are moving into our fifth year. In addition, this project has proven to be a model for other initiatives, such as the work I mentioned of alumni from the African high schools. Very important to AITI is its huge popularity with MIT students; for example, although we have only fourteen positions for the summer, we have received about one hundred applications for these positions.

The goals of MIT-AITI and the goals of LINC are closely related. As Professor Larson mentioned this morning, one of LINC's main goals is to expand and improve the use of IT for tertiary education. Certainly one way to achieve this goal is by actually involving technology students in developing countries and insuring that they have an impact in those countries. Another way is to build strong connections between institutions in developing countries and those in developed countries. For these reasons, LINC is a natural ally for AITI which until now has been a student-run organization. We have been looking for a home, and LINC will be an ideal fit for our model, enabling us to coordinate our MIT fundraising efforts with outside fundraising efforts, including foundations and companies. Furthermore, for those of us who are AITI veterans, partnership with LINC will make sure that our dreams stay on even after we leave MIT.

SECTION FIVE

STUDENT RESEARCH PROJECTS

The MIT-Africa Internet Technology Initiative

Presented by Solomon Assefa
Ph.D. Candidate in Electrical Engineering and Computer Science
MIT

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Tutorial Support for E-Learners
Through the Use of Cellular Phones

Presented by Junko Sugimura
Doctoral Student at Waseda University in Tokyo
Visiting Scholar at MIT

Today I would like to introduce the concept of supporting E-Learners through the technology of mobile phones. First of all, let me give you some of my own background. I have considerable experience with E-Learning, having been in both the student and teacher roles. My studies in Japan have centered around multimedia educational content creation. Right now I am very interested in researching various ways to support E-Learners in their educational process. Not only is it important to provide access to E-Learning for students, thus increasing the numbers of these virtual learners, but it is equally important to discover ways to maintain their initial motivation so they can achieve their ultimate goal.

Yesterday at this conference, many speakers discussed various aspects of using the Internet for educational purposes. My interest is to think of ways to make the experience of E-Learning more convenient and supportive for virtual learners. My research focuses on providing high quality mentoring/tutoring services for these students, employing the technology of mobile phone Internet connectivity. So our challenge is to establish a system of providing support to E-Learners using streaming video over cellular phones. My plan is to begin this program first in Japan and later in several Asian areas, where mobile phone technology and use is growing extremely fast. With this system, students can study any where and any time.

Before moving on to explain my plan, I would first like to talk about mobile phone usage in Japan. Young people in Japan use mobile phones for just about everything: connecting to the Internet; sending and receiving e-mail; downloading MP3 music; navigating directions; and taking digital photographs and even movies. Recent statistics show that 65% of all Japanese people use mobile phones and that they use these phones to conduct 80% of their email correspondence and 20% of their Internet use. Another interesting statistic is the fact that 92% of Japanese university students use their mobile phones during class, probably sending e-mails since this populations does 80% of its e-mailing via mobile phones. This age group in Japan conducts 80% of its computer activity through cellular phone technology and only 40% through P.C.'s. In terms of virtual education, this means that Japanese university-age students could easily combine their use of mobile phones and computers in a virtual education system that would be user-friendly and supportive.

My plan is to develop a P.C.- style interactive video tutoring system employing mobile phones. I am designing and developing such a system

through the MIT Center for Educational Computing Initiatives (CECI) under the direction of Professor Larson. As envisioned, this system would provide 24-7 use, employing streaming video over the Internet to deliver virtual textbooks, physics simulations, practice problems, along with educational mentoring and tutoring.

**Creating a Network of Academic Collaboration
Among Universities Both in the U.S. and Abroad**

**Presented by Nebibe Varol
M.I.T. Doctoral Student in Operations Research**

I would like to introduce the work that I carried out last semester with Professor Larson as part of an initiative to create a network of academic collaboration among universities both in the U.S. and abroad. To do this, I will briefly present some cases that we have been involved with. We initially scaled down this concept of cross-institution academic collaboration to a manageable, scaleable undertaking by seeking collaboration solely around an Operations Research course taught here at M.I.T. This course is taught by three professors, including Dr. Larson, and is called Urban Operations Research. It mainly deals with quantitative techniques, putting emphasis on applications in transportation systems analysis and applications in the design and planning of logistically oriented urban service systems such as fire and police departments, emergency medical services, and emergency repair services. The main aim of our initiative was to create a Web-based system that would enable the sharing of knowledge and material related to urban services by creating Internet cross-links among different institutions all over the world.

Initially, we tried to find contacts from different parts of the world, attempting to reach professors who either teach a course related to urban services or who have done research in this area. This was probably the most time consuming step in our work. We had to search through the Web, sending e-mails all over the world, and then wait for responses and wait to be directed to the right person. The existence of an organization interested in LINC- related activities would undoubtedly have helped us reach the related persons much more quickly. In the end, we focused our efforts on finding urban operations research cases from developing countries, thus finding real life problems to motivate the MIT Operations Research students. We wanted to offer them the chance to apply their analytical techniques to real life problems, while at the same time providing them with new insights into the kinds of urban operations research problems that exist in other parts of the world. We also wanted to form discussion groups on the Web, to let students at MIT discuss and compare their solutions with students in different parts of the world. This type of initiative matches up exactly with what LINC supports -- that is collaboration and cooperation across international borders with the goal of using technology-enabled education to provide quality higher education to learners everywhere.

As a result of our extensive Web search, we had positive feedback from different practitioners and professionals around the world. I would like to present three cases, from Turkey, Iran and Russia. The case from Turkey was presented to us by Istanbul Technical University. It concerns the expansion of existing health care facilities into the poor squatter settlements

of the city. Health care services differ with respect to quality in different districts in Istanbul, and the service capacity is not distributed in proportion to the district population. This health care situation has been aggravated by the unplanned growth of squatter settlements over the past several decades, due to rural to urban migration and to unusually rapid urbanization. These squatter settlements are spontaneous developments built solely with the resources of the inhabitants who have no legal claim to the land on which they are built. The settlements lack network and infrastructure, and they are usually inhabited by people of low socioeconomic status. They cannot be torn down completely due to some pressing political and social concerns, and the healthcare needs of the inhabitants are not being met by Istanbul public institutions. This is why the government currently faces a tremendous challenge to provide some health care services to these squatter settlements. In this case, the goal for our MIT students was -- working over the Internet in collaboration with Turkish students -- to find the optimum locations for new health care facilities, so as to attain a uniform distribution of health quality throughout the Istanbul districts.

The second case was from Sharif University of Technology, Teheran. Iran is located in the alpine Himalayan belt, one of the most active volcanic belts in the world and one that has experienced major earthquakes -- claiming thousands of lives, destroying many cities, and causing extensive damage to property. Although earthquakes pose significant threats to life and property, they cannot be prevented. However, effective measures can be taken in order to reduce loss of life and damage to property. The goal in this case was to create an online academic collaboration employing Operations Research techniques to determine the optimal location of rescue stations, enabling rescue teams to respond as quickly as possible in case of an earthquake.

The third case was from Russia. It involved the supervision of mobile objects, and the students' Operations Research focus here was the creation of a local radio positioning system for a set of mobile objects whose number ranges between 30 and 300. Each object was to carry a micro-transmitter responder for defining its position within a time period of a few seconds. According to our Russian academic collaborators, such local radio positioning systems have many interesting applications, for example, the supervision of migrating animals, the revisualization of some sports competitions, and the management of local transportation systems.

In conclusion, I would like to stress that the development and growth of LINC would make this kind of international, academic collaboration far easier to undertake.

Guided Learning Pathways

Presented by Lincoln Chandler
Doctoral Student in the MIT Operations Research Center

Today I want to share a little bit about the research that I have been working on since about June of last year. It is entitled "Guided Learning Pathways," or G.L.P. In this research, I seek the answers to some basic questions. The first question is: "how do we improve the quality of the educational experience?" The second question that I am interested in as a researcher is: "how do we increase access to the quality educational experience?" The answer to this is a key part of my research because if education is truly one of our most valuable resources, then why not structure these new initiatives so they are available to as many people as possible.

First I would like to talk about G.L.P., about the motivation for this research and give a conceptual definition of "Guided Learning Pathways." I will also speak a bit about the need for broad collaboration in making this initiative a reality. It is in fact this need for collaboration that prompted a second stream of activities -- activities on which I worked with Nebibe Varol who spoke earlier this morning, -- to get a better sense of what it would actually take to make these collaborations happen. The encouraging results of our efforts conducted last fall reveal a tremendous opportunity to answer both of the questions I posed earlier, and also underscore the serious need for an initiative like LINC.

To understand my motivation for doing research on something like G.L.P., you need only look as far as your average undergraduate classroom. I am sure that many of you, as educators, are familiar with the traditional educational model -- that is, many students served by only one curriculum. Now based upon what we know about students, in any population of learners you would expect to find different learning styles. Some people prefer to begin with abstract concepts and then move down to concrete examples, while others need the examples, with their more visual cues, to stimulate an understanding of the overall idea. This situation becomes even more complex in fundamental first year university courses, such as first year physics, for example. In these types of basic courses, you have large numbers of students, including many different academic majors and many different motivations for taking the course. You have a situation where the large number of enrollees is made up of students who are taking the class for different reasons, seeking different things from the material and planning to use the material in different ways. So what do you do? The compromise that a good instructor typically makes is to take the best- fit approach; you design a curriculum that speaks to as many students as possible. Such a curriculum covers a broad range of topics, but unfortunately because of constraints of time, the topics are usually covered at a minimal level of depth.

Now I have had several classes like this. I certainly remember the model where you have students who study for the test, pass the exams, pass the finals with "A's", and then after six months are unable to recall anything! I am sure you all have seen this because it happens a lot. Many experts believe that this is the result of a "one-size-fits-all" learning. You end up with non-committal short term learning, and as I found out when I came back to graduate school, this is very poor preparation for the graduate school experience where you have to commit more to the learning process and take a more vested interest. The idea behind G.L.P. is basically that if we could introduce more variety into educational curriculums and speak more directly to the individual needs of the learners, then there would be a greater opportunity to engage those learners and ultimately to foster a richer learning experience. I think of Guided Learning Pathways as a learner-based model having two main tenets. The first is that rather than thinking of courses in their entirety, we should consider the elements of a typical course at their most atomic level, looking at each element individually. The second tenet is that the order in which these various elements are to be presented to an individual student should be determined at some level by information we have gleaned from that individual learner.

A simple version of this learner-based model would be a classroom where a homework problem set is assigned, but rather than everyone doing the same ten problems there would be thirty problems to choose from. Student could pick a sub-set of those problems to test their own knowledge. Now at a very simple level, this is somehow allowing the learner to take charge of his or her own educational experience, perhaps investing in it a little more. Stepping the model up a few notches, let us think about it in a more abstract version. At the most abstract level, imagine that a course is broken down into each of its individual problems, lectures, visual aids, course graphs, etc. and that each of these elements is a separate node in a very large computer network. Each of these nodes would carry a series of attributes and describe the content within. Now, imagine that a learner enters who could in theory use this information as a roadmap to guide himself from the start to the finish of the course. This is what motivates the terminology, "Guided Learning Pathways." We want to design a system such that given start and end points, individuals could use information in their own personal preference index to motivate their own progression through the educational experience. Now, as you may imagine, this level of interactivity and variety in the curriculum is much more easily conceived than actually achieved.

To introduce any real variety into the course material, the kind that would be necessary to fully implement G.L.P., there would most certainly need to be an increase in the amount of material available to use. So perhaps the most basic question of all is: "where does all this extra content come from?" This is where the value of collaboration comes in. If any one institution were to be left to its own devices in creating this kind of new content, a tremendous investment of money and time would be involved. Not to mention the fact that any one university undertaking this new type of

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content would be limited by the resources of its faculty in the amount of variety they could attain. Therefore, in most instances you are not going to get a whole lot of variety if all the people from one institution are generating all this extra content. However, if you work in concert with other institutions and share your learning content, there is a much greater opportunity to achieve new perspectives, new teaching methods, and new material.

We now arrive at a second question raised by this research: "where do we find the collaborators?" It is this question that motivated the second phase of my research. Last fall, I set out with the goal of gaining a better understanding of what it really takes to identify potential collaborators for such an extensive effort. That is when I joined Nebibe Varol in an effort to gather and create supplemental materials for the MIT course, Urban Operations Research. The entire Urban O.R. text , along with the entire course content, has been online for several years. However, up until recently there was no well-defined mechanism in place to gauge how or where the content was being used. Now, with the recent launch of MIT Open CourseWare, the Urban O.R. web site and its content are even more accessible to the global community. In the interest of targeting our search for interested collaborators, we developed a bi-focal strategy. First, we installed a web statistic service to understand where visitors to the site were located geographically. Then, to complement the data that would come from that service, we also installed a survey on the web site, allowing users to post comments about the course material and to provide any information about themselves.

These web site services have been in place for a little over three months, but the data has already begun to provide a very telling story about the potential reach of this sort of collaboration. To get a sense of the breadth of content of the Urban O.R. web site, there have been over 5,000 unique hits in the past three months and the visitors who have logged onto this site represent six continents, including seventy countries. In addition, we have had over four hundred responses to the survey during this three-month period. As you can see, this represents a huge breadth of content, attained in only three months of research. Who knows what sort of valuable data and potential collaborations we have been missing up until now?

With regard to new content for the Urban O.R. course obtained through the web-site, Nebibe has already spoken earlier about some of the case studies that were received. In addition, eight professors from universities in the United States, Canada, and overseas have submitted links to their course materials, opening up their resources to students in the Urban O.R. class. Given the considerable volume of traffic we have seen on this web site, it is not unreasonable at all to assume that there may be many more interested collaborators out there. However, the issue today is how do we go about finding them in a targeted way. In this regard, an international, educational initiative like LINC would be of immeasurable value to my research. Rather than a bottom-up search for potential collaborators, an initiative such as LINC could provide a dedicated forum for discussion of these collaborations and educational issues within a global arena. The net

effect would be a structured and more inclusive approach to improving the world's educational outlook.

In conclusion, my research is guided by two key ideas: given the current state of education, I am interested in improving both the learning experience, and also improving access to quality education. It is my opinion that creative initiatives such as LINC and Guided Learning Pathways offer us a chance to essentially change the traditional, passive educational experience. We can change the classroom to invest more in the learner and we can change the scope of our efforts to extend beyond the local classroom, across countries and even continents. By combining these two ambitious initiatives, we can quite possibly change the educational world.